TRABAJO DE FIN DE GRADO

Grado en Odontología

TÉCNICAS DE ELEVACIÓN DE SENO MAXILAR MÍNIMAMENTE INVASIVAS

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RESUMEN:

Hasta hace poco, la mayoría de los procedimientos de elevación de seno realizados por los cirujanos bucales eran engorrosos y conllevaban un alto riesgo de posibles complicaciones, como infecciones, hemorragias y otras complicaciones postoperatorios.

La aparición de nuevas técnicas mínimamente invasivas hicieron que el procedimiento sea más cómodo para el paciente y el clínico.

Estas técnicas van desde el uso de tecnología piezoeléctrica hasta el uso del propio implante para elevar la membrana sinusal pasando por diferentes fresas atraumáticas como las fresas DENSAH, SCA kit, CAS kit o MISE, por trefinas y sistemas hidráulicos tales como el balón.

Se trata de técnicas mínimamente invasivas de abordaje crestal que pueden ser utilizadas incluso en situaciones con una altura de hueso residual muy limitada (3 mm).
Al contrario que con la técnica tradicional de Summers con la que solo se puede conseguir 3-4 mm de altura, con estas técnicas es posible una ganancia de más de 10 mm.

Son técnicas las cuales proporcionan numerosas ventajas pero de las que todavía son necesarios más artículos con una muestra de pacientes más alta para asegurar su superioridad frente a las técnicas clásicas.

ABSTRACT:

Until recently, most sinus lift procedures performed by dental surgeons were cumbersome and carried a high risk of potential complications, such as infection, bleeding and other postoperative side effects.

The emergence of new minimally invasive techniques made the procedure more comfortable for the patient and the clinician.

These techniques go from the use of piezoelectric technology to the use of the implant itself to elevate the sinus membrane through different atraumatic drills such as DENSAH drills, SCA kit, CAS kit or MISE, through trephines and hydraulic systems such as the balloon.

These are minimally invasive crestal approach techniques that can be used even in situations with very limited residual bone height (3 mm).
In contrast to the traditional Summers technique where only 3-4 mm of bone height can be achieved, with these techniques a gain of even more than 10 mm is possible.

They are novel techniques which provide numerous advantages but for which more articles with a larger sample of patients are still needed to ensure their superiority to the classical techniques.

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I. INTRODUCCIÓN

La sustitución de los dientes perdidos mediante implantes dentales es una buena opción de tratamiento con un alto grado de éxito. Se han descrito diferentes técnicas en cuanto a la colocación de implantes debido al desarrollo del campo de la implantología y al creciente número que han sido colocados (1).

Para la colocación de cualquier implante es necesario disponer de una cantidad mínima de hueso y este debe ser de una calidad adecuada para que pueda haber una correcta osteointegración y el implante perdure en el tiempo. Sin embargo, la perdida dentaria conlleva una reabsorción ósea y esta puede ser debida a múltiples causas. Para autores como Atwood y Coy, Mercier, Zarb, Fallschüssel y Misch, (2) estas causas pueden ser: Causas mecánicas (factores funcionales, factores prostodónticos, factores químicos), causas inflamatorias como puede ser la enfermedad periodontal o causas sistémicas o metabólicas como serán la edad, sexo, balance hormonal. En resumen ocurre por mecanismos multifactoriales (2).

Debido a la cantidad de ocasiones en las cuales a veces no tenemos una correcta disponibilidad ósea es necesario llevar a cabo algún procedimiento de aumento óseo previo a la colocación del implante. Centrándonos en la región de los dientes antrales, la colocación de implantes puede verse comprometida por su cercanía con el seno maxilar. En ocasiones se realiza lo que denominamos elevación de seno maxilar.

Debido a la proximidad del seno maxilar (SM) al área de trabajo del odontólogo, es de vital importancia conocer la anatomía para prevenir futuras complicaciones en la cirugía, al igual que realizar la evaluación preoperatoria del tratamiento con implantes de forma correcta.

I.1. Anatomía del seno maxilar.

El seno maxilar (SM) o antro de Highmore, es el más grande de todos los senos paranasales (frontal, etmoidal y esfenoidal). Existen cuatro pares de senos paranasales, denominados cada uno de ellos en función del hueso en el que se encuentren. Se trata de espacios llenos de aire revestidos por mucosa respiratoria la cual es ciliada y secreta moco. Se encuentran en contacto con las cavidades nasales y son inervados por ramas del nervio Trigémino (3).

La nariz junto con los senos paranasales forman una unidad funcional, además de ser una parte integral del tracto respiratorio. Se encargan de realizar diferentes funciones, calienta y humidifica el aire inspirando preparándolo para el óptimo intercambio de oxígeno y dióxido de carbono. Llevan a cabo funciones inmunológicas y homeostáticas compartidas con las vías respiratorias superiores e inferiores (4). Además de llevar a cabo funciones fonatorias y olfatorias.

Los senos maxilares, uno a cada lado, llenan completamente los cuerpos del maxilar. Tienen forma piramidal con el vértice dirigido lateralmente y la base en la pared lateral de la cavidad nasal adyacente (3).

El desarrollo del seno maxilar comienza en la semana 17 de vida intrauterina. En el momento del nacimiento existirá una cavidad rudimentaria de un volumen de 60-80 mm^3. El crecimiento del seno es proporcional al crecimiento de los huesos faciales. La altura del seno aumenta hasta los 18 años, mientras que por el contrario, el ancho y la longitud alcanzan proporciones adultas a la edad de 12 años (4). Las mediciones del seno maxilar en adultos varían significativamente entre diferentes estudios, siendo el rango de dimensiones: de 38 a 45 mm de largo, de 25 a 35 mm de ancho y de 36 a 45 mm de alto. El volumen promedio del seno maxilar en múltiples estudios ha sido de 150 mm3, con un rango de 100-250 mm3 (5).

La pared medial o base del seno maxilar está formado por el maxilar y por partes del cornete inferior y el hueso palatino que descansa sobre el hiato maxilar. La abertura del seno maxilar u *ostium* se encuentra en el meato medio, en situación anterosuperior y por encima del cornete inferior por donde drena hacia la cavidad nasal.
La superficie superolateral (techo) del seno maxilar se relaciona por encima con la orbita, donde se encontrará el canal y conducto infraorbitario. La tuberosidad del maxilar forma la pared dorsal, limitando con la fosa pterigopalatina, mientras que la apófisis alveolar y palatina del hueso maxilar formará el suelo del SM, pudiendo relacionarse con las raíces de dientes antrales (2,3)
En cuanto a la irrigación, el SM recibe el aporte sanguíneo a través de ramas que proceden de las ramas infraorbitarias y alveolares superiores de las arterias maxilares. Las ramas infraorbitarias y alveolares del nervio maxilar (V2) se encargan de la inervación de dicho seno (3).

El SM está revestido por un epitelio cilíndrico ciliado pseudoestratificado con células caliciformes formadoras de moco, llamado membrana de Schneider, cuyo grosor varía de 0,13 a 0,5 mm, pudiendo aumentar y fibrosarse, en proporción a distintas patologías. La mucosa se continúa con un tejido conjuntivo rico en fibras y con el periostio. En la pared medial de seno se producen corrientes ciliares que transportan las secreciones hasta el ostium de salida (2). Las células madre situadas en la capa perióstica de dicha mucosa tienen potencial osteogénico por lo que tendrán un papel muy importante en la curación de injertos óseos colocados mediante procedimientos de elevación de seno maxilar (4).

I.2. Indicaciones y contraindicaciones de elevación del seno maxilar.

En la mayor parte de los casos, la restitución de dientes en el sector posterior del maxilar suele enfrentarse a problemas específicos para la colocación de implantes dentales ya que como se ha mencionado anteriormente el hueso que se encuentra en esta zona tendrá un volumen inadecuado. Esta falta de volumen estará relacionada con el tamaño del seno maxilar así como con la reabsorción de la cresta alveolar. Esto han dado lugar a tasas de éxito menos favorables que en otras regiones de la boca.

Durante los últimos 25 años se han desarrollado procedimientos quirúrgicos con el objetivo principal de incrementar el volumen óseo local permitiendo así la colocación de implantes de más de 8 mm de longitud. En aquellos casos en los que la falta de volumen óseo este relacionado con un seno maxilar agrandado, se propone la realización de un elevación de seno maxilar (7).

La elevación de seno maxilar es un procedimiento quirúrgico que consiste en incrementar verticalmente la cantidad de hueso en esa región elevando la membrana de Schneider.

Es por ello que este procedimiento estará indicado en áreas edéntulas de la región posterior del maxilar con hueso inadecuado para la colocación de implantes facilitando así la rehabilitación con implantes en pacientes con atrofia maxilar severa posterior. Se ha establecido una clasificación en relación al grado de neumatización y atrofia o reabsorción de la zona diferenciándose cuatro grados. Clasificación de Salagaray y Lozada (8):

- Grado I: altura del segmento maxilar subantral igual o superior a 10 mm (no hay necesidad de elevación)

- Grado II: altura del segmento maxilar subantral menor de 10 mm y mayor de 8 mm.
- Grado III: altura del segmento maxilar subantral entre 4 y 8 mm.
- Grado IV: altura del segmento maxilar subantral inferior a 4 mm.

En los grados II, III y IV será necesaria la realización de algunas de las técnicas para ganar hueso en sentido vertical (8).

Como cualquier procedimiento, existen también unas contraindicaciones. Por ello se debe realizar una adecuada selección de casos. Entre las contraindicaciones encontramos (9):

- Sepsis.
- Enfermedades sistemas descontroladas.
- Trastornos psicológicos.
- Drogadicción y alcoholismo.
- Tabaquismo importante.
- Pacientes sometidos a radiación en el territorio maxilofacial.
- Pacientes en tratamiento con quimioterapia.
- Paciente en tratamiento con bifosfonatos o fármacos que alteren el metabolismo óseo.
- Rinosinusitis aguda o crónica.
- Tumores maxilares o del seno maxilar.
- Quistes de retención de gran tamaño.
- Cuerpos extraños en el interior del seno.
- Rinitis alérgica.
- Fístulas oroantrales.

- Alteraciones del seno como trastornos de la función de la membrana sinusal o estrechamiento del complejo osteomeatal.
- Inadecuada relación de los rebordes alveolares.
- Enfermedad periodontal activa.

Muchas de estas alteraciones pueden tratarse y solucionarse para conseguir así una situación de salud y en ese momento sí que podría ser posible la realización del procedimiento.

Por otro lado, en aquellos pacientes en los que este contraindicado la realización de elevación del seno podrían utilizarse otras opciones terapéuticas. Podrían utilizarse implantes cortos siempre y cuando la cantidad de tejido óseo fuese suficiente o incluso insertar los implantes en otras localizaciones como pueden ser los implantes pterigoideos, cigomáticos o aquellos que se insertan en la tuberosidad del maxilar (11).

Además, se pueden llevar a cabo diferentes procedimientos de aumento óseo y aumentar así el reborde alveolar (injertos en bloque, regeneración ósea guiada y distracción alveolar osteogénica)(10).

I.3. Evolución de la elevación del seno maxilar. Breve repaso desde los orígenes hasta la actualidad.

Hasta hace unos años, la rehabilitación de espacios edéntulos en la zona posterior del maxilar con implantes dentales suponía un gran reto en cirugía bucal. Fue a partir de los años 70 cuando se comenzó a discutir la posibilidad de rehabilitar esta zona con implantes osteointegrados en casos con escaso hueso alveolar (9).

En los años 60, Philip Boyne utilizó por primera vez el injerto óseo en el seno maxilar con el fin de aumentar el volumen del tejido óseo. Para corregir la disminuida altura del hueso residual se realizó un abordaje tipo Caldwell-Luc, se elevó la membrana sinusal y se colocó en el suelo del seno un injerto compuesto por hueso autógeno particulado medular. Esta técnica fue presentada por H. Tatum en el año 1977. En 1980 P. Boyne y R. James publicaron una técnica quirúrgica con acceso por la pared lateral del seno, para permitir la colocación de implantes. De nuevo, Tatum en 1986 publicó dos técnicas de aumento vertical del piso antral: la técnica de abordaje por la pared lateral del seno con colocación simultánea de implantes y otra técnica de acceso crestal (12).

La técnica que con más frecuencia se ha utilizado y por tanto la que mejor se ha descrito en la literatura con el paso de los años es la conocida como elevación de seno con ventana lateral o elevación traumática (9).

Este procedimiento consiste en realizar una ventana en la pared anterolatreal del seno permitiendo así la entrada y el relleno de la cavidad antral (9). Para comenzar el

procedimiento se realiza una incisión crestal. Se levanta un colgajo a espesor total lo que hace que se exponga la pared lateral del seno maxilar. Se realiza una ostectomía haciendo una ventana en la pared anteroexterna del seno y la membrana se Scheider quedará expuesta. El hueso de la ventana ósea se utilizará como nuevo suelo del seno maxilar. La membrana se separa cuidadosamente de las paredes del antro maxilar creando un espacio para el aumento de seno. Introducimos el material de injerto y lo insertamos firmemente mientras que el colgajo mucoperióstico cerrará la ventana.

Se requiere un tiempo de espera de 4-9 meses, según los biomateriales empleados, para la colocación de los implantes y se pueden conseguir más de 10 mm de ganancia ósea (2).

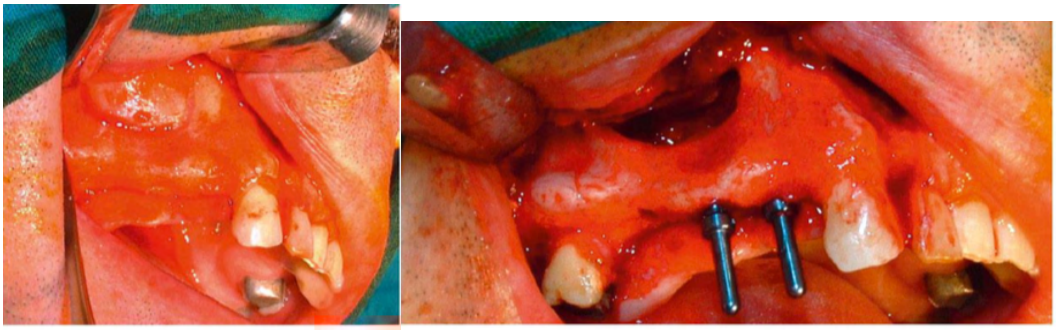


Figura 1: Diseño de la ventana lateral a la izquierda y ventana realizada a la derecha (2).

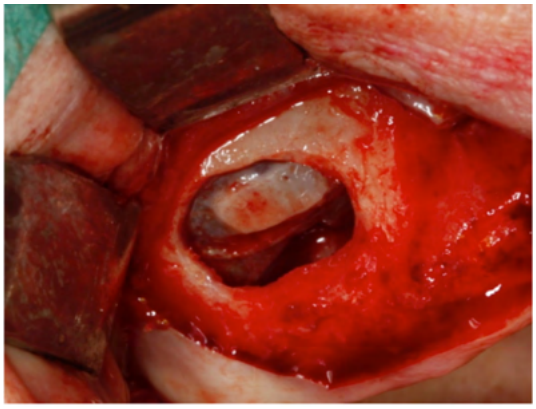


Figura 2: Ventana ósea para la elevación del seno maxilar (9).

Tatum describió otra técnica de elevación utilizando lo que se llama ``socket formers´´ (de acceso crestal) pero fue en 1994 cuando Summers perfeccionó esta técnica utilizando osteótomos dando lugar a una técnica menos traumática (9).

Esta es llamada elevación atraumática o de acceso crestal cuyo procedimiento básico implica una incisión donde se ha planeado la inserción del implante y se levanta un colgajo a espesor total para exponer la cresta alveolar. En la técnica clásica se realiza una osteotomía manual llegando al suelo del seno maxilar. El diámetro de los osteótomos será progresivo y serán accionados con ayuda de un martillo de esta forma se consigue la elevación de la cortical del suelo del seno junto con la membrana de Schneider. Se realiza la colocación simultánea del implante. Se requiere una altura mínima de hueso residual hasta el suelo del seno de 5 a 6 mm. La ganancia ósea vertical suele ser de 3 a 4 mm y la técnica alcanza una supervivencia de los implantes del 92,8-96% a los 5 años. (9, 2).

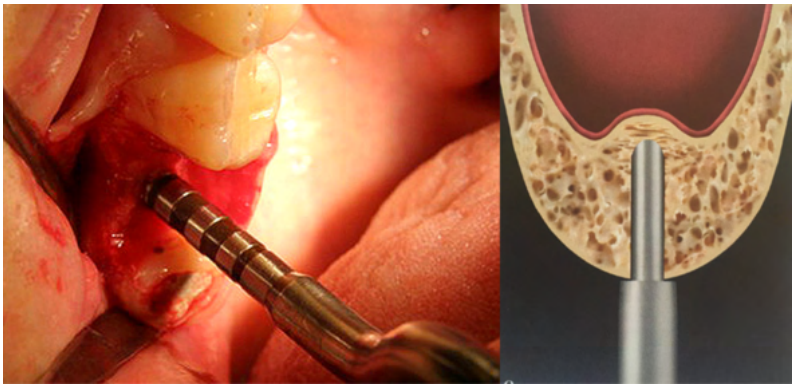


Figura 3: Elevación del seno maxilar con osteótonos (9).

Tradicionalmente la elevación del seno traumática es utilizada en casos de reabsorción mas severos mientras que la técnica atraumática quedará reservada para casos más leves en los que se necesite menos ganancia de volumen óseo.

Muchos autores han realizado clasificaciones que nos ayudan a decidir que procedimiento llevar a cabo. Una de las más sencillas es la propuesta por Misch en la que en función de la cantidad de hueso disponible en altura y en anchura se decide que tratamiento que se realiza (13):

- Altura > 12 mm → colocación de las fijaciones más anchas y largas posibles.
- Altura entre 10-12 mm → elevación de seno atraumática y colocaciones inmediata de implantes.
- Altura entre 5 -10 mm → elevación de seno traumática y colocación diferida de los implantes a los 2-4 meses.
- Altura < 5 mm → elevación de seno traumática diferida de los implantes a los 6-10 meses.

Estos dos procedimientos descritos son las dos técnicas clásicas que se han llevado a cabo en todos estos años. Pero como se sabe, el mundo de la implantología avanza a pasos agigantados hacia nuevas técnicas cada vez menos invasivas o evolucionando y modificando las ya existentes. De esta forma, hoy en día disponemos de técnicas más novedosas y menos traumáticas que van a ser comentadas en este trabajo.

I.4 Complicaciones y riesgos.

Unas de las complicaciones más frecuentes derivadas de esta técnica de elevación del seno maxilar es la perforación de la membrana de Schneider. En el caso de la técnica abierta es de un 25% y en el caso de la técnica cerrada de un 3,8 % (2). En ocasiones esta tasa es inferior debido a que la técnica, al ser cerrada, es una técnica ``ciega´´ y no se verán las perforaciones pasando estas inadvertidas.

Se ha visto que existen varios factores que pueden potenciar la perforación de membrana. La disminución del grosor de la membrana al igual que una compleja morfología del seno puede complicar el procedimiento. El tabaquismo, además de comprometer la cicatrización y la supervivencia del implante también se ha visto que se trata de un factor de riesgo para la perforación intraoperatoria. Aquellos pacientes que presenten tabiques sinusales también tienen más riesgo de perforación ya que la adhesión de la membrana es más fuerte en estos tabiques (14).

Otras complicaciones aunque menos frecuentes, que pueden ocurrir durante el procedimiento son las hemorragias intensas. Estas suelen deberse a la lesión de alguna estructura adyacente. Es importante evitar dañar vasos sanguíneos, en la arteria alveolar posterosuperior sobretodo en la elevación del colgajo y la realización de la ventana intraósea (15).

En cuanto a las complicaciones postoperatorias, la más frecuente son las infecciones. Se suelen localizar dónde se encuentra el injerto óseo, es decir, por debajo de la membrana

sinusal. La infección del seno propiamente dicho no es tan común aunque la sintomatología es mayor (9).

En el caso de la elevación de seno con técnica abierta las infecciones suponen un 3 %, mientras que en el caso de la técnica cerrada suponen un 0,8 % (2).

Otra de las complicaciones que puede aparecer tras la elevación del Seno Maxilar, es el vértigo postural paroxístico benigno (BPPV), un trastorno del oído interno caracterizado por episodios breves y repentinos repetidos de sensación de giro producidos por cambios en la posición de la cabeza. En cirugías que involucran el área maxilofacial y dental, se cree que la causa es una combinación de un período prolongado de posición supina o caída directa de partículas de polvo óseo en la cóclea y el desplazamiento de otolitos durante procedimientos quirúrgicos debido al potencial traumático de las técnicas quirúrgicas (uso del martillo y cincel)(16). Es por esto por lo que solo se han reportado casos de BPPV en la técnica crestal o de Summers (17).

Con las nuevas técnicas mínimamente invasivas se intenta no dar golpes con un martillo por lo que se evita la aparición de dicha complicación.

II. OBJETIVOS.

El objetivo de este trabajo es conocer y describir las diferentes técnicas que tenemos en la actualidad para la elevación del seno maxilar que sean mínimamente invasivas.

Como objetivos secundarios, se pretende analizar cada una de ellas conociendo la ganancia ósea que se consigue, las complicaciones intra y post-operatorias, la supervivencia de los implantes y las ventajas y desventajas de cada una de ellas.

Esto nos llevará a discutir cual de ellas son las más seguras, eficaces y utilizadas.

III. METODOLOGÍA

Se ha realizado una búsqueda bibliográfica en buscadores específicos. Se utiliza Pubmed, desde dónde se ha accedido a la mayoría de los artículos consultados. También se ha utilizado los materiales proporcionados por la Biblioteca Dulce Chacrón CRAI. Otras páginas consultadas han sido The Cochrane Collaboration y Medline. En páginas como OVID o Journal of Evidence-Based Dental Practice se han realizado búsquedas pero sin encontrar muchos resultados.

La búsqueda fue limitada a los últimos 15 años, en los idiomas inglés y español. Se seleccionó la opción *Full Text Availability* para poder acceder a su lectura. Las palabras claves utilizadas han sido: *sinus lift, maxillary sinus augmentation, minimally invasive maxillary sinus lift, Intralift,*

Para los datos históricos y conceptos teóricos invariables en el tiempo he suprimido el rango de antigüedad para poder acceder a un mayor número de documentos.

Los artículos fueron excluidos en su mayoría porque estaban basados en estudios en otros animales como el cerdo, se centraban en consecuencias de la elevación de seno como el vértigo posicional paroxístico benigno o se centraban en la explicación de biomateriales lo cual no es la finalidad de este trabajo. Solo se admiten aquellos artículos en los que se expone de forma clara las diferentes técnicas mínimamente invasivas al igual que la técnicas clásicas. Nos centraremos en aquellas publicaciones encontradas que aportan datos sobre las ventajas de cada técnica y los resultados que han obtenido con ellas.

IV. RESULTADOS Y DISCUSIÓN

Con el fin de conseguir menos complicaciones e intervenciones menos cruentas, hoy en día disponemos de técnicas mínimamente invasivas, siendo estas menos traumáticas y con mayor probabilidad de éxito.

Actualmente hay una gran cantidad de técnicas y dispositivos nuevos con el fin de facilitar tanto la cirugía como el postoperatorio de los pacientes. Debido al gran número de instrumental y procedimientos disponibles, se va a organizar la discusión en los siguientes apartados, con el fin de agrupar de forma mas sencilla todas las técnicas: sistema piezoeléctrico, sistemas hidráulicos , en diferentes fresas atraumáticas, trefinas y técnicas con las que se consigue la elevación del seno maxilar con el propio implante.

a. Sistema piezoeléctrico. Intralift®, HPISE.

Comenzando con el sistema Intralift®, este utiliza tecnología piezoeléctrica, que junto con un kit especifico de puntas de ultrasonido permiten realizar la elevación del seno maxilar por presión hidrodinámica. Se trata de una técnica atraumática, mínimamente invasiva y de abordaje crestal. En 2001, Vercellotti (18) propuso una técnica de elevación basada en el uso de ultrasonidos. Posteriormente, se demostró que este último era mínimamente invasivo para la elevación del suelo del seno maxilar. En la misma línea, en 2012, Troedhan (19) desarrolló un levantamiento del seno ultrasónico hidrodinámico llamado Intralift®. Este sistema fue diseñado para elevar la membrana sinusal sin ejercer ninguna fuerza de desgarro sobre ella.

La pequeña preparación con la que se accede al suelo del seno maxilar, se realiza a nivel de la cresta ósea empleando el kit de puntas Intralift® (Puntas TKW 1, 2, 3, 4 y 5). Este equipo

consta de unas puntas cilíndricas diamantadas que van ampliando el diámetro de la preparación progresivamente hasta llegar a la última la cual eleva la membrana sinusal (20).

Figura 4: Puntas Intralift para elevación del seno maxilar (20)

Cada punta ultrasónica tiene un diámetro y expulsa un caudal de irrigación determinado, además se aconseja seleccionar una potencia de vibrado especifica para cada una de ellas. El protocolo a seguir es del siguiente: (20)

- Se comienza con la primera de las puntas denominada TKW 1 destinada a la perforación inicial cuyo caudal de irrigación está entre 70-100 ml/minuto.

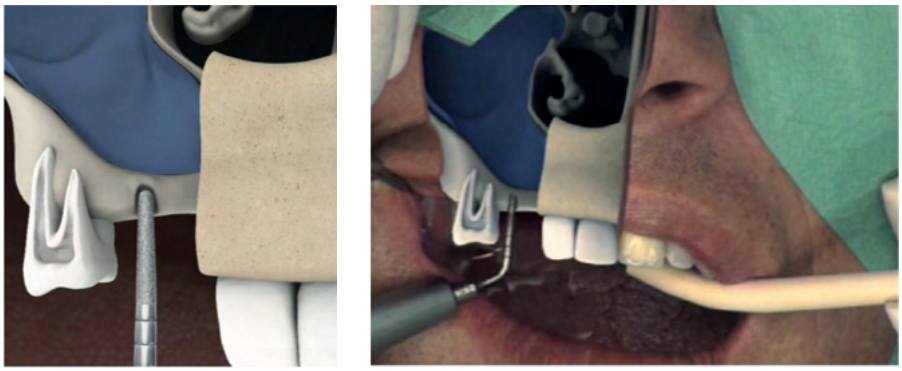


Figura 5: Perforación inicial con punta TKW 1 Intralift.(21).

- A continuación se emplean las siguientes puntas TKW 2, TKW 3 y TKW 4 cuyo caudal de irrigación es algo inferior a la primera punta y se encargan de realizar la perforación preliminar para alargar el conducto de acceso a la membrana de Schneider.

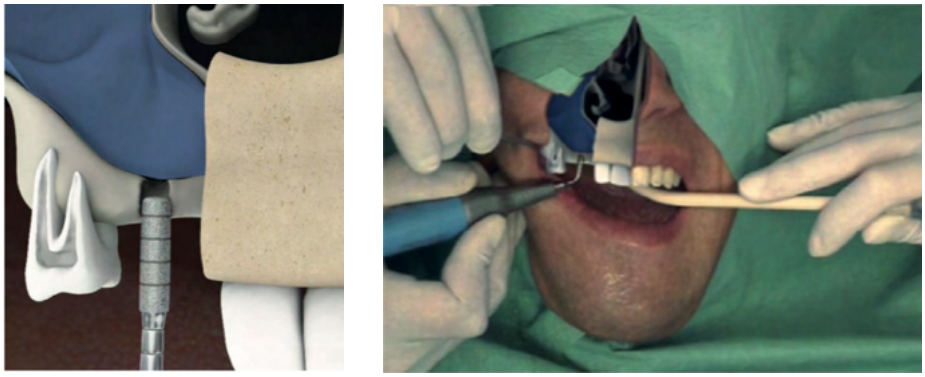


Figura 6: Preparación de la cresta alveolar con punta TKW 4 (21)

- Finalmente con la punta TKW 5, la cual es una punta no diamantada, se eleva la membrana de Schneider gracias a la presión hidrodinámica del suero estéril que sale desde su interior con un caudal de irrigación de 30-40 ml/minuto.

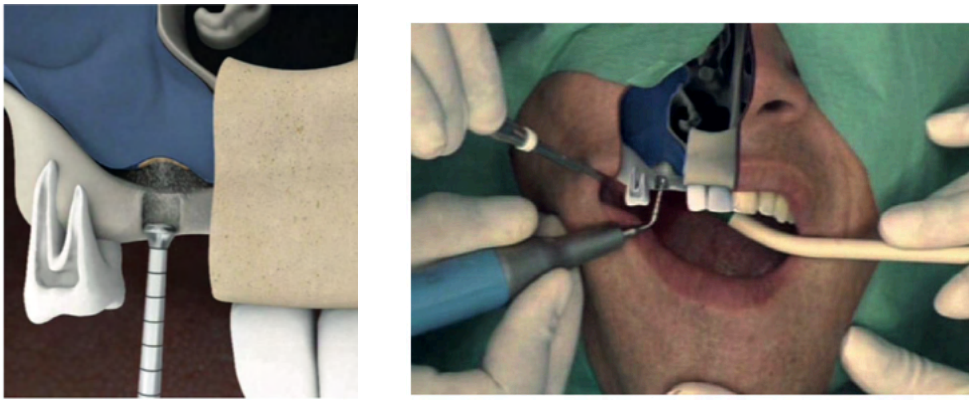


Figura 7: elevación de la membrana sinusal con punta TKW 5 (21).

- Tras la elevación del seno maxilar con la propia punta TKW 5 se coloca el implante.

Gracias a la modulación de la frecuencia ultrasónica, el riesgo de daño de la membrana es limitado.

Según el articulo ya citado de Troedhan (19), tanto el caudal de irrigación como el tiempo de exposición están relacionados con la cantidad de espacio creado. Así mismo, un caudal alto trae consigo un aumento del riesgo de rotura de la membrana de Schneider. Así todo, en cuanto a la perforación de la membrana sinusal, el uso de la presión hidrodinámica es más segura en comparación con la técnica cerrada de Summers. Se trata de una técnica poco invasiva ya que el acceso es pequeño (3mm) y no necesita instrumentos adicionales, aunque después el acceso de ensancha para colocar el implante que es siempre mayor de 3 mm. Además, durante el proceso de elevación no se aplican fuerzas de desgarro a la membrana, sino que se aplica una presión uniforme, incluso en los márgenes, zona muy delicada donde la membrana sigue unida al piso óseo (19).

En cuanto a la situación de partida en la que se puede utilizar esta técnica, entendiéndose como altura de hueso residual, Julien Llopet (18) colocó 11 implantes en cadáveres cuando la altura era de 9 mm, mientras que, tanto en los artículos de Angelo Troedhan (21,23) como en el de Rocío Velázquez-Cayón (22) los milimetros de hueso residual era de 4 mm o menos. La altura de hueso alcanzada con este técnica llegó a ser de 17 mm en uno de los artículos de Troedhan (23), una ganancia media de 10,7 mm de hueso. Sin embargo, en otro de sus artículos, las exploraciones con CBCT a los 4 meses de la intervención revelaron un aumento hasta 16,3 mm en cortes transversales y 16,8 mm en cortes sagitales (21). A los 7 meses se redujo dando lugar finalmente a una altura de 14,6 mm en cortes transversales y 14,7 mm en cortes sagitales.

Respecto a la colocación de los implantes y al material de relleno, tanto en un primer articulo de Troedhan (21) como en el caso expuesto por Rocío Velázquez-Cayón (22) en su articulo, se insertó material de injerto óseo para mantener el volumen conseguido con la elevación y se esperó 8 meses para colocarlos en el caso de Troedhan y entre 5 y 7 meses en el caso de la Dra. Velázquez-Cayón. En un segundo articulo de Troedhan (23), de los 637 implantes que se colocaron, 302 fueron insertados de forma inmediata mientras que los 35 restantes fueron colocados 7, 92 meses después de la elevación concluyendo que la colocación del implante al igual que el material de relleno quedaría a elección del profesional que realizase la intervención.

Algo importante para saber si una técnica es segura o no para el pacientes es conocer las complicaciones intra y postoperatorias que pueden surgir. Julien Llopet (18) comparó la técnica Intralift® con la técnica clásica de Summers y observó que la complicación postoperatoria de perforación de membrana es inferior con el sistema piezoeléctrico que con la técnica de Summers ya que de 11 elevaciones que realizó ninguna condujo a perforación mientras que con la técnica de Summers dos de ellas si lo hicieron. En el articulo de 2012 de Troedhan (21), donde se llevaron a cabo 14 elevaciones de seno y en el caso de Rocío Velázquez-Cayón (22) se realizó un seguimiento de los pacientes por si sufrieran algún dolor, hinchazón , sangrado días después de la intervención y no ocurrió ninguna complicación postquirúrgica sospechosas de perforación de membrana. En su siguiente articulo, Troedhan (23), de las 446 elevaciones se observaron directamente o mediante la maniobra de Valsalva, 25 perforaciones de membrana (6%) . Sin embargo, los cirujanos del dicho estudio decidieron proceder con un injerto subantral y solo se perdieron 2 implantes (0,31%) .

Otro técnica que funciona con un sistema piezoeléctrico es el llamado HPISE. A diferencia de otras técnicas, esta no requiere un osteótomo para la fractura del suelo del seno. HPISE rompe el suelo del seno con vibración piezoeléctrica y eleva la membrana del seno usando presión hidráulica, sin compactación ósea (24).

Se trata de un procedimiento muy similar al anteriormente explicado. Comienza con una incisión a espesor total para exponer la cresta ósea. Se introduce una primera punta redonda de carburo de tungsteno de 1,6 mm de ancho , con irrigación externa y conectada al dispositivo piezoeléctrico. Esta punta consigue romper el suelo del seno maxilar a la vez que se va controlando la profundidad ya que tiene líneas indicadoras a intervalos de 2 mm (24).

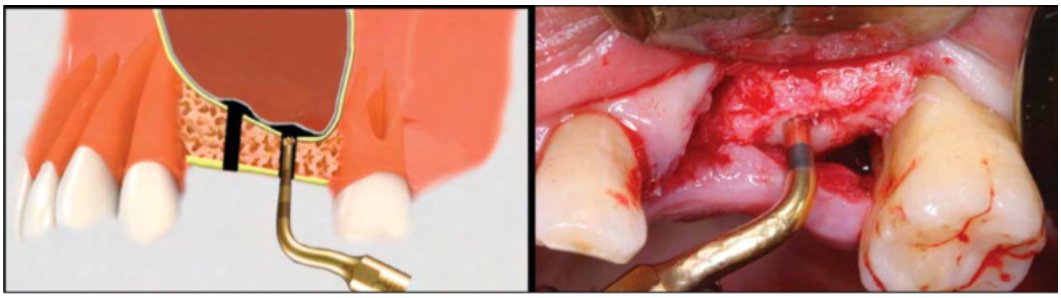


Figura 8: Invasión del seno maxilar con la primera punta redonda de 1,6 mm (24)

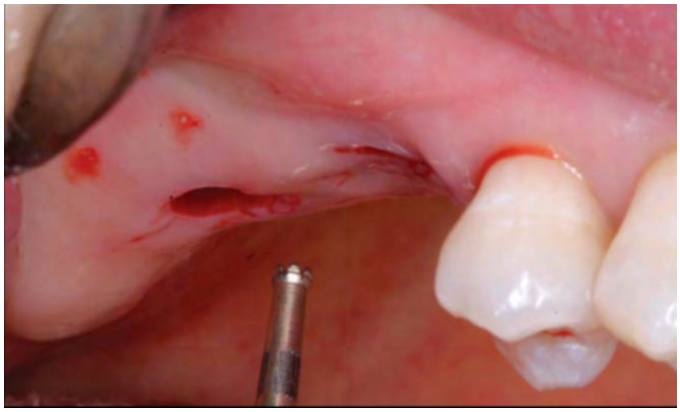


Figura 9: Primera punta redonda (25).

Después de romper el suelo del seno con la punta redonda, se inserta una punta cilíndrica de 2,8 mm de ancho para ampliar el sitio de la ostetomía y elevar la membrana sinusal mediante presión hidráulica por irrigación interna de suero estéril (24).

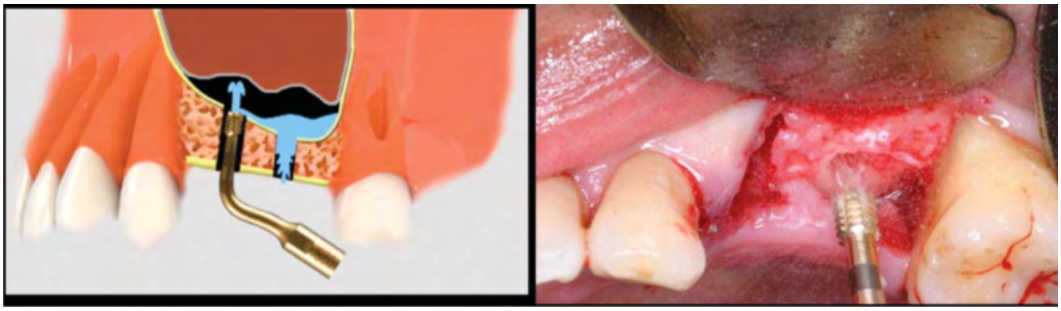


Figura 9: Punta HPISE elevando la membrana sinusal mediante presión hidráulica (24).

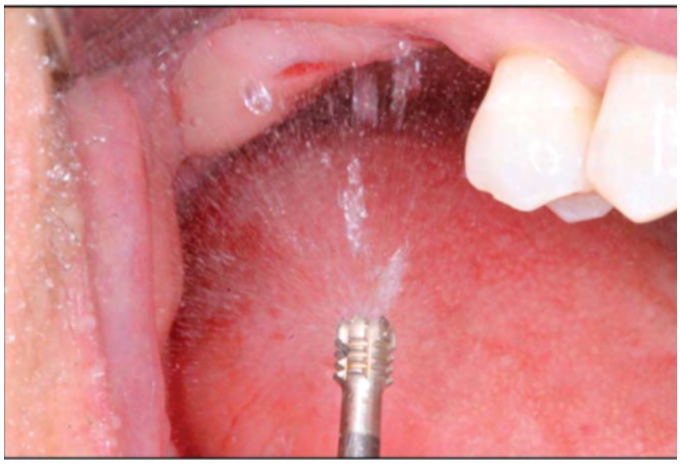


Figura 10: Punta HPISE (25).

Por último se comprobara la integridad de la membrana y se decide si es necesaria la colocación de material de injerto óseo para la posterior inserción de los implantes (24).

Ji-Min Kim realiza dos estudios en los que utiliza esta técnica para elevar la membrana sinusal. En el primero de 2012 (24) realiza 250 elevaciones a 224 pacientes con una altura previa de hueso alveolar de 6,14 mm de media, sin embargo en el segundo de 2014 (25), la altura de la que parte es algo inferior de 4,98 mm de media en sus 11 elevaciones de 10 pacientes. Hyung-Ju Lee (26) realiza 114 elevaciones en 103 pacientes siendo la altura inicial de 6,18 mm de media, por otra parte, Mohan Wang (27), el cual realiza un estudio para comparar la técnica de ventana lateral con la técnica HPISE, practica 14 elevaciones de seno en 8 pacientes con una altura residual media de 3,81 mm.

La ganancia de altura fue en torno a 5-5,5 mm en el primer articulo de Ji-Min Kim (24), Hyung-Ju Lee (26) y Mohan Wang (27), siendo 5,49 mm, 5,7 mm y 5,27 mm respectivamente, llegando en algún caso a ser de 10,5 mm. En el segundo artículo de Ji-Min Kim (25) la ganancia fue algo superior, 8,23 mm de media.
En todos los casos la colocación de los implantes fue inmediata. En cuanto al material de relleno, en todos los casos se colocó y además, Ji-Min Kim (24,25) optó por utilizar en mucho de sus casos un coagulo de fibrina con factores de crecimiento autólogo obtenido mediante la centrifugación de la propia sangre del paciente.

En cuanto a las complicaciones, en el primer articulo de Ji-Min Kim (24) se produjeron 10 perforaciones de membrana en 353 sitios de implantes lo que supone un 2,83% y un total de 11 implantes fracasaron, siendo por tanto la tasa de éxito de 97,2 %. En su segundo

artículo (25) no se produjo ninguna complicación. En el caso de Hyung-Ju Lee (26), de los 169 implantes fracasaron 8 por perforación de la membrana sinusal (2 implantes) como por falta de estabilidad primaria (6 implantes), siendo el éxito del 95,8 %.

Cuando Mohan Wang (27) compara la técnica de ventana lateral con la técnica HPISE en su articulo, los pacientes refieren menos hinchazón y dolor con el sistema piezoeléctrico. 6 de los 8 pacientes en los que se realizó la ventana lateral sufrieron dolor mientras que solo 1 de los 8 pacientes en los que se llevo a cabo la técnica HPISE sufrió dolor

b. Fresas atraumáticas. Oseodensificación, SCA kit, MISE, CAS kit.

El uso de fresas llamadas atraumáticas también se considera otra técnica mínimamente invasiva para la elevación del seno maxilar. Existen diferentes técnicas y kits de fresas con los que conseguir una mayor cantidad de hueso para la colocación de implantes.

Unas de ellas son las fresas de Oseodensificación (Densah). Como ya sabemos, la estabilidad primaria de los implantes depende de la cantidad y la calidad del hueso, el diseño del implante y de la técnica quirúrgica empleada (28). Una estabilidad primaria disminuida, puede provocar defectos de estabilidad secundaria, es decir en la osteointegración (29).

Durante el proceso de osteodensificación de estas fresas, el hueso es compactado durante la perforación y por tanto, el torque de inserción del implante aumenta por densificación de las paredes del sitio de la osteotomía. La fresas densificadoras, constan de un cincel de corte y un largo vástago que permite aumentar progresivamente el diámetro a medida que se profundiza en la osteotomía. Además estas fresas se pueden accionar en dos direcciones de rotación, en el sentido de las agujas del reloj y en sentido anti horario. Cuando estas giran a la derecha, es decir igual que el reloj, cortan con mucha precisión dejando una osteotomía circular, es por ello que se utilizará en hueso de mayor densidad. Por el contrario, cuando giran hacia la izquierda, son capaces de oseodensificar, es decir, no sacar hueso de su interior sino depositarlo en las paredes y en el ápice de la osteotomía, creando junto con el suero una onda (presión hidroneumática) que ayudara a la elevar la membrana de Schneider sin dañarla. (30,31).

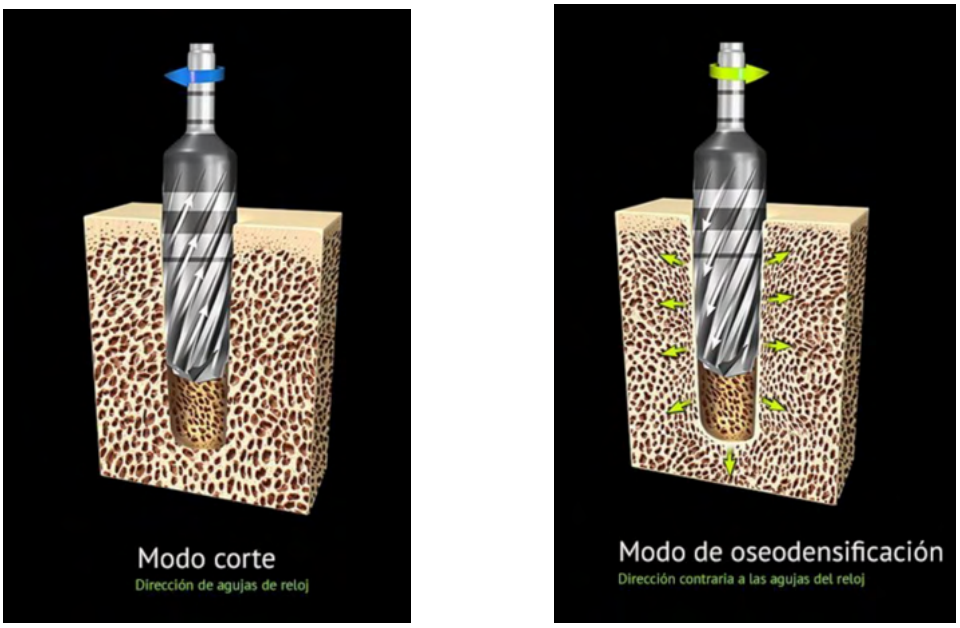


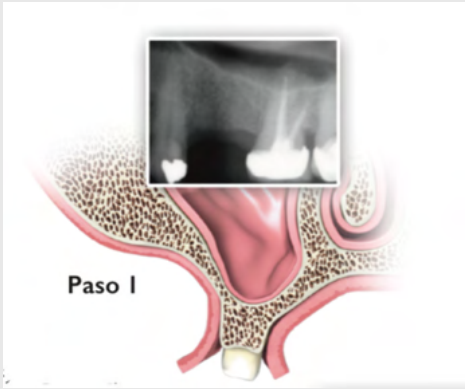
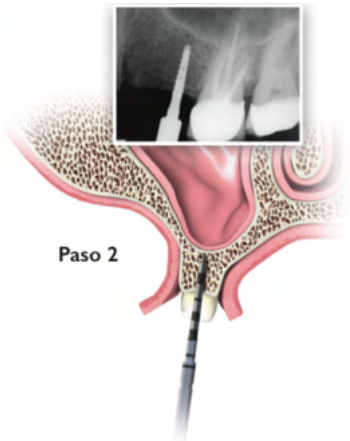
Figura 11: Fresas Densah en sus dos modos (31)

La osteodensificación es una técnica que implica la deformación plástica del hueso que se crea por contacto deslizante y rodante de una fresa densificadora de tal manera que compacta el hueso con una mínima elevación de calor (32).

Esta técnica se desarrollo en el año 2013 por el Dr. Huwais (33) quién empezó a utilizar estas fresas estriadas de diseño especializado que ayudan a densificar el hueso mientras preparan el sitio de la osteotomía, permitiendo aumentar la densidad ósea en el área periimplante y mejorando la estabilidad mecánica del implante (32,33).
Las fresas se utilizan a alta velocidad (1200 rpm) en sentido contrario a las agujas del reloj con un riego externo constante de suero fisiológico.

El aumento de la densidad ósea es un factor crítico para garantizar la estabilidad primaria del implante. Esta técnica se introdujo para el aumento horizontal en las crestas alveolares

estrechas, pero también se puede utilizar para ganar altura vertical con una elevación del seno interno mediante un abordaje transcrestal con las técnicas descritas en las siguiente tabla (32).

Técnica de osteodensificación para elevación de seno transcrestal
Paso 1: medir la altura del seno maxilar.    *Figura 12: Paso 1 (31)*
Paso 2: utilizar fresa piloto en el sentido de las agujas del reloj estándar hasta 1 mm del suelo del seno maxilar.    *Figura 13: Paso 2 (31)*
Paso 3: utilizar siguiente fresa DENSAH de 800 a 1220 RPM en sentido antihorario

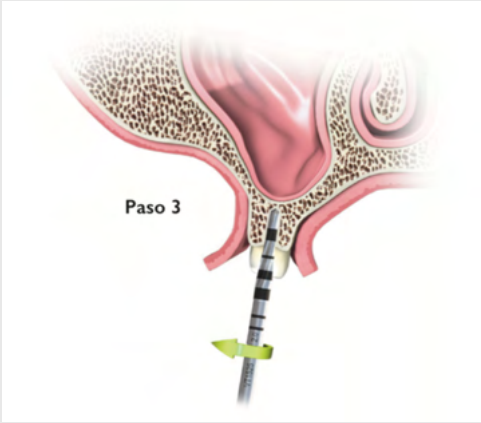


Figura 14: Paso 3 (31)

Paso 4: con fresa final se avanza más allá del suelo del seno a un máximo de 3 mm.

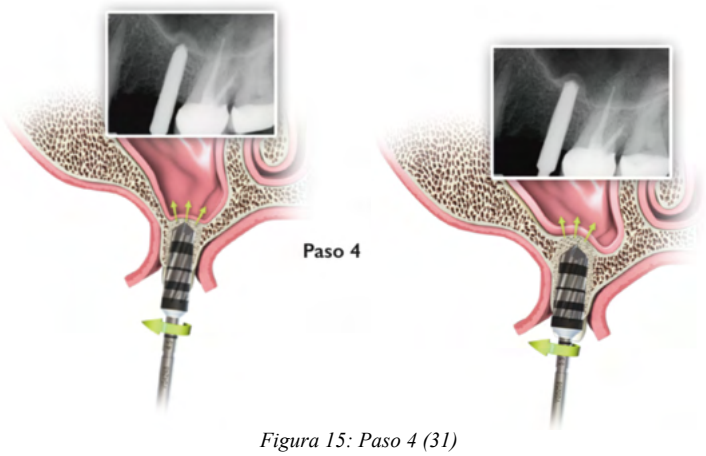


Figura 15: Paso 4 (31)

Paso 5: si la altura del hueso posterior es de 4 a 5 mm, agregar hueso al sitio de la osteotomía y avanzar la fresa (máximo de 3 mm) a una velocidad de 150 a 200 RPM. Colocar el implante.

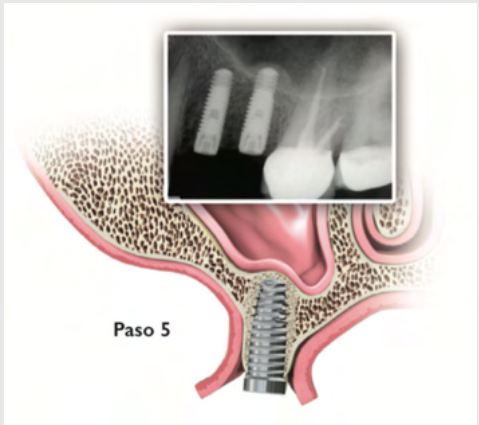


Figura 16: Paso 5 (31)

NOTA: siempre reducir el tamaño (diámetro) del lugar de la osteotomía de 0,7 mm a 1,0 mm con respecto al implante seleccionado.

De acuerdo con el protocolo DENSAH del creador (33), si se necesita una elevación adicional más allá de los 3 mm, se puede agregar un material de aloinjerto y empujarlo suavemente hacia el seno para lograr un aumento adicional de 2 mm en la altura. Se utiliza hueso esponjoso bien hidratado para rellenar la osteotomía en el lugar de la perforación del diámetro final y luego se pasa la última fresa DENSAH sin irrigación en sentido contrario a las agujas del reloj para propulsar el aloinjerto hacia el seno (32).

Se trata de una técnica relativamente novedosa por lo que no se han encontrado una gran cantidad de reporte de casos. Nilesh Salgar (34), ha encontrado en las fresas de oseodensificación un método para elevar la membrana del seno maxilar y conseguir así un mayor volumen de hueso. En su estudio llevado a cabo en tres pacientes, con un total de 5 implantes, tuvo una ganancia media de 11, 9 mm, llegando incluso en uno de los pacientes a conseguir un incremento de 13,6 mm, comparando esta técnica con la técnica de ventana lateral que como ya se sabe se utiliza cuando necesitamos elevar gran cantidad de milímetros. La situación inicial de la que partía era en todos los casos menos de 1,5 mm. Huwais, (35) utilizó las fresas DENSAH para la elevación del seno maxilar y la posterior colocación de implantes en un estudio llevado a cabo en 222 pacientes, un total de 261 implantes colocados. En este caso uno de los de criterios de inclusión era tener al menos una altura de hueso residual de 2 mm aunque la gran mayoría de los sujetos (75%) partían de 4 mm o más, por tanto la altura inicial era superior. En este caso, se consiguió ganar 7 mm de hueso.

La gran diferencia entre Nilesh Salgar (34) y Huwais (35), es que el primero de ellos, no colocó los implantes de forma simultanea si no que optó por material de injerto óseo y una

membrana dejando pasar unos meses hasta la inserción de estos. Huwais (35), por el contrario colocó los implantes el mismo día de la intervención en el 94 % de los pacientes.

Ninguno de los autores reportó ninguna complicación intraoperatoria ni ninguna perforación de membrana. Aunque la tasa de supervivencia de los implantes colocados por Huwais (35) fue del 97% ya que fracasaron ocho implantes, cinco a los 3 meses y tres a los 6 meses.

Para ambos autores, la clave del éxito de esta técnica tan novedosa es estar familiarizado con el sistema de fresas, planificar de forma adecuada la intervención y el entrenamiento del cirujano. Es un método que puede compararse con la ganancia conseguida con la ventana lateral pero con el beneficio de una menor invasividad.

Las ventajas de esta técnica son principalmente tres, la primera de ella es, como hemos dicho antes, obviar las desventajas del abordaje de ventana lateral y la altura crestal residual mínima adecuada necesaria para la técnica trancrestal de Summers. En segundo lugar, compactando el hueso como un autoinjerto en las paredes de la osteotomía, el implante mejora la estabilidad primaria. Y por último, se trata de una técnica para elevar el seno maxilar con muy bajo riesgo de perforación de membrana como podemos ver en los artículos consultados, en los que no se documentó ninguna (34).

Otras fresas atraumáticas que podemos emplear para la elevación del seno maxilar son las de la casa comercial Neobiotech. Encontramos dos kit diferentes, uno de acceso lateral (SLA kit) y otro de acceso crestal (SCA kit).

SLA kit de abordaje lateral de Neobiotech, se trata de un sistema con un kit de fresas atrumáticas para contra-ángulo. Por ello se trata de una técnica rápida y segura, que genera un mínimo sangrado y reduce la inflamación y el dolor (36). Estas son fresas podrían considerarse como trefinas pero presentan algunas diferencias con respecto a las convencionales. Estas tienen la periferia del área de contacto curva por lo que se mantiene en contacto con la cortical ósea y no con la membrana de Schneider. Además como se expresa en el articulo de Farré-Pagés (37), se reduce el tiempo del acto quirúrgico y se disminuye el riesgo de perforar la membrana de Schneider. También se reducirá el costo quirúrgico ya que el uso del kit y la colocación del implante se pueden realizar con el mismo contra-ángulo. Se trata de una técnica que puede causar controversia ya que al ser de abordaje lateral es más invasiva y por tanto no vamos a profundizar en ella.

Como hemos indicado con anterioridad dentro de la casa comercial Neobiotech, existen otras fresas de acceso crestal denominadas SCA kit. Este kit consta de una fresa piloto para marcar el abordaje, unas fresas S que se trata del instrumento principal del kit ya se que se encarga de crear un orificio en la pared cortical inferior del seno sin dañar la membrana.

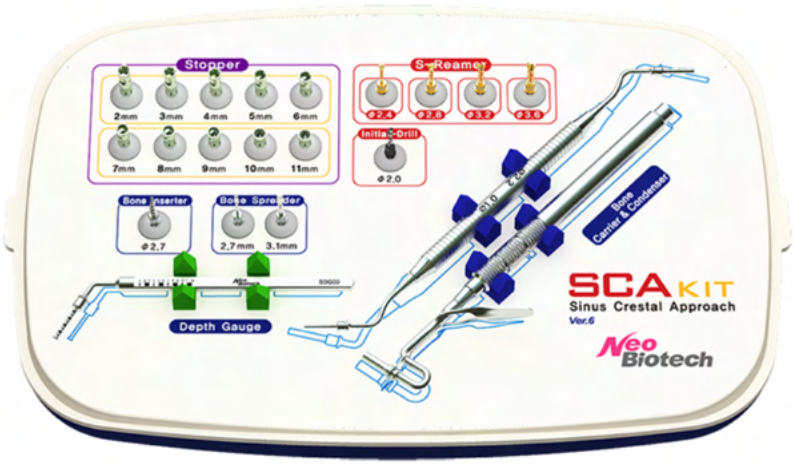


Figura 17: SCA kit de Neobiotech (38)

Existen diferentes diámetros de estas fresas, 2,4, 2,8, 3,2 y 3,6. Una parte muy importante de este kit son los *stoppers* que se utilizan para evitar la perforación de la membrana y por tanto se aplica a todos los instrumentos del kit. Dentro del kit también encontramos una sonda de medición, un transportador de material de relleno, un introductor y un condensador de hueso. También encontramos un distribuidor (extensor) óseo con el que extender lateralmente el hueso insertado (38).

Mediante un TAC, se mide la altura del hueso residual y se perfora a una profundidad 1 mm menor que la longitud del implante que se pretende colocar. A continuación, se perfora la pared inferior del seno maxilar con la fresa S, equipada con un tope 1 mm más largo que la fresa inicial. El S-Reamer tiene múltiples topes de perforación y varios diámetros. Una vez perforado el suelo del maxilar, se evalúa la altura del hueso residual con un medidor de profundidad. La ausencia de perforación se confirma con la maniobra de Valsalva. Si la membrana sinusal no está perforada, se coloca un injerto óseo con el portainjerto y condensador mientras se eleva la membrana del seno. Una vez completada la elevación de

la membrana del seno maxilar, se colocan en la zona implantes de diámetros y longitudes adecuados (39).

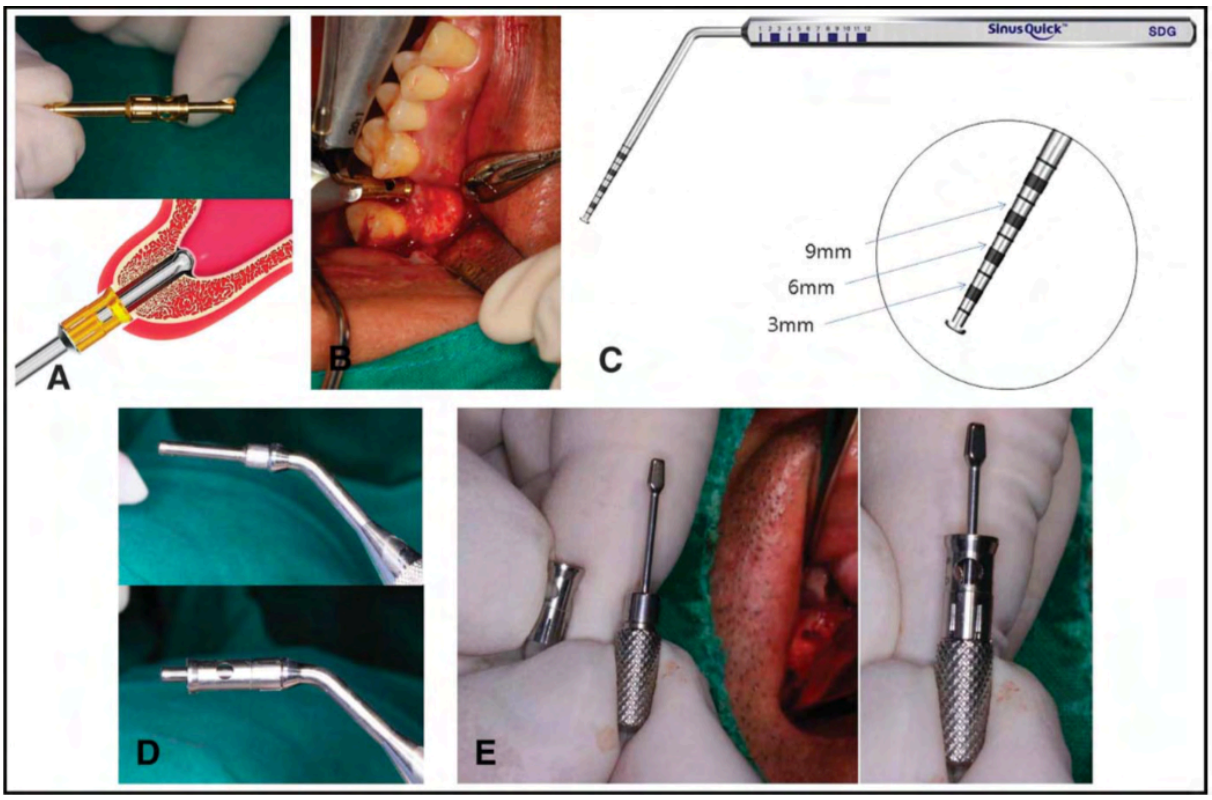


Figura 18: A y B, fresado hasta que el stopper contacte con la cresta del hueso alveolar. C, la guía de profundidad se inserta con cuidado para medir la altura de hueso alveolar. D, el condensador de hueso es utilizado para compactar el material de injerto óseo. E, con un distribuidor (extensor) óseo se extiende lateralmente el material de relleno (39).

La totalidad de los artículos encontrados sobre casos en los que se haya utilizado este sistema para la elevación del seno maxilar son procedentes de Asia , estando publicados en *Chinese Journal of Dental Research.* La altura residual de hueso antes de la intervención era de 4-7,8 mm mientras que la altura postquirúrgica era de 8-16,2mm en el caso de Kim YK (39). Por tanto, el volumen aumentado de la altura del hueso alveolar después de la cirugía osciló entre 2 y 9,2 mm con esta técnica, 5,81 mm de media. En el caso de Xian Zhou, (40), la altura de la que se partía era de entre 4 y 9 mm, una media de 6,4 mm. Se consiguió una ganancia de 2,8 - 7,4 mm, una media de 4,8 mm, algo inferior que en el

articulo anterior. En ambos casos se observó en las revisiones posteriores una perdida de volumen debido a la reabsorción posterior. Para Kim YK (39) esta disminución fue de 0,06 a 2,6 mm a los 6 meses y en el caso de Xian Zhou (40) fue de 0,61 mm a los 12 meses.

Ambos autores optaron por material de injerto óseo y colocaron los implantes de forma simultanea. La rehabilitación protésica se realizó 4-6 meses después de la intervención.

En cuanto a las perforaciones de membrana sinusal, ninguno de los autores las cometió. Tampoco ningún fallo en la osteointegración por tanto ninguno de sus implantes fracasó. Solamente uno de los pacientes de Kim YK (39) sufrió infección local después de la cirugía pero se resolvió con la toma de antibióticos, al igual que otro de los pacientes que a los 5 meses sufrió sinusitis pero con antibióticos, incisión y drenaje la situación se solucionó. Xian Zhou (40) introdujo un material de relleno con colágeno con propiedades antibióticas lo que podría haber reducido el riesgo de complicaciones infecciosas.

Continuando con el mundo de las fresas atraumáticas, encontramos también el sistema MISE (Minimal Invasive Sinus Elevation). Se trata de una técnica transalveolar que se realiza con instrumental rotatorio y calibrado en profundidad para no perforar la membrana sinusal (41).

El M.I.S.E. kit EVO es un sistema de fresas y topes que permite un levantamiento no traumático y gradual del seno maxilar hasta una altura de 5-10 mm por encima de la situación inicial, con una técnica sencilla, rápida y segura, suficientemente estandarizada para permitir un porcentaje muy elevado del éxito. La enorme ventaja frente a las técnicas tradicionales que utilizan osteótomos radica en el uso de topes de profundidad, que permiten un levantamiento gradual y perfectamente predecible (progresando 1 mm a la vez) de la membrana de Schneider, preservándola intacta y minimizando las molestias del paciente, especialmente en términos de el síndrome de vértigo paroxístico benigno que es inducido por las percusiones del martillo quirúrgico (42).

Colocar y quitar los topes es rápido y fácil y el protocolo es el siguiente: (43)

- Una primera fresa cilíndrica para realizar el orificio preliminar (2 mm del suelo del seno maxilar).

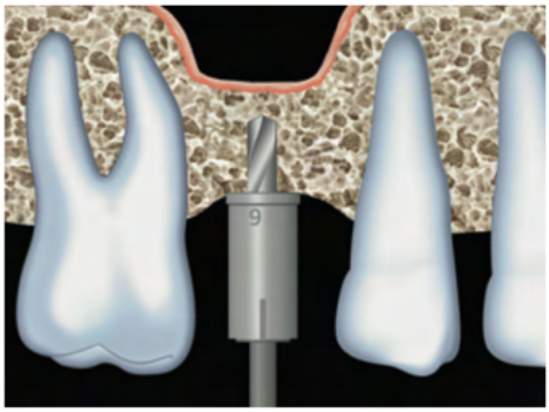


Figura 19: Fresado inicial con fresa de 2 mm de diámetro y a 2 mm de seno maxilar (43).

- Una fresa biselada con punta plana con la que llegar hasta nivel del seno maxilar.

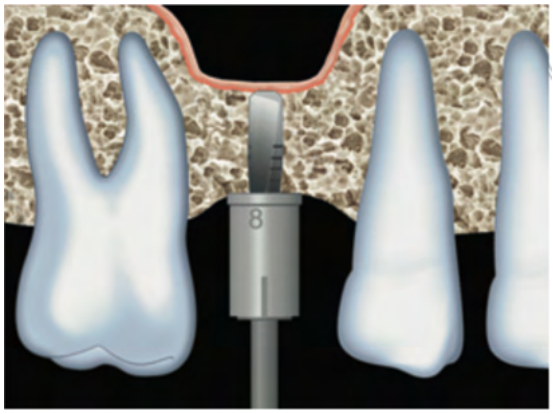


Figura 20: fresado con punta plana/redondeada para llegar hasta la membrana del seno maxilar (43).

- Radiografía de control para comprobar la profundidad alcanzada.
- Abrasión del suelo del seno maxilar con una fresa redonda que no corta y abundante irrigación con topes de incrementos de 1 mm cada vez.

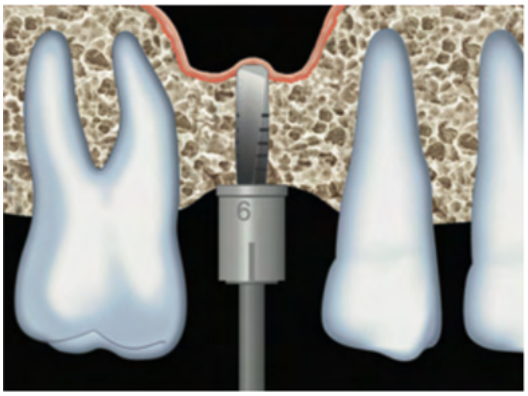


Figura 21: fresado con fresas redondeadas y en incrementos de 1 mm (43).

- Comprobación manual de la integridad de membrana sinusal.
- Elevación de la mucosa y regularización de la osteotomía con fresa redonda empleada a 1 mm más profunda que la anterior.

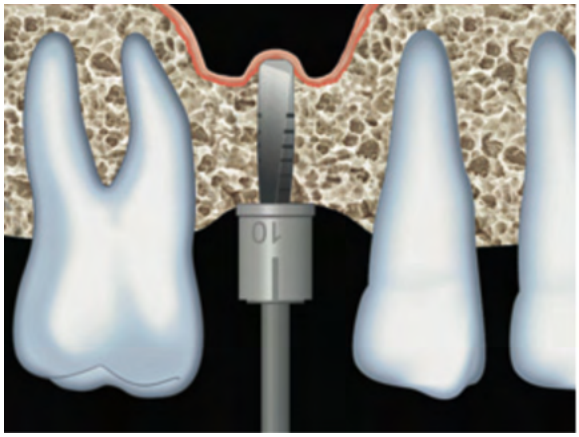


Figura 22: Elevación de la membrana sinusal (43).

- Inserción del material de relleno, el kit tienen un total de 3 puntas plugger de diferentes diámetros, caracterizadas por una cavidad particular que les permite empujar el material de relleno por debajo de la membrana Schneider sin compactarlo excesivamente, para que pueda expandirse de manera homogénea.

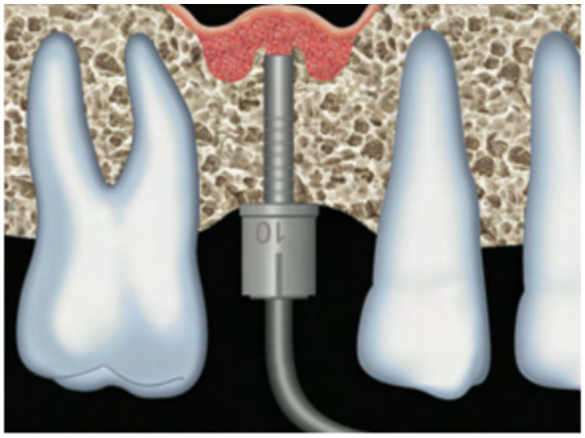


Figura 23: colocación del material de relleno (43).

- Inserción de los implantes.

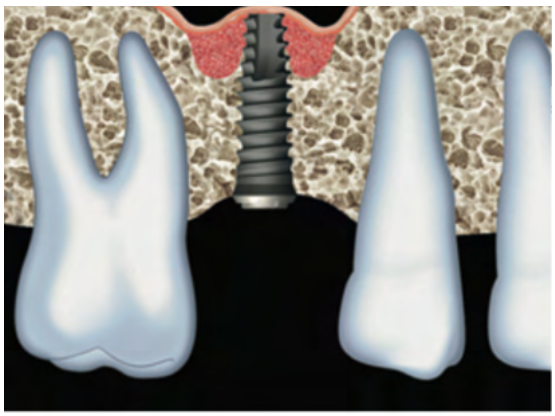


Figura 24: Implante colocado (43).

Otro instrumento manual incluido en el kit es una punta denominado ``profundímetro´´fundamental para ir controlando la profundidad durante todos los pasos (38). En cuanto a las puntas cilíndricas que realizan la elevación no cortan, permiten perforar el sitio del implante y llevarlo gradualmente a diámetros mayores. Se pueden reconocer gracias a los anillos de colores en la base del mango, que siguen un código de color preciso para orientar la secuencia de uso (42,43).

Con respecto a otras técnicas que permiten la inserción de un solo diámetro de implante, el M.I.S.E. kit se puede utilizar para insertar implantes cilíndricos roscados y no roscados, donde el tamaño del cuerpo del implante corresponde al diámetro de la parte de trabajo de las últimas fresas rotatorias utilizadas habiéndolas de diferentes diámetros(42).

Nuno Matos Garrido (41) y demás colaboradores llevaron a cabo un estudio donde colocaron 20 implantes en 19 pacientes con la técnica MISE y observaron que la ganancia media de hueso vertical fué de 4,4 mm. Angelo Sisti llevo a cabo dos artículos (43,44) en los que quiso estudiar la eficacia de esta técnica, uno en el año 2011 y otro en el 2012. En el primero de ellos, el rango de altura inicial fue de 1,2 a 9,8 mm, mientras que en el segundo de ellos fue un poco más

pequeño, de 1,2 a 5 mm y la ganancia final fue de 2,2 a 13,4 mm y de 6,6 a 13,4 mm respectivamente, una media aproximada de 7 mm en ambos casos. En la tesis del Dr. Karim Nasser (45) la situación es algo similar, ya que la situación de partida fue un hueso con 3-10 mm de altura y la ganancia media fue de 4,6 mm llegando incluso en algún caso a los 8 mm.

En cuanto a la inserción de los implantes, se trata de una técnica que la colocación se realiza de forma simultanea. Lo que si puede variar es el hecho de dejarlos sumergido o no. Angelo Sisti (43,44) optó por la técnica sumergida y a los 4 meses realizaría una intervención para descubrirlos, sin embargo, Karim Nasser (45), de 91 implantes, en 28 de ellos no utilizó la técnica sumergida, si no que finalizó la colocación de los implantes con un pilar de cicatrización. Diferentes biomateriales fueron utilizados como material de relleno, sin destacar ninguna diferencia entre ellos.

Con respecto a la complicaciones, tanto Nuno Matos Garrido (41) como Karim Nasser (45) no cometieron ninguna perforación de membrana sinusal aunque si que hubo algunas complicaciones postquirúrgicas. En el articulo de Nuno Matos Garrido (41) se perdió un implante de los 20 que se colocaron por una deficiente osteointegración. En el caso de Karim Nasser (45), de los 91 implantes colocados, 6 sufrió alguna complicación (6,6 %), 3 fracasos en la osteointegración y la consiguiente perdida de los implantes, 2 aflojamiento de tornillos de la conexión protésica y 1 descementado de la prótesis fija

En el caso de Angelo Sisti (43,44), tanto en el primer articulo de 2011 donde se colocaron 64 implantes como en el segundo de 2012 donde se colocaron 20, hubo una pequeña perforación de membrana sin consecuencias negativas, En los casos de una pequeña laceración de la membrana del seno, el uso de colágeno parece ser eficaz para prevenir la dislocación del

material del injerto. Aun así, con las técnicas de osteótomo, las laceraciones de la membrana son mucho más frecuentas, ya que van del 2 al 5%, y cuando la elevación del seno excede los 5 mm, las tasas de laceración varían del 10 al 20% (43).

Muchos de los pacientes, 28 de 50 (43) y 12 de 17 (44) sufrieron hinchazón sin dolor durante los primeros días tras la intervención aunque no se detectaron más signos de inflamación después de la primera semana.

Otro kit de fresas que existen para realizar una elevación de seno maxilar de forma mínimamente invasiva es el CAS kit. Se trata de un sistema mixto ya que son fresas atraumáticas pero con una parte hidráulica.

Este kit consta de una fresa guía para marcar el lugar de la inserción del implante. A continuación de utiliza la llamada fresa *twist* (helicoidal) , con la que se realiza el primer fresado y a la que se le pueden colocar un *stopper*. Estos pueden ser de diferentes longitudes . Se recomienda detener la perforación cuando queden unos 2 mm de hueso, que se calculara de antemano utilizando radiografías o imágenes de TC. Estas se utilizaran a una velocidad de 1000-1500 rpm (46).

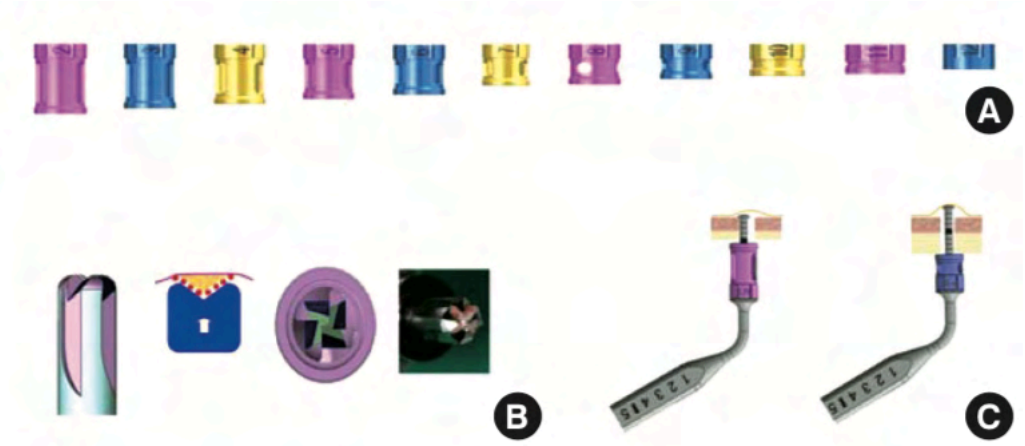


Figura 25: Componentes del kit. A, stoppers de diferentes longitudes. B, fresas CAS. C, medidor de profundidad y elevación de membrana (47).

El otro tipo de fresa que forma parte de este kit es la fresa CAS. Se trata de una fresa cónica así que formara una perforación cónica en el hueso durante el fresado. Constan también de un sistema de *stoppers* en incrementos de 1 mm para evitar la perforación excesiva en la cavidad sinusal. El diseño atraumático de la punta permite realizar la cirugía de forma segura

independientemente de la forma que tenga el seno. Además, permite recolectar hueso autólogo, para el posterior relleno. Su velocidad recomendada es de 400- 800 rpm (47).

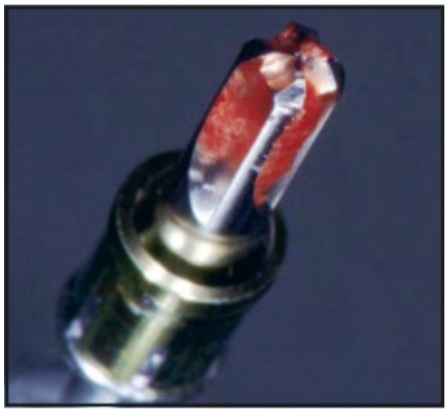


Figura 26: Fresa CAS con hueso autólogo (48).

Se comprobara con un instrumento que la membrana esta despegada del hueso y se utilizara después, el elevador hidráulico. En el caso de un solo implante, la solución salina de 0,2 a 0,3 ml eleva la membrana aproximadamente 3 mm (47).

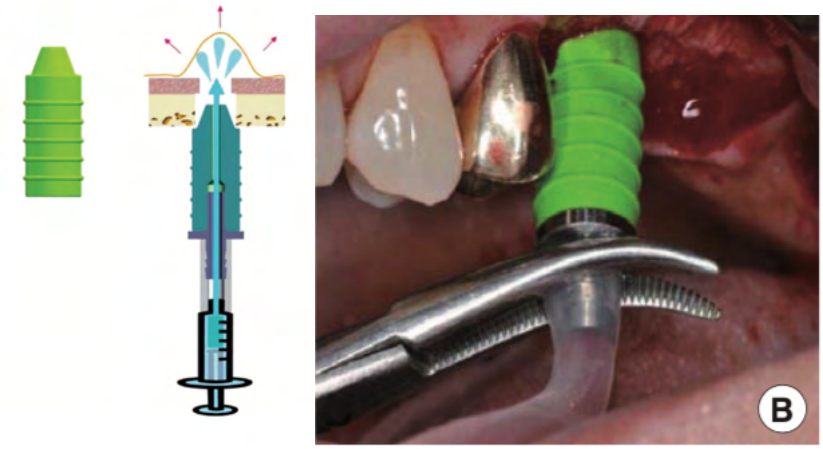


Figura 27: elevador hidráulico con el que elevar la membrana sinusal (47)

Para el procedimiento de injerto óseo, también forma parte del kit, el transportador, el condensador y el espaciador. Existen diferentes diámetros y se utilizan para llevar el material al interior y extenderlo de forma uniforme (46,47).

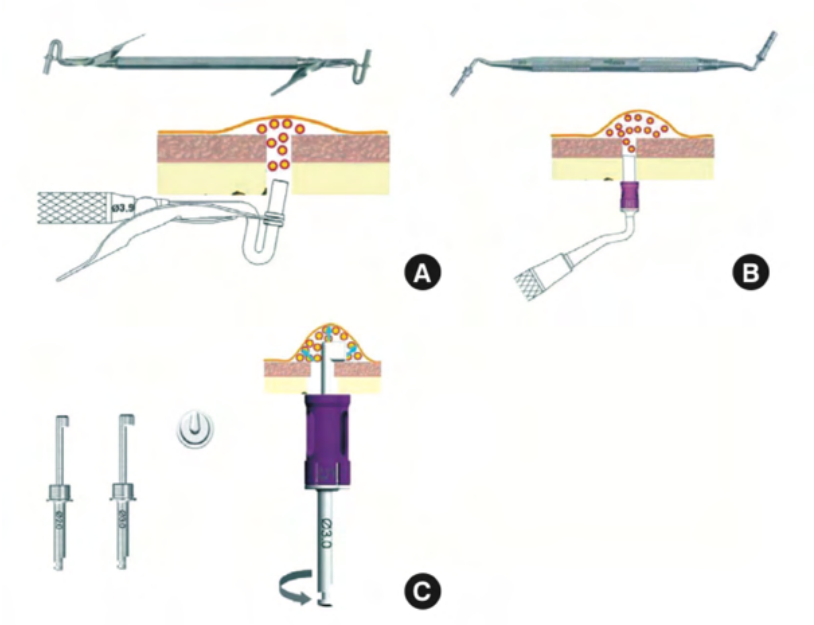


Figura 28: A, transportador. B, condensador. C, espaciador (47)

En el articulo de Young-Kyun Kim (47), se les realiza un cuestionario a 28 dentistas sobre su experiencia al utilizar el CAS kit. Al menos 24 dentistas (85,7 %) citaron la seguridad, el buen rendimiento de corte y la facilidad de uso como la principal ventaja del kit CAS. Solo dos dentistas consideraron la recolección de hueso autógeno de la fresa CAS como la principal ventaja.

Fulvio Gatti y cols. (48) llevaron a cabo un estudio de cohortes donde se colocaron 49 implantes con sus respectivas elevaciones del seno maxilar. La situación de partida era una altura residual de más de 3 mm pero menos de 8 mm. A los 2 años de la intervención la perdida era de 0,33 ± 0,24 mm. En este caso se decidió que si la diferencia entre la altura de hueso residual y la

longitud del implante era mayor de 2 mm, se pondría material de relleno. En caso contrario, se optaría por prescindir de material de injerto óseo. 32 de ellos recibieron material de relleno, mientras que 17 no lo hicieron no habiendo diferencias significativas entre ambos. Los implantes fueron colocados en mismo día de la intervención dejándolos enterrados, a los 6 meses se procedería a una segunda intervención para destaparlos y al mes siguiente se colocarían las coronas. Ninguna complicación intra o postoperatoria fue documentada lo que nos confirma que se trata de un técnica segura para los pacientes. Aunque los artículos encontrados sobre esta técnica han sido muy escasos.

c. Trefinas

Una trefina se trata de un cilindro hueco con un borde terminal dentado que crea un cilindro de hueso en el sitio óseo y pueden ser utilizadas junto con osteótomos para elevar el seno maxilar de forma segura y mínimamente invasiva (49).

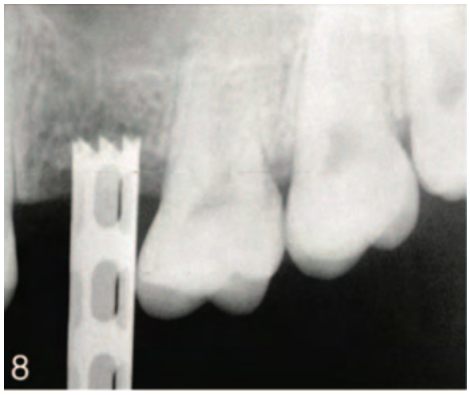


Figura 29: Trefina en el lugar de la osteotomía donde se observan los los bordes dentados (49).

Existen infinidad de kits de trefinas. Estos estarán compuestos por trefinas más anchas y más estrechas y por osteótomos de diferentes tamaños.

Tanto los osteotomos como las trefinas tienen unos protectores de inserción o *stoppers* que evitan invadir accidentalmente la cavidad sinusal (50).

El procedimiento comienza con la realización de una incisión crestal a espesor total para exponer la cresta ósea. Se comienza la perforación con una trefina con un *stopper* con una longitud 1 mm menor que la altura del hueso subsinusal. A continuación con el osteótomo correspondiente, se compacta el hueso formado por la trefina. En muchas ocasiones, en este paso es donde se coloca el material de injerto óseo compactándose todo a la vez. Después se profundiza con el osteótomos cada vez más, adentrándose en el seno progresivamente. Estos impactos repetidos, con o sin material de injerto, dan lugar a la fractura del suelo del

seno, seguida de la elevación de la membrana hasta 4, 5 y 6 mm y por último se coloca el implante (50).

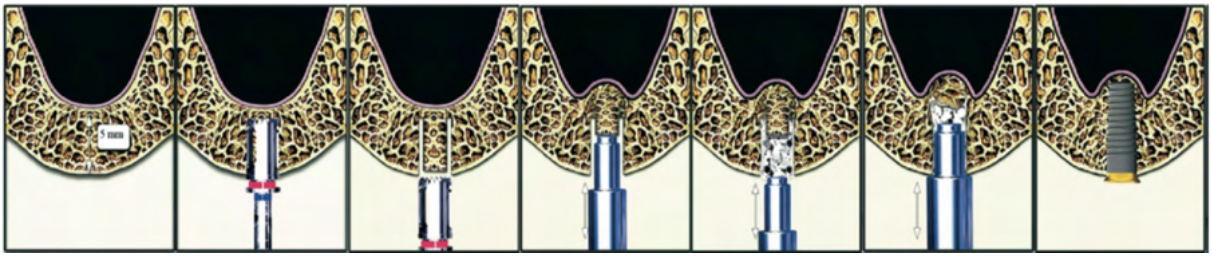


Figura 30: La primera trefina se introduce 1 mm por debajo del suelo del seno y deja un núcleo óseo. El osteótomo correspondiente compacta el núcleo y se introduce a la misma altura. El material de injerto se introduce y se compacta utilizando osteótomos profundizando cada vez más. Se fractura el suelo del seno y se eleva la membrana. Se coloca el implante (50).

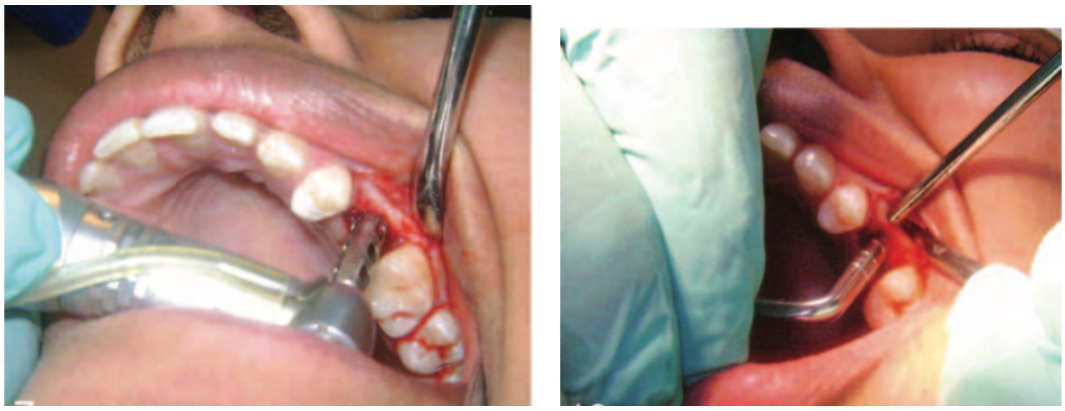


Figura 31: Imagen clínica de uso de la trefina y el osteótomo correspondiente (49).

Cuando se va a utilizar la técnica de la trefina con la colocación simultánea de implantes, se selecciona una que tenga un diámetro exterior no mayor que el diámetro del implante. Esto permite que toda la profundidad de las roscas del implante se enganchen al hueso, asegurando la estabilidad primaria en la colocación del implante. Si se va a utilizar un implante cónico, se recomienda utilizar una trefina del diámetro del ápice del implante que se va a colocar para garantizar que la mitad crestal del implante se enganche al hueso, logrando la estabilidad primaria. Además, para evitar el sobrecalentamiento del hueso y

permitir que el irrigante fluya hacia el extremo de corte, se recomienda utilizar una trefina con una ligera presión (49).

No se han encontrado ningún articulo donde se haya estudiado cuantos mm de hueso se han conseguido con esta técnica. En el caso explicado por Lanka Mahesh (49) se colocó 1 implante, el cual no fracaso ni desencadenó ninguna complicación. Al mismo tiempo, no se utilizó ningún injerto óseo, por lo que el implante estuvo en contacto directo con el hueso autógeno, lo que aceleró la osteointegración mediante el contacto directo con el implante.

Paul A. Fugazzotto tiene dos artículos (51,52) en los que utiliza esta técnica para elevar el seno maxilar y posteriormente colocar los implantes. En el primero de ellos lleva a cabo 71 y en el segundo 116. En ninguno de ellos se compara la situación inicial con la final por lo que no se puede expresar la ganancia que se consigue. Sin embargo, a la conclusión que si llega en ambos, es que cuando quedan de 4 a 5 mm de hueso alveolar coronal al suelo del seno, el uso de trefina y un osteótomo es menos traumático para el paciente que la repetida percusión como un intento de compactar 4 a 5 mm de hueso y levantar el suelo del seno con la entrada inicial del osteótomo. En sus artículos no se refiere ninguna complicación en ninguno de sus pacientes. Fugazzotto (52) informó de una tasa de éxito acumulada del 98,0% con esta técnica después de 13-48 meses de seguimiento. En su informe de casos, a los 5 años de seguimiento la radiografía periapical intraoral muestra un excelente hueso periimplantario a nivel crestal, y se puede apreciar un tejido blando periimplantario clínicamente sano sin ninguna recesión.

d. Sistemas hidráulicos.

Otra de las técnicas mínimamente invasivas de las que disponemos para la elevación del seno maxilar es aquella en la que se utiliza un balón para elevar la membrana sinusal. Esta técnica fue desarrollada para conseguir mejores resultados con menor trauma para el pacientes y menores complicaciones intraoperatorias (53).

El proceso quirúrgico comienza con una incisión crestal levantando un colgajo mucoperiostico a espesor total. La posición del seno se habrá determinado previamente con un TAC, incluso si el espesor de hueso es muy fino, se podrá ver el contorno a través del hueso bucal. Se realiza una osteotomía con abundante irrigación, preservando siempre la integridad de la membrana y el ultimo milímetro correspondiente al suelo del seno maxilar. Este fresado se realizará con la utilización de *stoppers* o manguitos guía (9,54).

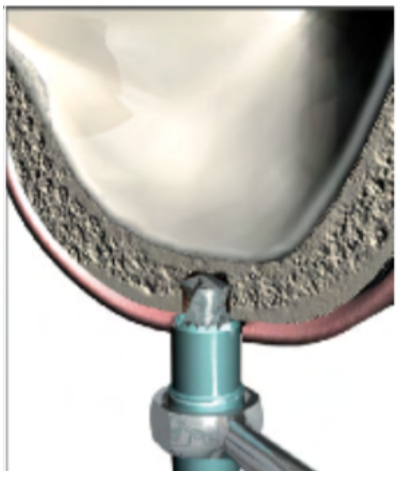


Figura 32: Fresado inicial respetando el último milímetro (9).

Mediante un ligero golpe se consigue fracturar el suelo del seno. Mediante la introducción de un instrumento romo, se comprueba que el suelo del seno este totalmente separado (9,54).

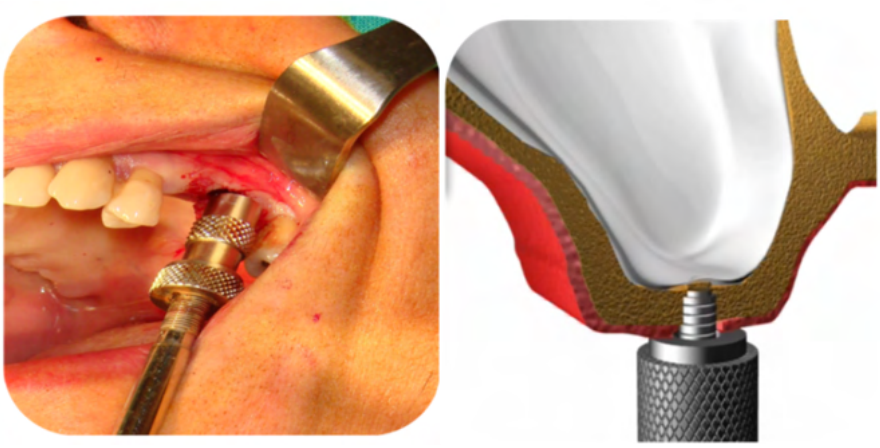


Figura 33: Fractura del suelo del seno mediante osteótomo (9).

En este punto se utiliza un globo de material de látex. Antes de introducir el globo es importante inflarlo de 3 a 4 ml solución salina para comprobar que no tiene fugas. A continuación se vacía y se coloca contra el suelo del seno. El globo se infla lentamente con 2 a 4 ml de solución salina y a medida que se expande, la membrana se eleva. Se realizan un 5 insuflaciones de forma progresiva (9,54).

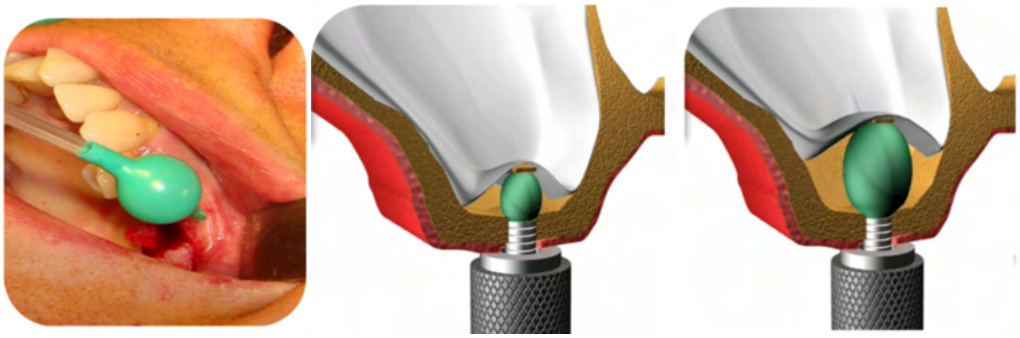


Figura 34: Introducción del globo e insuflación progresiva (9).

Después de unos dos minutos, el globo se desinfla y se retira. Se comprueba visualmente y con la maniobra de Valsalva si se ha producido un perforación en la membrana. El espacio creado por el globo será relleno del material elegido, ya sea xenoinjerto o aloinjerto y será compactado (9,54).

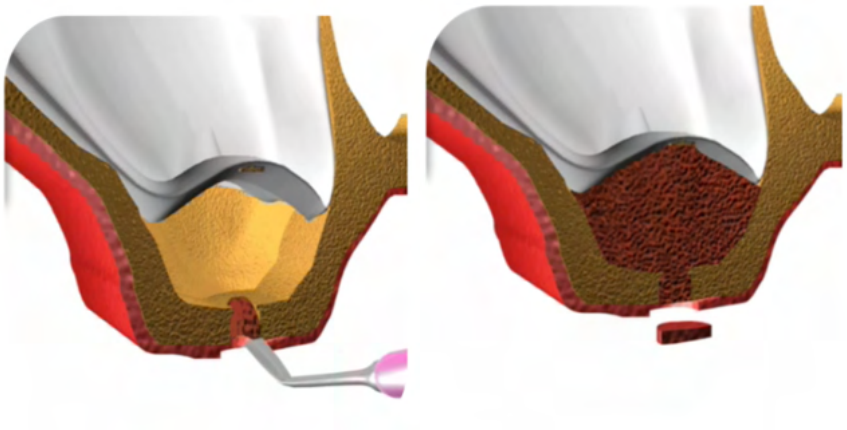


Figura 35: Compactación del material de relleno (9).

Se han encontrado bastantes casos en lo que se utilizó esta técnica. En la tesis de la Dra. Stefania Arena (9), dónde se llevaron a cabo 33 elevaciones de seno con esta técnica, la altura de hueso residual previos a la intervención era de 3,3 mm de media. La situación inicial fue parecida en ambos artículos de Kfir (55,56), ya que la altura media era de 3,4 mm en un primer articulo de 36 elevaciones y de 3,8 mm en un segundo articulo de 112 pacientes. Esta altura era un poco mas favorable para Xiulian Hu (57), con casi 5 mm de hueso residual de media en sus 28 elevaciones y para Massimo Petruzzi (58), donde la altura era de 8 mm de media en sus 40 pacientes. Las 24 elevaciones de seno maxilar que realizó Ziv Mazor (59) presentaban una altura de hueso residual en un rango mas amplio, de 2 a 6 mm.

En cuanto a la altura presente una vez realizada la intervención, la Dra. Arena (9), consiguió una altura media de 11, 9 mm (2,5 a 17 mm), sin embargo, Efraim Kfir (55,56) consiguió llegar en algunos de sus casos a 18 mm de altura, en todos sus casos consiguió una ganancia de mas de 10 mm. La altura media conseguida por Massimo Petruzzi (58) fue de 14,66 mm.

En cuanto al material de injerto todos los autores lo utilizaron para mantener la membrana elevada. Excepto la Dra. Arena (9) que colocó los implantes 6 meses después de la intervención, todos los demás artículos consultados colocaron los implantes de forma simultanea.

Con respecto a las complicaciones quizás se ven un ligero aumento con respecto a las demás técnicas que hemos explicado. Como vemos en el articulo de Kfir (56) de 2009, de 112 pacientes, hubo 12 perforaciones de membrana (10,71%). Tanto en el articulo de Xiulian Hu (57) como en la tesis de la Dra. Stefania Arena (9), se produjeron 2 perforaciones de membrana(7,14 % y 6,1% respectivamente) , mientras que Massimo Petruzzi (58) menciono 3 en su articulo (7,5 %).

En el articulo de Huda Moutaz Asmael (53) se comparan estos artículos mencionados con 5 más, es decir un total de 10 sobre esta técnica expuesta y se estableció que con esta técnica, se pueden conseguir entre 3 y 10,8 mm de altura de hueso, una media de 6,96 mm y la tasa de perforación de la membrana de Schneider es del 6,76 % de media. En algunos de estos estudios, la perforación de la membrana se trató con éxito mientras que otros abortaron el procedimiento. Además, algunos autores demostraron que las causas de la perforación de

la membrana sinusal, podrían deberse al inflado demasiado rápido del globo y a la fractura del suelo del seno durante los procedimientos con osteótomos.

Otro sistema hidráulico, es el desarrollado por la Universidad de Viena (60), Jeder-System. Este sistema consta de la fresa Jeder, la bomba Jeder y unos tubos de conexión. La bomba genera una alta presión hidráulica (1,5 bares) en el sistema, empujando así la membrana del seno desde la perforación. La bomba también genera vibraciones hidráulicas para elevar y separar aún más la membrana del hueso. Todo el procedimiento se controla midiendo constantemente la presión y el volumen del líquido introducido.

Figura 36: Sistema Jeder-System (60)

Jeder-System
Paso 1: Se levanta un colgajo mucoperióstico a espesor total. Se lleva la primera fresa hasta 1-2 mm por debajo del suelo del seno. Para verificar la profundidad se puede realizar una radiografía.
Paso 2: A continuación con la fresa Jeder, se genera una alta presión hidráulica utilizando una solución salina. La fresa colocada en el centro de la cámara de presión de Jeder se desplaza lentamente a través del hueso crestal.

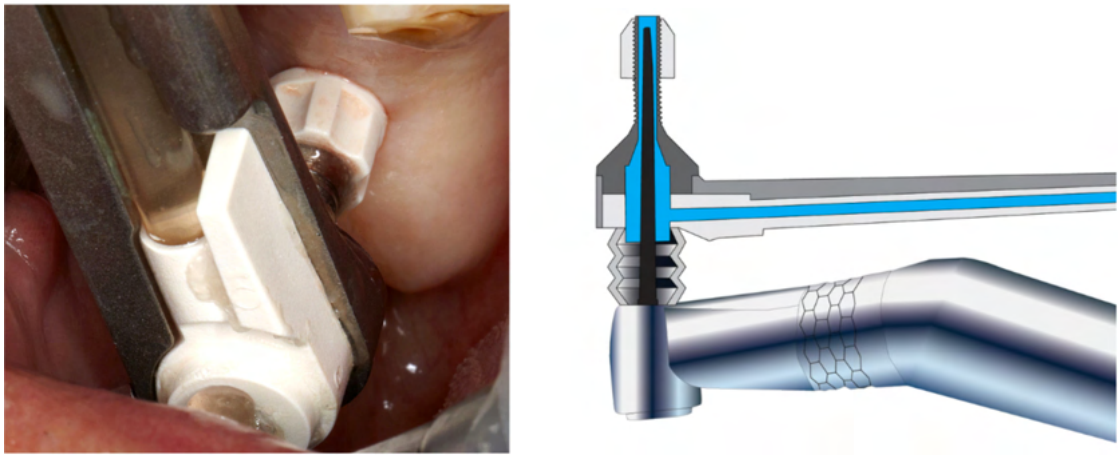


Figura 37: Se crea una presión hidráulica utilizando solución salina (60).

Paso 3: Al producirse la entrada al seno, el fluido presurizado hace retroceder la membrana, asegurando que la fresa no la perfora. Al mismo tiempo, un descenso repentino de la presión en la pantalla de la bomba de Jeder indica al cirujano que la entrada en el seno ha tenido éxito.

Paso 4: La solución salina se pone en vibraciones hidráulicas (50 Hz) mediante la bomba Jeder, separandose aún más la membrana del hueso. De este modo, se crea un espacio para el material de aumento y el implante. Tras la extracción de la solución salina mediante la bomba Jeder, se introducen el material de aumento y el implante.

Todo el procedimiento se controla constantemente mediante la medición continua de la presión y el volumen del fluido introducido en la pantalla de la bomba Jeder. La bomba Jeder incorpora un mecanismo de seguridad para evitar la introducción de una presión y un volumen de líquido excesivos. Con cada toque en el pedal de la bomba Jeder, inyecta sólo 0,2 mL de solución salina por tanto no hay peligro para la membrana de (60).

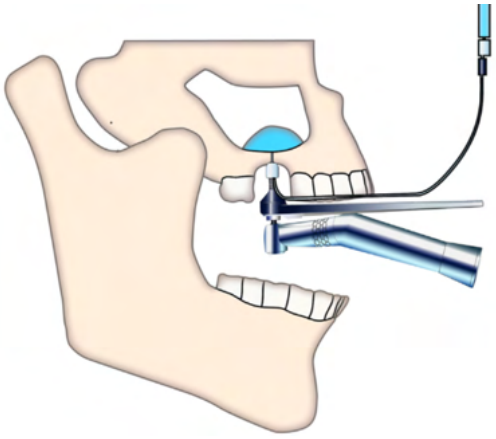


Figura 38: La elevada presión empuja la membrana de Schneider (60).

Philip Jesch (60) en 2013 puso a prueba esta técnica en su estudio llevado a cabo en 18 pacientes donde realizó 20 elevaciones. La situación de partida era una altura de hueso residual de 4,6 ± 1,4 mm y la altura final total fue de 13,8 ± 2.3 mm de hueso. Se introdujo material de injerto óseo y la colocación de los implantes fue inmediata. Se produjo una sola perforación de membrana lo que supuso un 5 %. Uno de los implantes se perdió a los 9 meses pero después de 3 meses se volvió a colocar en el mismo lugar y no hubo más complicaciones.

Se han encontrado también algún articulo que explican como elevar la membrana sinusal con sistemas hidráulicos utilizando simplemente un jeringa de plástico. Esta jeringa se cortaría a una longitud un poco inferior a donde se encuentra el seno maxilar. Después de llenar la jeringa con solución salina, se introduce en la cavidad ósea manteniendo la conexión hermética y se presiona lentamente para que el liquido se filtre bajo la membrana y se separe del suelo óseo debido a esta presión hidráulica creando así la elevación (61).

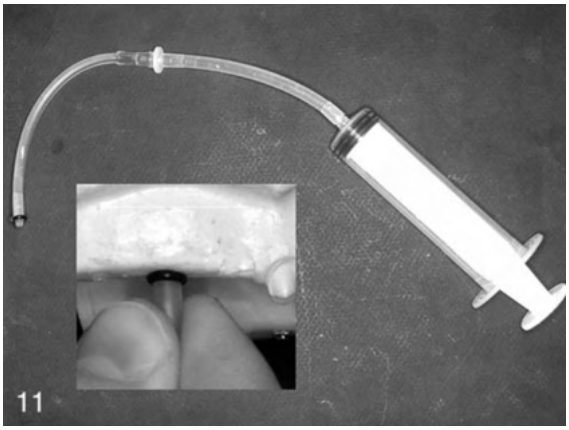


Figura 39: Tubo de silicona modificado y jeringa (61).

e. Implantes (DIVA y iRaise)

Otra de las técnicas para conseguir la elevación del seno maxilar siendo mínimamente invasivo, es con los propios implantes. Destacaremos dos sistemas: DIVA y iRaise.

Comenzando con los implantes DIVA, se trata de un implante dinámico con un tornillo de sellado interior que facilita y agiliza el procedimiento de elevación de seno transcrestal, lo que reduce aún más el riesgo de desgarro inadecuado de la membrana de Schneider (62).

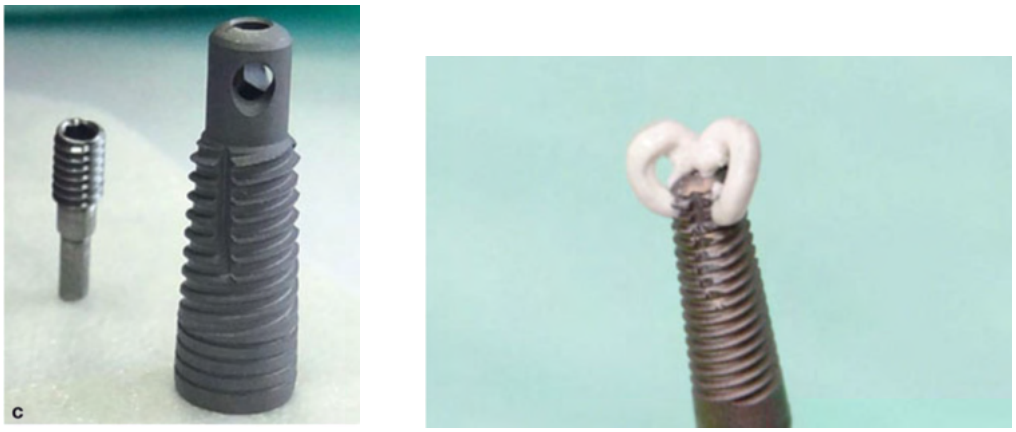


Figura 40: Implantes DIVA e inyección de sustituto óseo a través del canal del implante (62)

DIVA, es una nueva tecnología de elevación de seno maxilar que ofrece una solución innovadora permitiendo realizar elevaciones de seno de forma conjunta a la colocación del implante mediante un procedimiento sencillo, fácil de aprender y relativamente corto, con un riesgo significativamente menor de complicaciones y molestias para el paciente (63).

La tecnología de elevación de seno DIVA posee tres innovaciones, el uso del propio implante para elevar la membrana del seno sin riesgo de perforación, su capacidad para detectar el movimiento de la membrana del seno a través del implante y una configuración que permite la inyección de sustituto óseo directamente a través del implante (63).

El procedimiento es el siguiente: (62,63)

- Después de comprobar el escáner y elegir el lugar adecuado para la colocación del implante, se comienza el fresado con la fresa piloto hasta 1 mm por debajo del seno maxilar.

Figura 41: Paso 1 (63)

- A continuación se utiliza un osteótomo y se aplica una ligera presión hasta notar el primer crack que nos indica la rotura del hueso del suelo del seno.

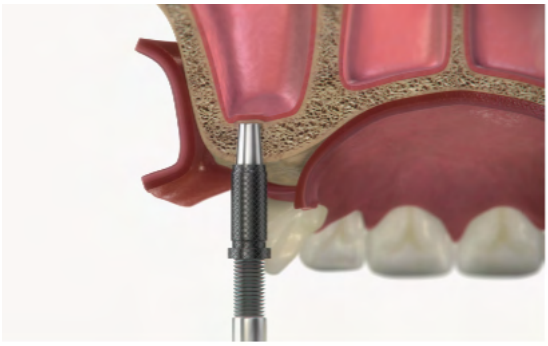


Figura 42: Paso 2 (63)

- Después se introduce el implante DIVA con una rotación controlada hasta que la estabilidad primaria inicial se consigue.

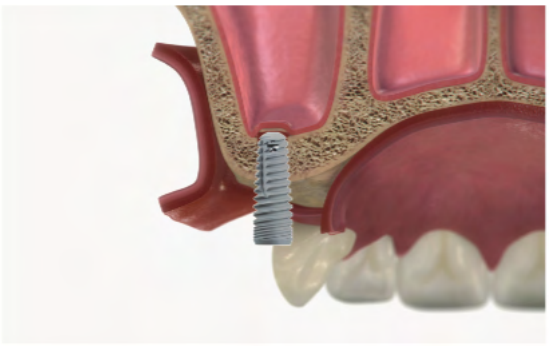


Figura 43: Paso 3 (63)

- Con el destornillador especial adjunto, se retira el tornillo que cierra la válvula situado dentro del dispositivo.. La hemorragia que se observa desde el canal DIVA indica la fractura del suelo del seno. Este tornillo cierra la válvula localizada en la parte más apical del implante. Este debe retirarse antes de conectar el sistema hidráulico y posteriormente, una vez terminada la elevación sinusal se debe recolocar para sellar esa parte del implante.

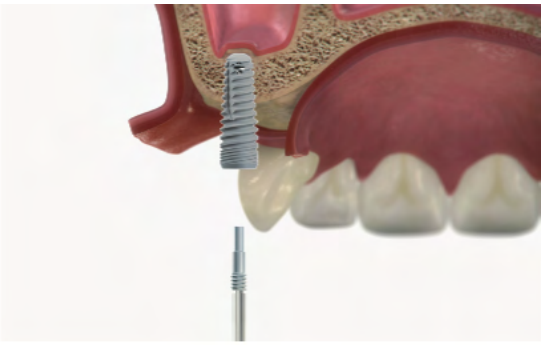


Figura 44: Paso 4 (63)

- Se conecta una jeringa para introducir suavemente 1 ml de solución salina a través del implante para elevar la membrana del seno. Se retira la jeringa y la cánula, se acopla la carraca al implante enrocándolo con cuidado 1 mm. Se repite este procedimiento de solución salina y carraca hasta que se consiga elevar la membrana lo necesario para la introducción completa del implante.

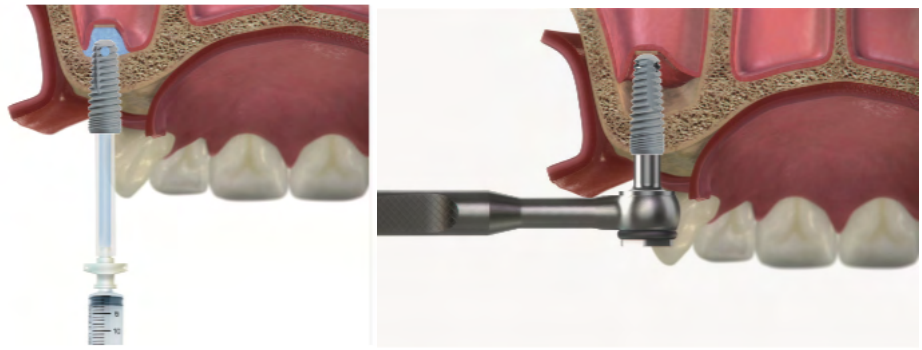


Figura 45: Paso 5 (63)

- Posteriormente, se inyecta con otra jeringa material de injerto óseo a través del implante hasta que desborde.

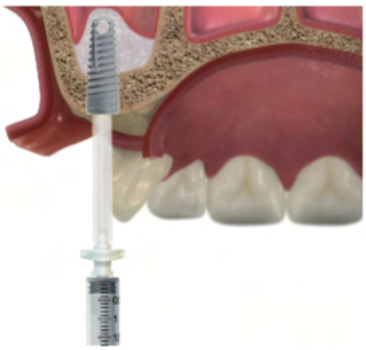


Figura 46: Paso 6 (63)

- Por ultimo, con el destornillador, se introduce de nuevo el tornillo que cierra la válvula del implante con el fin de conseguir el sellado absoluto de su parte apical y evitar el paso de bacterias

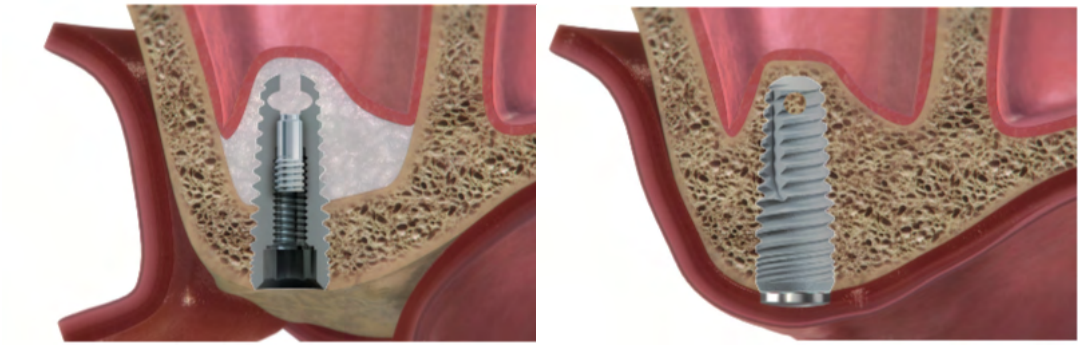


Figura 47: Último paso e implante osteointegrado (63)

El otro sistema de implantes con los que conseguir la elevación del seno maxilar son los implantes iRaise. Es un sistema hidráulico como el anterior lo único que cambia es el mecanismo interno del implante. Con los implantes DIVA tanto la solución salina como el material de injerto se introducían por la zona mas coronal del implante a través de un canal recto, mientras que en los iRaise la zona de entrada esta en mitad del cuerpo del implante y el canal tiene forma de L.

En la siguiente imagen se puede comprobar la diferencia en la estructura interna de ambos:

Figura 48: A la izquierda, implantes DIVA (59), a la derecha implantes iRaise con conducto en L (64).

El procedimiento es igual que con el sistema anterior, se comienza con la osteotomía del lugar donde va a ir colocado el implante hasta la cortical del seno (1 mm por debajo). Según la bibliografía consultada en esta caso no se utiliza un osteótomo en este paso si no que directamente se inserta el implante dejando la entrada del canal expuesta. A continuación se inyecta 2 ml de solución salina a través del implante para que así la presión hidráulica separe la membrana del suelo del seno. Al retirar el suero se observará sangre que nos indica la correcta elevación del seno (64).

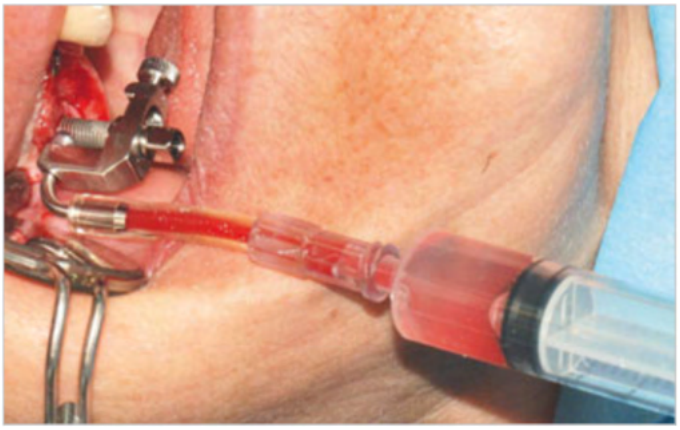


Figura 49: Sangre observada en el suero (64).

Por último se cambia la jeringa de suero por la de material de injerto óseo, se introduce y se acaba de colocar el implante con una llave dinamométrica asegurándonos que el orificio de entrada de los materiales se introduzca por completo en el hueso maxilar para evitar la colonización bacteriana procedente de la cavidad oral. Esto también es una diferencia con respecto al anterior sistema ya que en el se iba enroscando el implante lentamente de milímetro en milímetro (64).

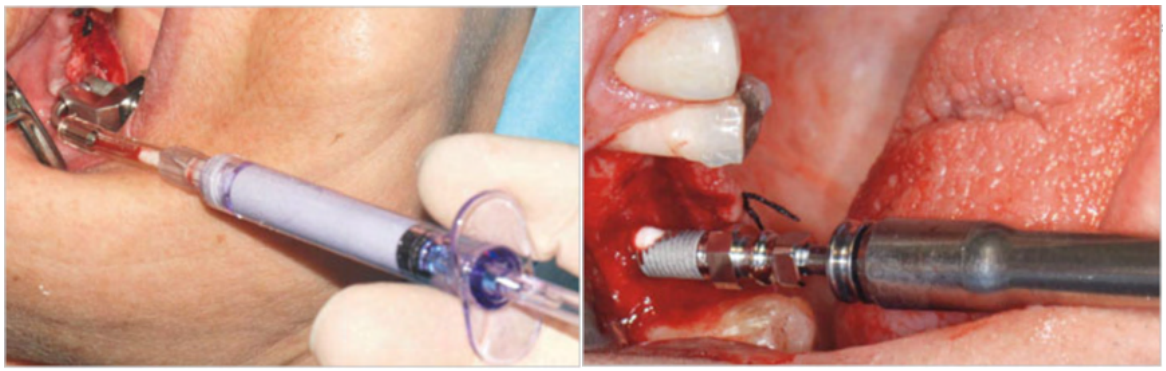


Figura 50: Introducción del material de relleno y colocación definitiva del implante (64)

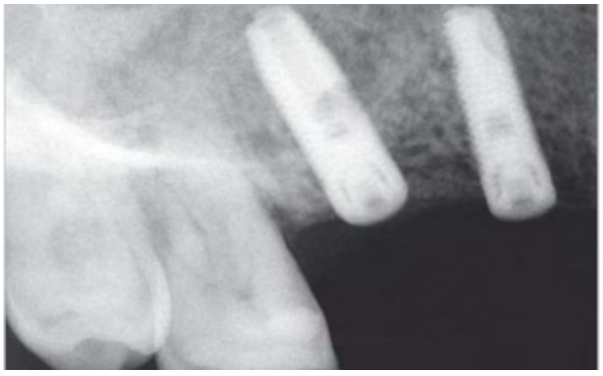


Figura 51: Radiografía final después del procedimiento (64)

En cuanto a la altura de hueso residual necesaria para llevar a cabo la elevación del seno maxilar a través de estos sistemas de implantes, será de 3 mm o más en el caso de los implantes DIVA según ambos artículos de Oded Nahlieli (62,65) . En el caso de los

implantes iRaise, la altura residual de hueso alveolar será de 4 mm o más para Hadar Better (64) y Liat Chaushu (66) y de 3 mm o más para Marco Tallarico (67). Estos serán los milímetros de hueso necesarios para que los implantes queden con una buena estabilidad primaria.

Liat Chaushu (66) en su articulo de 2020 sobre los implantes iRaise, divide sus 50 pacientes en dos grupos de 25, en uno de los grupos deja los implantes enterrados y otro no. Se vio que la ganancia fue de 7,8 mm en el primer grupo y de 9,3 mm en el segundo grupo, no habiendo más diferencias entre ambos grupos. Marco Tallarico (67), consiguió también con la técnica iRaise hasta una altura de 12, 78 mm en sus 18 pacientes.

En cuanto a las complicaciones, en ninguno de los artículos consultados sobre implantes DIVA y iRaise (62-66) sufrieron perforaciones de membrana. Si que se ha visto una mayor tendencia a las infecciones locales y por consiguiente el fracaso en la osteointegración y perdida del implante en los casos DIVA.

En un primer articulo de Oded Nahlieli (62), de 218 implantes colocados, 7 fracasaron (3,2%) mientras que en un segundo articulo de este autor (65), de 378 implantes, fracasaron 21 (5,5%). En el caso de los artículos de Hadar Better (64), Liat Chaushu (66) y Marco Tallarico (67) donde se utilizaron los implantes iRaise ninguno sufrió infección y por tanto ninguno de los implantes fracaso.

Este hecho puede deberse a la conformación del canal interior del implante. Recordamos que los implantes iRaise tienen un canal en forma de L y la desembocadura es en el lateral del implante, en mitad del cuerpo de este. Al colocarlo de forma definitiva este orificio quedara rodeado completamente por el hueso alveolar impidiendo la llegada de bacterias procedentes de la cavidad oral. Aunque tal y como apunta Oded Nahlieli (62) en su articulo

donde fracasaron 7 de 218 implantes en 5 pacientes diferentes, 3 de los 5 pacientes eran diabéticos pudiendo ser la causa del fracaso.

Una ventaja de esta técnica mediante implantes es la utilización del canal para diferentes fines como puede ser la administración de fármacos en el interior del hueso en casos de enfermedades inflamatorias, el aumento óseo adicional, la administración de otros agentes cuando la calidad del hueso es deficiente, y para la supervisión endoscópica durante y después del procedimiento (62).

V. CONCLUSIONES:

Con este trabajo se ha comprobado que la realización de técnicas de elevación de seno de acceso crestal está en constante evolución. Se trata de técnicas que se llevan a cabo de forma habitual en la clínica dental y es por ello que a día de hoy se siguen desarrollando nuevos sistemas y dispositivos.

En cuanto a las indicaciones de estas técnicas, se podrán realizar con éxito elevaciones de seno maxilar de rebordes muy absorbidos, incluso de menos de 3 mm. Dentro de las ventajas, la principal será la gran cantidad de ganancia ósea que se consigue, llegando a conseguir más de 10 mm en prácticamente la totalidad de las técnicas descritas.
Un menor número de complicaciones, tanto perforaciones de la membrana sinusal como infecciones serán también grandes ventajas al igual que la reducción del tiempo quirúrgico. En definitiva, suponen un mayor porcentaje de éxito a largo plazo y una disminución de la morbilidad.

Cada una de las técnicas explicadas son mínimamente invasivas y pueden considerarse seguras para el paciente ya que tienen poca incidencia de complicaciones. Todas ellas presentan cifras aceptables de éxito ya que son procedimientos exitosos para la elevación del seno maxilar y la osteointegración del implante.
El operador será el encargado de la elección de la técnica en base a su experiencia y a sus preferencias.

La principal limitación de este trabajo fue el pequeño tamaño de muestra que se encontró en la bibliografía consultada. Son técnicas bastante novedosas que requieren más

investigación y estudios con un mayor número de pacientes. Sería ideal el desarrollo de una técnica que reúna la mejores propiedades de cada una de ellas, algo que con el paso del tiempo podrá conseguirse.

VI. RESPONSABILIDAD SOCIAL:

Hoy en día los implantes son la opción más utilizada para reponer ausencias dentales por sus múltiples ventajas. Como ya se ha expresado al comienzo de este trabajo, la elevación del seno maxilar es una intervención necesaria para aumentar la disponibilidad ósea en sectores posteriores del maxilar superior. Esta región presenta limitaciones a la hora de colocar los implantes ya que suelen ser procesos alveolares con mucha reabsorción y la calidad del hueso es pobre lo que dificulta la estabilidad primaria y por consiguiente el éxito de la osteointegración.

Es importante estudiar las diferentes técnicas que tenemos para realizar las elevaciones sinusales al igual que desarrollar aquellas que son más novedosas. En general estas nuevas técnicas mínimamente invasivas conllevan una disminución del riesgo de perforación de membrana y otras complicaciones siendo más seguras para los pacientes que las técnicas más clásicas. Además son procedimientos que requieren menos tiempo de sillón por lo que a nivel económico también supondrían una ventaja. Estas técnicas suelen ser compatibles con la inserción simultanea de los implantes por lo que nos ahorraríamos una segunda cirugía.

VII. BIBLIOGRAFIA:

1. Warreth A, McAleese E, McDonnell P, Slami R, Guray SM. Dental implants and single implant-supported restorations. J Ir Dent Assoc. 2013 Feb-Mar;59(1):32-43. PMID: 23539970.

2. Donado Rodríguez M, Martínez González J.M. Cirugía bucal : Patología y Técnica. 4ª ed. Barcelona: Elsevier Masson; 2005.

3. Drake R, Vogl A.M, Mitchell A. Gray: Anatomía para estudiantes. 2ª ed. Barcelona: Elsevier España; 2010

4. Whyte A, Boeddinghaus R. The maxillary sinus: physiology, development and imaging anatomy. Dentomaxillofac Radiol. 2019 Dec;48(8):20190205. doi: 10.1259/dmfr.20190205. Epub 2019 Aug 13. Erratum in: Dentomaxillofac Radiol. 2019 Sep 10;:20190205c. PMID: 31386556; PMCID: PMC6951102.

5. Przystańska A, Kulczyk T, Rewekant A, Sroka A, Jończyk-Potoczna K, Lorkiewicz-Muszyńska D, Gawriołek K, Czajka-Jakubowska A. Introducing a simple method of maxillary sinus volume assessment based on linear dimensions. Ann Anat. 2018 Jan; 215: 47-51

6. Aktuna Belgin C, Colak M, Adiguzel O, Akkus Z, Orhan K. Three-dimensional evaluation of maxillary sinus volume in different age and sex groups using CBCT. Eur Arch Otorhinolaryngol. 2019 May;276(5):1493-1499.

7. Rodoni L.R, Glauser R, Feloutzis A, Hämmerle C.H. Implants in the posterior maxilla: a comparative clinical and radiologic study. Int J Oral Maxillofac Implants 2005;20(2):231-237.

8. Hernández Tejeda, N., & López Buendía, M. del C. (2013). Elevación de seno maxilar y colocación simultánea de implantes utilizando plasma rico en factores de crecimiento (PRFC), hidroxiapatita y aloinjerto. Reporte de un caso de siete años. *Revista Odontológica Mexicana*, *17*(3), 175–180.

9. Arena S. Estudio mediante el sistema compudent navigator sobre los injertos óseos realizados con la técnica de elevación de seno convencional y la técnica de catéter-globo [tesis doctoral]. Madrid (España). 2016

10. Chiapasco M, Casentini P, Zaniboni M. Bone augmentation procedures in implant dentistry. Int J Oral Maxillofac Implants 2009;24 Suppl:237-259.

11. Vandeweghe S, De Ferrerre R, Tschakaloff A, De Bruyn H. A wide-body implant as an alternative for sinus lift or bone grafting. J Oral Maxillofac Surg 2011;69(6):e67- e74.

12. Robles Garcia M. Elevación del seno maxilar mínimamente invasiva: técnica intralift. SECIB. 2010. 3(9): 7-15.

13. Misch C.E. Implantología contemporánea. 3ª ed. España: Elsevier; 2009.

14. Schwarz L, Schiebel V, Hof M, Ulm C, Watzek G, Pommer B. Risk Factors of Membrane Perforation and Postoperative Complications in Sinus Floor Elevation Surgery: Review of 407 Augmentation Procedures. J Oral Maxillofac Surg 2015;73(7):1275-1282.

15. Zijderveld S.A, van den Bergh J.P, Schulten E.A, ten Bruggenkate C.M. Anatomical and surgical findings and complications in 100 consecutive maxillary sinus floor elevation procedures. J Oral Maxillofac Surg 2008;66(7):1426-1438.

16. Reddy K S, Shivu ME, Billimaga A. Benign paroxysmal positional vertigo during lateral window sinus lift procedure: a case report and review. Implant Dent. 2015 Feb;24(1):106-9.

17. S, Mauro V, Vernamonte S, Messina AM. An unusual complication of osteotome sinus floor elevation: benign paroxysmal positional vertigo. Int J Oral Maxillofac Surg. 2011 Feb;40(2):216-8.

18. Llopet, Julien DDS; Montaudon, Michel MD, PhD; Guillaud, Etienne PhD; Ella, Bruno DDS, PhD Comparison of 2 Crestal Sinus Floor Lift Techniques Performed on Human Cadavers, Implant Dentistry: October 2014 - Volume 23 - Issue 5 - p 626-632 doi: 10.1097

19. Troedhan AC, Kurrek A, Wainwright M, Jank S. Hydrodynamic ultrasonic sinus floor elevation--an experimental study in sheep. J Oral Maxillofac Surg. 2010 May;68(5):1125-30. doi: 10.1016/j.joms.2009.12.014. Epub 2010 Mar 4.

20. Acteongroup.com. 2021. ACTEON: #1 For Dental Equipment, Imaging and Pharma. [online] Disponible en: https://www.acteongroup.com/us/

21. Troedhan, A., Kurrek, A., & Wainwright, M. (2012). Biological Principles and Physiology of Bone Regeneration under the Schneiderian Membrane after Sinus Lift Surgery: A Radiological Study in 14 Patients Treated with the Transcrestal Hydrodynamic Ultrasonic Cavitational Sinus Lift (Intralift). *International Journal of Dentistry*, *2012*, 576238.

22. Velázquez-Cayón R, Romero-Ruiz MM, Torres-Lagares D, et al. Hydrodynamic ultrasonic maxillary sinus lift: review of a new technique and presentation of a clinical case. Med Oral Patol Oral Cir Bucal. 2012;17(2):e271-e275. Published 2012 Mar 1. doi:10.4317/medoral.17430

23. Troedhan, A., Kurrek, A., Wainwright, M., Schlichting I., Fischak-Treitl B. and Ladentrog M. The transcrestal hydrodynamic ultrasonic cavitational

sinuslift: Results of a 2-year prospective multicentre study on 404 patients, 446 sinuslift sites and 637 inserted implants. Open Journal of Stomatology, 2013; 3: 471-485.

24. Kim JM, Sohn DS, Heo JU, Park JS, Jung HS, Moon JW, Lee JH, Park IS. Minimally invasive sinus augmentation using ultrasonic piezoelectric vibration and hydraulic pressure: a multicenter retrospective study. Implant Dent. 2012 Dec;21(6):536-42. doi: 10.1097/ID.0b013e3182746c3d. PMID: 23149505.

25. Kim JM, Sohn DS, Bae MS, Moon JW, Lee JH, Park IS. Flapless transcrestal sinus augmentation using hydrodynamic piezoelectric internal sinus elevation with autologous concentrated growth factors alone. Implant Dent. 2014 Apr;23(2):168-74. doi: 10.1097/ID.0000000000000053. PMID: 24637529.

26. Lee, H.-J., Moon, J.-W., Lee, J.-H., Park, I.-S., Kim, N.-H., & Sohn, D.-S. Multicenter clinical study on the hydrodynamic piezoelectric internal sinus elevation (HPISE) technique. *Journal of the Korean Association of Oral and Maxillofacial Surgeons*, *38*, 85. 2012.

27. Wang M, He J, Liu X. Maxillary Sinus Floor Elevation Using the Lateral Window Osteotomy Versus Crestal Window Technique with Endoscopy and Hydraulic Pressure. Acta Microscopica . 2020 Feb;29(2):642–9.

28. Almutairi AS, Walid MA and Alkhodary MA: The effect of osseodensification and different thread designs on the dental implant primary stability. F1000Res. 2018; 7: 1 - 10.

29. Palaskar J N, Joshi N, Shah P et al.:Influence of different implant placement techniques to improve primary implant stability in low-density bone: A systematic review. J Indian Prosthodont Soc,2020; 1: 20 - 25.

30. Kothayera M, Abdelfattaha A M: Effect of Using Densah Burs on Implant Stability and Peri-implant Marginal Bone Loss in Maxillary Implant Supported Partial Overdentures. DOI: 10.21608/omx.2020.28640.1062

31. Versah Spain. Productos para Oseodensificación. 2021. Versah Spain. Productos para Oseodensificación en España. [online] Disponible en: https://www.versah-spain.es/

32. Bhalla N, Dym H. Update on Maxillary Sinus Augmentation. Dent Clin North Am. 2021 Jan;65(1):197-210. doi: 10.1016/j.cden.2020.09.013. Epub 2020 Nov 2. PMID: 33213709.

33. Huwais S. Enhancing implant stability with osseodensification – a case report with 2 year follow-up. Implant Pract 2018;8(1):34

34. Salgar N. ; Osseodensified Crestal Sinus Window Augmentation: An Alternative Procedure to the Lateral Window Technique. J Oral Implantol 1 February 2021; 47 (1): 45–55

35. Huwais, S. et al. A Multicenter Retrospective Clinical Study with Up-to-5-Year Follow-up Utilizing a Method that Enhances Bone Density and Allows for Transcrestal Sinus Augmentation Through Compaction Grafting. International Journal of Oral & Maxillofacial Implants, [s. l.], v. 33, n. 6, p. 1305–1311, 2018. DOI 10.11607/jomi.6770

36. SLA Kit abordaje lateral del seno | Recursos Médicos. [online] Disponible en: https://recursosmedicos.com/producto/sla-kit-abordaje-lateral-del-seno/

37. Farré-Pagés N, Augé-Castro ML, Alaejos-Algarra F, Mareque-Bueno J, Ferrés-Padró E, Hernández-Alfaro F. A novel trephine design for sinus lift lateral approach. Case report. Med Oral Patol Oral Cir Bucal. 2011 Jan 1;16 (1):e79-82

38. SCA kit abordaje crestal del seno | Recursos Médicos. [online] Disponible en: https://recursosmedicos.com/producto/sca-kit-abordaje-crestal-del-seno/

39. Kim YK, Lee JY, Park JW, Kim SG, Oh JS. Sinus Membrane Elevation by the Crestal Approach Using a Novel Drilling System. Implant Dent. 2017 Jun;26(3):351-356. doi: 10.1097/ID.0000000000000570. PMID: 28288021.

40. Zhou X, Hu XL, Li JH, Lin Y. Minimally Invasive Crestal Sinus Lift Technique and Simultaneous Implant Placement. Chin J Dent Res. 2017;20(4):211-218. doi: 10.3290/j.cjdr.a39220. PMID: 29181458.

41. Matos, N., Moreno, J., Jiménez, A., Ortiz, I., Núñez, E., España, A., & Velasco, E. (2018). Implant Treatment By Transalveolar Maxillary Sinus Elevation.MISE (Maxilary Indirect Sinus Elevation). *Revista Española Odontoestomatologia de Implantes*, *22*(1), 39–45.

42. M.I.S.E. EVO - Drill And Stop System For Maxillary Sinus Lift - Implantology And Surgery Oral Surgery | Sweden & Martina [online]. Sweden-martina.com. Disponible en: https://www.sweden-martina.com/en_au/product/implantology_and_surgery-13438/oral_surgery-1398/mise_evo-666.html#tabs-8-20

43. Sisti A, Canullo L, Mottola MP, Iannello G. A case series on crestal sinus elevation with rotary instruments. Eur J Oral Implantol. 2011 Summer;4(2):145-52. PMID: 21808764.

44. Sisti A, Canullo L, Mottola MP, Iannello G. Crestal minimally-invasive sinus lift on severely resorbed maxillary crest: prospective study. Biomed Tech

(Berl). 2012 Jan 9;57(1):45-51. doi: 10.1515/bmt-2011-0038. PMID: 22718591.

45. Nasser K. La elevación indirecta del seno maxilar en el tratamiento con implantes. Técnica MISE [tesis doctoral]. Sevilla (España). 2020.

46. CAS Kit - Easier and Quicker Sinus Lifting - OSSTEM UK [Internet]. OSSTEM IMPLANT UK. Disponible en: https://www.osstemuk.com/surgery-kits/cas-kit-sinus-lifting-implantology-dental-implants/

47. Kim YK, Cho YS, Yun PY. Assessment of dentists' subjective satisfaction with a newly developed device for maxillary sinus membrane elevation by the crestal approach. J Periodontal Implant Sci. 2013 Dec;43(6):308-14. doi: 10.5051/jpis.2013.43.6.308. Epub 2013 Dec 31. PMID: 24455444; PMCID: PMC3891863.

48. Gatti F, Gatti C, Tallarico M, Tommasato G, Meloni SM, Chiapasco M. Maxillary Sinus Membrane Elevation Using a Special Drilling System and Hydraulic Pressure: A 2-Year Prospective Cohort Study. Int J Periodontics Restorative Dent. 2018 Jul/Aug;38(4):593-599. doi: 10.11607/prd.3403. PMID: 29889923.

49. Mahesh L, Kurtzman GM, Shukla S. Trephine core: an alternative sinus lift technique. J Oral Implantol. 2014 Jul;40 Spec No:391-6. doi: 10.1563/aaid-joi-D-14-00047. Epub 2014 Mar 12. PMID: 24621196.

50. Tilotta F, Lazaroo B, Gaudy JF. Gradual and safe technique for sinus floor elevation using trephines and osteotomes with stops: a cadaveric anatomic study. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2008 Aug;106(2):210-6. doi: 10.1016/j.tripleo.2007.12.030. Epub 2008 Jun 11. PMID: 18547840.

51. Fugazzotto PA. The modified trephine/osteotome sinus augmentation technique: technical considerations and discussion of indications. Implant Dent. 2001;10(4):259-64. doi: 10.1097/00008505-200110000-00009. PMID: 11813667

52. Fugazzotto PA. Immediate implant placement following a modified trephine/osteotome approach: success rates of 116 implants to 4 years in function. Int J Oral Maxillofac Implants. 2002 Jan-Feb;17(1):113-20. PMID: 11858567.

53. Asmael HM. Is antral membrane balloon elevation truly minimally invasive technique in sinus floor elevation surgery? A systematic review. Int J Implant Dent. 2018 Apr 17;4(1):12. doi: 10.1186/s40729-018-0123-9. PMID: 29663095; PMCID: PMC5902438.

54. Soltan M, Smiler DG. Antral membrane balloon elevation. J Oral Implantol. 2005;31(2):85-90. doi: 10.1563/0-773.1. PMID: 15871527.

55. Kfir E, Kfir V, Eliav E, et al. Minimally invasive antral membrane balloon elevation: report of 36 procedures. J Periodontol. 2007;78:2032–5

56. Kfir E, Goldstein M, Yerushalmi I, et al. Minimally invasive antral membrane balloon elevation—results of a multicenter registry. Clin Implant Dent Relat Res. 2009;11:e83–91.

57. Hu X, Lin Y, Metzmacher AR, et al. Sinus membrane lift using a water balloon followed by bone grafting and implant placement: a 28-case report. Int J Prosthodont. 2009;22:243–7

58. Petruzzi M, Ceccarelli R, Testori T, et al. Sinus floor augmentation with a hydropneumatic technique: a retrospective study in 40 patients. Int J Periodontics Restorative Dent. 2012;32:205–10.

59. Mazor Z, Kfir E, Lorean A, et al. Flapless approach to maxillary sinus augmentation using minimally invasive antral membrane balloon elevation. Implant Dent. 2011;20:434–8.

60. Jesch P, Bruckmoser E, Bayerle A, Eder K, Bayerle-Eder M, Watzinger F. A pilot- study of a minimally invasive technique to elevate the sinus floor membrane and place graft for augmentation using high hydraulic pressure: 18-month follow-up of 20 cases. Oral Surg Oral Med Oral Pathol Oral Radiol. 2013;116(3):293–300.

61. Sotirakis EG, Gonshor A. Elevation of the maxillary sinus floor with hydraulic pressure. J Oral Implantol. 2005;31(4):197-204. doi: 10.1563/1548-1336(2005)31[197:EOTMSF]2.0.CO;2. PMID: 16145848.

62. Nahlieli O. Dynamic Implant Valve Approach for Dental Implant Procedures. The Chinese Journal of Dental Research. 2014. 17 (1): 15-21

63. DIVA | Paltop [Internet]. Paltopdental.com. Disponible en: https://www.paltopdental.com/content/diva

64. Better H, Slavescu D, Barbu H, Cochran DL, Chaushu G. Patients' perceptions of recovery after maxillary sinus augmentation with a minimally invasive implant device. Quintessence International [Internet]. 2014 Oct [cited 2021 Apr 5];45(9):779–87

65. Nahlieli O, Zagury A, Michaeli E, Bruck N, Nahlieli DD, Casap N. Four-years' experience with dynamic implants with internal port for minimally invasive

sinus elevation. Quintessence Int. 2016;47(8):669-75. doi: 10.3290/j.qi.a36328. PMID: 27284586.

66. Chaushu L, Chaushu G, Better H, Naishlos S, Kolerman R, Aragoneses JM, Calvo-Guirado JL, Nissan J. Sinus Augmentation with Simultaneous, Non-Submerged, Implant Placement Using a Minimally Invasive Hydraulic Technique. Medicina (Kaunas). 2020 Feb 13;56(2):75. doi: 10.3390/medicina56020075. PMID: 32069970; PMCID: PMC7074246.

67. Tallarico M, Meloni SM, Xhanari E, Pisano M, Cochran DL. Minimally Invasive Sinus Augmentation Procedure Using a Dedicated Hydraulic Sinus Lift Implant Device: A Prospective Case Series Study on Clinical, Radiologic, and Patient-Centered Outcomes. Int J Periodontics Restorative Dent. 2017 Jan/Feb;37(1):125-135. doi: 10.11607/prd.2914. PMID: 27977827.

VIII. ANEXOS:

Autor y titulo	Año	Nº de implantes	mm de hueso residual antes de la intervención	Complicaciones	mm de hueso después de la intervención	Material de injerto e inserción de implantes inmediata.
Julien Llopet, DDS y cols. Comparison of 2 Crestal Sinus Floor Lift Techniques Performed on Human Cadavers.	2014	11 (intralift) 11 (técnica de Summers)	< 9 mm	0 Perforaciones de membrana (intralift) 2 Perforaciones de membrana (Técnica de Summers)	--	2 cm^2 de material de injerto óseo. No se colocó implantes ya que se trata de un estudio realizado en cadáveres.
A.Troedhan. Biological y cols. Principles and Physiology of Bone Regeneration under the Schneiderian Membrane after Sinus Lift Surgery: A Radiological Study in 14 Patients Treated with the Transcrestal Hydrodynamic Ultrasonic Cavitational Sinus Lift (Intralift)	2012	14	4 mm o menos	0 perforaciones de membrana	14,6 mm (transversal) 14,7 mm (sagital)	Material de injerto óseo + esponja colágeno radiolúcido de aproximadamente 2 cm^3. No inserción de implantes inmediata.
Velázquez-Cayón R y cols. Hydrodynamic ultrasonic maxillary sinus lift: review of a new technique and presentation of a clinical case.	2012	1	3-4 mm	--	--	Material de injerto óseo + membrana. No inserción de implantes inmediato.

Troedhan A. y cols. The transcrestal hydrodynamic ultrasonic cavitational sinuslift: Results of a 2-year prospective multicentre study on 404 patients, 446 sinuslift sites and 637 inserted implants .	2013	404 pacientes 446 elevaciones de seno maxilar.	4 mm	97% de los pacientes no sufrieron complicaciones postoperatorias.	Hasta 17 mm	A elección del cirujano.
Ji-Min Kim y cols. Minimally Invasive Sinus Augmentation Using Ultrasonic Piezoelectric Vibration and Hydraulic Pressure: A Multicenter Retrospective Study	2012	250 elevaciones de seno 353 implantes 224 pacientes	6,14 mm de media	Perforaciones en 10 de los 353 sitios de implantes (2,83%) 11 implantes fracasados. Éxito de 97,2 %.	Ganancia de 5,49 mm de media. (0,5-10 mm).	< 5 mm → coagulo de fibrina con factores de crecimiento autólogo. (188) > 6 mm → material de injerto óseo (62) Colocación simultanea de implantes.
Ji-Min Kim y cols. Flapless Transcrestal Sinus Augmentation Using Hydrodynamic Piezoelectric Internal Sinus Elevation With Autologous Concentrated Growth Factors Alone	2014	11 elevaciones de seno. 16 implantes 10 pacientes	4,98 mm de media.	0 perforaciones	Ganancia de 8,23 mm de media. Altura: 13,95 mm de media llegando incluso a 27,9 mm.	Colocación simultanea de implantes. Coagulo de fibrina con factores de crecimiento autólogo. Como material de relleno.
Hyung-Ju Lee y cols. Multicenter clinical study on the hydrodynamic piezoelectric internal sinus elevation (HPISE) technique.	2012	169 implantes 103 pacientes 114 elevaciones de seno	6,18 mm de media.	Fracaso de 8 implantes (95,8 %) por perforación (2) o por falta de estabilidad primaria (6).	Ganancia de 5,7 mm de media (0,5-10,5 mm)	Material de injerto óseo. Colocación simultanea de implantes.
Mohan Wang Maxillary Sinus Floor Elevation Using the Lateral Window Osteotomy Versus Crestal Window Technique with Endoscopy and Hydraulic Pressure	2020	14 implantes 8 pacientes	3,81 mm de media.	-	Ganancia de 5,27 mm de media.	Material de injerto óseo

Nilesh Salgar. Osseodensified Crestal Sinus Window Augmentation: An Alternative Procedure to the Lateral Window Technique	2021	3 pacientes 5 implantes	1,1 ± 0,4 mm	0	13 ± 1,3 mm	Material de injerto óseo + membrana.
Huwais S. Y cols. A Multicenter Retrospective Clinical Study with Up-to-5-Year Follow-up Utilizing a Method that Enhances Bone Density and Allows for Transcrestal Sinus Augmentation Through Compaction Grafting	2018	222 pacientes 261 implantes	>2 mm (media 5,4 mm)	0	Ganancia de 7 mm.	Material de injerto óseo y colocación instantánea de los implantes (94%).
Young-Kyun Kim y cols. Sinus Membrane Elevation by the Crestal Approach Using a Novel Drilling System.	2017	19 pacientes 21 implantes	4-7,8 mm	0 perforaciones 1 infección local 1 sinusitis	8-16,2 mm	Material de injerto óseo e inserción de implantes inmediata. Tto. prostodóntico 4-6 meses después.
Xian Zhou y cols. Minimally Invasive Crestal Sinus Lift Technique and Simultaneous Implant Placement.	2017	11 pacientes 12 implantes	> 4 mm pero < 9mm.	0 perforaciones	Ganancia de 2,8-7,4 umm.	Material de injerto óseo e implantes simultáneos. Rehabilitación a los 6 meses.

Nuno Matos Garrido y cols. Tratamiento con implantes mediante la elevación transalveolar del seno maxilar. Técnica MISE (maxillary indirect sinus elevation)	2018	19 pacientes 20 implantes	--	0 Perforaciones 1 implantes perdido durante la osteointegración.	Ganancia media de 4,4 mm.	Material de injerto óseo. Inserción simultanea. Carga a los 6 meses.
Angelo Sisti y cols. A case series on crestal sinus elevation with rotary instruments	2011	50 pacientes 64 implantes	1,2 -9,8 mm, media de 6,2 mm.	1 perforación sin consecuencias negativas. 28 pacientes con hinchazón pero sin dolor.	Ganancia de 2,2 a 13,4 mm, media de 7,73 mm. 18 meses después, altura de hueso de 10,10 a 15,5 mm, media de 15,40 mm	Material de injerto óseo (hidroxiapatita) Inserción simultanea. 4 meses para descubrir los implantes.
Angelo Sisti y cols. Crestal minimally-invasive sinus lift on severely resorbed maxillary crest: prospective study	2012	17 pacientes 20 implantes	1,2 – 5 mm	1 perforación de membrana sin consecuencias negativas. 12 pacientes hinchazón sin dolor primer día	Elevación obtenida de 6,6- 13,4 mm. 24 meses después la altura de hueso era de 10,1 a 25,5 mm.	Material de injerto óseo (hidroxiapatita) Inserción simultanea. 4 meses para descubrir los implantes .
Karim Nasser Nasser. La elevación indirecta del seno maxilar en el tratamiento con implantes. Técnica MISE.	2020	91 implantes	3- 10 mm	85 pacientes sin complicaciones (93,4 %) 6 pacientes con complicaciones (6,6%)	Ganancia de 1,4 a 8 mm, una media de 4,6 mm. Perdida de hueso marginal media 0,76 mm.	No se utilizaron biomateriales en 2 pacientes (2,2 %). 28 pacientes técnica no sumergida. 63 pacientes técnica sumergida.

Fulvio Gatti y cols. Maxillary Sinus Membrane Elevation Using a Special Drilling System and Hydraulic Pressure: A 2-Year Prospective Cohort Study	2018	35 pacientes 49 implantes	> 3 mm pero < 8 mm.	0	-	32 material de injerto óseo 17 sin material de injerto óseo
Paul A. Fugazzotto The Modified Trephine/Osteotome Sinus Augmentation Technique: Technical Considerations and Discussion of Indications	2001	71 elevaciones de seno. 61 pacientes	4-5 mm	0 complicaciones	-	Material de injerto óseo. 51 implantes colocados simultáneamente.
Lanka Mahesh Trephine Core: An Alternative Sinus Lift Technique	2014	1 implante	-	0 complicaciones Inflamacion alrededor de la restauración.	-	Colocación simultanea. 5 meses para descubrir el implante.
Paul A. Fugazzotto Immediate Implant Placement Following a Modified Trephine/Osteotome Approach: Success Rates of 116 Implants to 4 Years in Function	2002	116 implantes	-	0 complicaciones	-	Colocación simultanea.
Stefania Arena Estudio mediante el sistema compudent navigator sobre los injertos óseos realizados con la técnica de elevación de seno convencional y la técnica de catéter-globo	2016	33 elevaciones con técnica de Tatum. 33 elevaciones con técnica de globo. 119 implantes en total.	1,3 a 4,8 mmm, media de 3,3 mm (en ambos grupos)	2 perforaciones (globo)→ 6,1% 3 perforaciones (Tatum) → 9,1%	Media de 11,9 mm (2,5-17 mm).Globo Media de 14,2 mm (6,3-20,2 mm) Tatum.	Material de injerto óseo. 6 meses hasta la colocación de los implantes.

Huda Moutaz Asmael Is antral membrane balloon elevation truly minimally invasive technique in sinus floor elevation surgery? A systematic review	2018	10 artículos revisados.		Perforación de membrana del 6,76%. Éxito del 91,6%.	Ganancia de 3 a 10,8 mm, media de 6,96.	Supervivencia de los implantes (96,62%)
Efraim Kfir y cols. Minimally Invasive Antral Membrane Balloon Elevation: Report of 36 Procedures	2007	36 elevaciones de 36 pacientes	3.4 ± 2.1 mm	1 perforación de membrana. (2,77%) 2 fracaso en implante.	Ganancia de > 10 mm. Desde 8 a 18 mm.	Material de injerto óseo. Colocación inmediata de implantes.
Efraim Kfir y cols. Minimally Invasive Antral Membrane Balloon Elevation – Results of a Multicenter Registry.	2009	112 pacientes	3.8 ± 2.1 mm	12 perforaciones de membrana (10,71%). 1 infección con fistula.	Ganancia de > 10 mm. Desde 11 a 18 mm.	Material de injerto oseo. Colocación instantánea de los implantes.
Xiulian Hu y cols. Sinus Membrane Lift Using a Water Balloon Followed by Bone Grafting and Implant Placement: A 28-Case Report	2009	28 elevaciones en 28 pacientes.	4.92 ± 1.24 mm	2 perforaciones de membrana (7,14%) 1 sangrado nasal leves post operatorio.	Ganancia de 10.9 ± 2.06 mm	Material de injerto óseo. Colocación inmediata de implantes.

Massimo Petruzzi y cols. Sinus Floor Augmentation with a Hydropneumatic Technique: A Retrospective Study in 40 Patients	2012	40 pacientes.	8.00 ± 2.19 mm	3 perforaciones de membrana. (7,5 %) 4 edemas hemifaciales.	14.66 ± 1.48 mm	Material de injerto oseo. Colocación instantánea de los implantes.
Ziv Mazor y cols. Flapless Approach to Maxillary Sinus Augmentation Using Minimally Invasive Antral Membrane Balloon Elevation.	2011	24 elevaciones de seno, en 20 pacientes.	2–6 mm	0 perforaciones	Ganancia de 11 mm.	Material de injerto oseo. Colocación instantánea de los implantes.
Philip Jesch y cols. A pilot-study of a minimally invasive technique to elevate the sinus floor membrane and place graft for augmentation using high hydraulic pressure: 18-month follow-up of 20 cases	2013	20 elevaciones en 18 pacientes.	4,6 ± 1,4 mm	1 perforaciones (5%) 1 implante perdido a las 9 meses. (3 meses después se volvió a colocar)	Ganancia 9,2 ± 1,7 mm Altura conseguida 13,8 ± 2.3 mm	Material de injerto óseo Colocación simultanea de implantes.
Oded Nahlieli. Dynamic Implant Valve Approach for Dental Implant Procedures.	2014	63 pacientes. 218 implantes.	> 3 mm	Fallo de 7 implantes en 5 pacientes (3,2%).	-	Implantes DIVA

Oded Nahlieli y cols. Four-years' experience with dynamic implants with internal port for minimally invasive sinus elevation.	2016	172 pacientes 378 implantes	> 3 mm < 5 mm (257 IOI) > 5 mm (121 IOI)	Fracaso de 21 implantes en 9 pacientes (5,5%)	-	Implantes DIVA
Hadar Better y cols. Patients' perceptions of recovery after maxillary sinus augmentation with a minimally invasive implant device.	2014	20 elevaciones de seno 18 pacientes	4 mm o más		-	Implantes iRaise
Liat Chaushu y cols. Sinus Augmentation with Simultaneous, Non-Submerged, Implant Placement Using a Minimally Invasive Hydraulic Technique	2020	50 pacientes en dos grupos de 25. (sumergidos y no sumergidos)	4 mm o más	0 complicaciones	Ganancia de 7,8 mm de media en el 1 grupo. Ganancia de 9,3 mm de media en el 2 grupo.	Implantes iRaise
Marco Tallarico y cols. Minimally Invasive Sinus Augmentation Procedure Using a Dedicated Hydraulic Sinus Lift Implant Device:A Prospective Case Series Study on Clinical, Radiologic, and Patient-Centered Outcomes	2017	18 pacientes	3 mm o más (media 4,78 mm)	0 perforaciones Algunos dolor e hinchazón.	12,78 mm	Implantes iRaise

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Dental implants and single implant-supported restorations

Abstract: Replacing missing teeth using dental implants is a good treatment option with a high degree of success. As the dental implantology field develops and the number of implants placed worldwide increases, several terms and techniques have been formulated. Therefore, a basic knowledge of dental implants is necessary for every dental student and dentist. The current article sheds light on how the dental implant integrates with its surrounding bone and what factors can affect this integration. The relationship between the implant and its surrounding soft tissue, different types of the dental implants, and the restorative components and procedures, are all reviewed.

Key terms: osseointegration; single dental implant ; single implant abutment; screw-retained; restoration; cement-retained restoration.

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Introduction

The use of dental implants in replacing single and multiple missing teeth is proven to be a valid treatment with a high success rate.[1] To achieve the best treatment outcome in all implant systems, the implant has to be able to integrate with its surrounding tissue.

Several clinical studies have reported that, under optimum circumstances, a long-term rigid union between the implant surface and the surrounding bone can be achieved and maintained for indefinite periods of time.[2,3] Therefore, to maintain the rigid union, continuous remodelling of the bone supporting the implant in the presence of functional loading is essential. However, this integration is highly affected by several factors, such as bone quality, quantity and the implant loading condition.[1,2]

In general, dental implants usually consist of the implant body and the abutment to which the restorations are attached. To attach the restorative counterpart to the implant, an impression has to be made. The impression technique here is similar to that used in conventional prosthodontics work.

There are a variety of dental implant systems, and several terms and techniques have emerged with the use of dental implants. Some of these terms are confusing and knowing all of the terms and techniques is not easy.

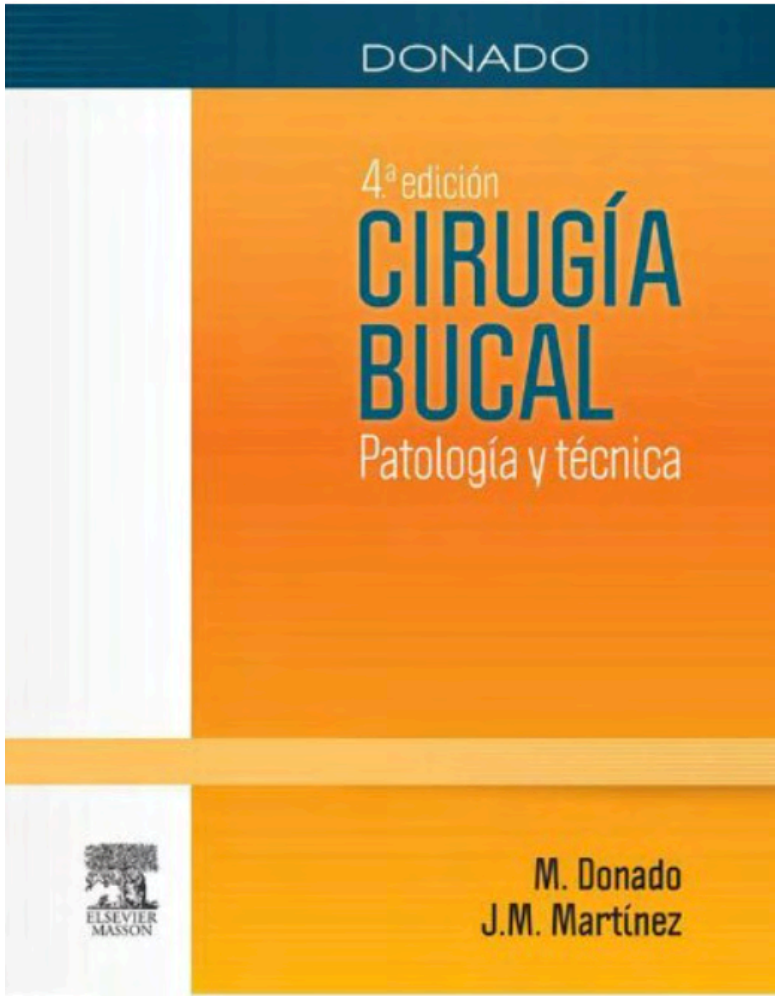
This article provides clarification of the terms used in dental implantology, as well as an overview of the subject area, both of which are vital for every dental student and dentist.

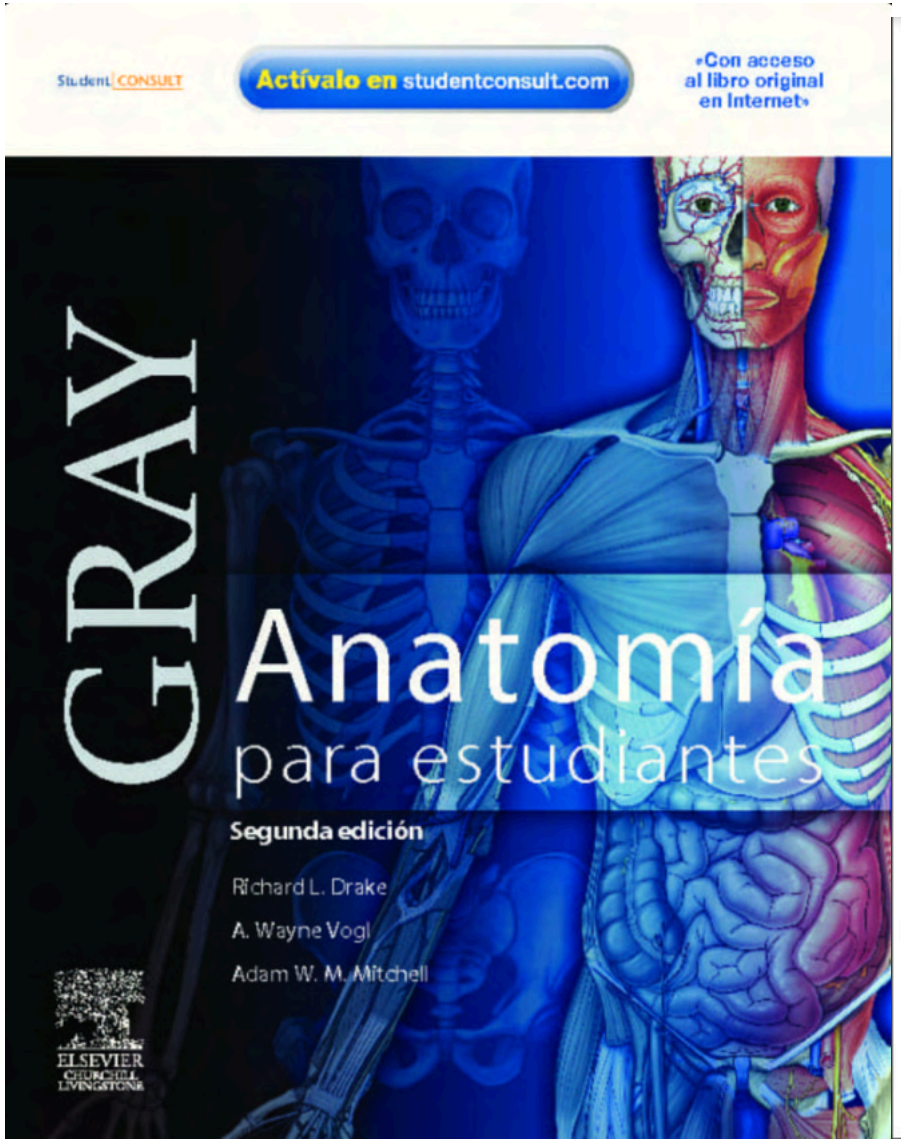
Background

Bone-implant contact and osseointegration

The connection between implant surfaces and bone can be mediated by either connective tissue fibres or by intimate contact of bone and implant surface. While the former indicates a failure of any implant system, the latter is the objective of the implant surgery and is known as osseointegration. Commencement of either mechanism is influenced by many factors, which will be discussed later.[4,5]

Light microscopy of histological studies on retrieved osseointegrated and failed implants in humans and some animals revealed that





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REVIEW ARTICLE

The maxillary sinus: physiology, development and imaging anatomy

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Objectives: The maxillary sinus is of paramount importance for otolaryngologists, rhinologists, oral and maxillofacial surgeons, head and neck and dental and maxillofacial radiologists. A comprehensive review article concerning the physiology, development and imaging anatomy was undertaken.
Methods: Relevant literature pertaining to the physiology of the sinonasal cavity, development of the paranasal sinuses and imaging anatomy of the maxilla and maxillary sinus from 2000 to 2019 was reviewed. Emphasis was placed on literature from the last 5 years.
Results: Extensive recent research using imaging has provided new insights into the development of the maxillary sinus, the other paranasal sinuses and the midface. The fundamental physiological concept of mucociliary clearance and its role in sinus health is emphasized. The paranasal sinuses are an integral part of a common mucosal organ formed by the upper and lower airway. An in-depth understanding of the soft-tissue and neurovascular relationships of the maxillary sinus to the deep fascial spaces and branches of the trigeminal nerve and external carotid artery respectively is required to evaluate and report imaging involving the maxillary sinus. Sinusitis of rhinogenic, rather than odontogenic origin, originates from nasal inflammation followed by anterior ethmoid disease and secondary obstruction of the ostiomeatal unit. The role of anatomical variants that predispose to this pattern of disease is discussed in detail with illustrative examples.
The maxillary sinus is intimately related to the roots of the posterior maxillary teeth; the high frequency of mucosal disease and sinusitis of odontogenic aetiology is now well recognized. In addition, an understanding of the anatomy of the alveolar process, morphology of the alveolar recess of the maxillary sinus and neurovascular supply are essential both for deliberate surgical intervention of the sinus and complications related to oral surgical procedures.
Conclusions: An understanding of the fundamental principles of the development, physiology, anatomy and relationships of the maxillary sinus as depicted by multi-modality imaging is essential for radiologists reporting imaging involving the paranasal sinuses and midface.
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Introduction

There are four pairs of paranasal sinuses: the maxillary, ethmoid, frontal and sphenoid. They are air-filled, mucosa-lined spaces within the maxillofacial region and skull centred on and communicating with the nasal cavity.

The nose and paranasal sinuses form a functional unit as well as being an integral part of the respiratory tract

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Introducing a simple method of maxillary sinus volume assessment based on linear dimensions

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Abstract: Measuring sinus volume in a general practice clinic is a complex and time-consuming procedure, requiring experience in the use of radiological methods. In the presented research, the automatically estimated maxillary sinus volume was compared with maxillary sinus volume assessed with mathematical formulas used to calculate the volume of spheres and pyramids. The starting point for the statistical analysis were specific measurements of the sinuses. We wanted to discover which geometric shape has the volume that is nearest to the automatically estimated volume.

The study was performed using samples of CT scans of pediatric patients age 1 to 17. The dimensions (maximal width, maximal height, maximal length) were used for manual calculations. For the automatic volume calculation, the CT Image Segmentation algorithm (Syngo Via for Oncology, Siemens) was used. Pearson's correlation coefficient was applied to analyse the interrelationship between automatically and manually calculated volume of maxillary sinus. It was statistically established that the "sphere", "pyramid" and "mean" manually calculated maxillary sinus volume were accurate and strongly correlated with the automatically estimated maxillary sinus volume. The volume of the sphere corresponds better with the automatic measurements than the volume of the pyramid. The variations are significant and they were made reliable with the application of a statistical test. It is quick and

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HEAD & NECK

Three-dimensional evaluation of maxillary sinus volume in different age and sex groups using CBCT

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Abstract
Aim Sinus maxillaris is an important anatomical formation in many branches of dentistry due to its proximity to the field of work. Various methods have been used in literature to measure the maxillary sinus volume (MSV) such as cadavers, stereology, two-dimensional conventional radiographs, computed tomography (CT), magnetic resonance imaging (MRI). The aim of this study is to evaluate the change of maxillary sinus volume according to age and gender with MIMICS 19.0 (Materialise HQ Technologielaan, Leuven, Belgium) which is one of three-dimensional modeling software.
Materials and methods This study was performed in 200 patients selected by a retrospective review of the archives of the Dicle University, Faculty of Dentistry, Department of Oral and Maxillofacial Radiology. Patients were divided into five age groups (18–24 years, 25–34 years, 35–44 years, 45–54 years, and ≥ 55 years) and by sex. Cone-beam computed tomography (CBCT) images of the patients were transferred to the MIMICS software and the MSV was measured. All statistical analyses were performed using the SPSS (Statistical Package for Social Sciences, version 21) software.
Results There was no statistically significant difference between the right and left maxillary sinus volume according to the findings obtained from our study, and maxillary sinus volume in males was found to be significantly higher than that of females. Another finding of our study is that the maxillary sinus volume decreases with age increase. Especially it was also found that the sinus volume in males in the 18–24 age group was statistically significantly higher than females.
Conclusion Consequently, maxillary sinus volume measurements can be made on CT, CBCT, MRI scans using reconstruction software.

Keywords Maxillary sinus volume · Cone-beam computed tomography · Third party software

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Introduction

The success of treating sinonasal disorders the comprehensive knowledge and the proper visualiziation of the anatomic conditions of the osteomeatal complex and the paranasal sinuses is crutial in head and neck surgery, especially in otolaryngology, skull base surgery and maxillofacial surgery [1, 2].

The maxillary sinuses are of great interest to dentists because of their proximity to the area in which dentist's work. Knowledge of the maxillary sinus anatomy is valuable to prevent possible complications in maxillofacial surgery, and in the preoperative evaluation of dental implant treatment, estimation of the size of graft required for a sinus lift, and orthodontic mini-implant treatment. Besides dentistry, in forensic medicine, the maxillary sinus can be used for sex determination in cases in which the whole body cannot be found [3–7].

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Implants in the Posterior Maxilla: A Comparative Clinical and Radiologic Study

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Purpose: *The aim of this study was to evaluate implants placed according to several methods of sinus floor augmentation.* **Materials and Methods:** *Forty-eight patients (median age of 62 years, range 23 to 89) had been treated at least 3 years prior to examination with screw-type implants in the posterior maxilla. Depending on the vertical dimension of the residual bone, 1 of 3 surgical procedures had been performed: sinus lift by lateral antrostomy (SL) in 13 patients; osteotome technique (OT) in 18 patients; standard implantation in 17 patients (control). In each patient 1 implant was randomly chosen for analysis (48 implants with a mean observation time of 4.6 ± 1.4 years). Examination included probing pocket depth (PPD) measurement and radiographic examination. Radiographs were digitized to assess the marginal bone level. Differences between the groups were tested using analysis of variance, the Student t test and the Kruskal-Wallis test.* **Results:** *Mean PPD was 3.0 mm for the SL, 3.1 mm for OT, and 3.1 mm for control. The mean radiographic bone level was 1.53 mm for SL, 2.40 mm for OT, and 1.96 mm for control. No statistically significant differences were found between the groups for either of these parameters.* **Discussion and Conclusion:** *Clinical examinations as well as radiographically stable bone levels indicated similar biomechanical conditions for prosthetic restorations when applying the 3 surgical procedures tested.* Int J Oral Maxillofac Implants 2005;20:231–237

Key words: *dental implants, maxilla, maxillary sinus, osteotome technique, radiography, sinus floor elevation*

The posterior maxilla often presents specific problems for the placement of dental implants. The generally poor bone quality frequently encountered in this region in conjunction with inadequate bone volume related to both the size of the maxillary sinus and resorption of the alveolar ridge have rendered long-term success rates for implants less favorable here than in other regions of the mouth.[1–4] During the past 25 years, surgical procedures have been developed with the aim of increasing the local bone volume, thus enabling the placement of implants or allowing the placement of implants of more than 8 mm in length.[5]

In situations where the lack of bone volume is related to an enlarged maxillary sinus, elevation of the sinus floor has been advocated to permit implant placement. Among the variety of techniques that have been described, the 3 that are the most widely used are *(1)* the 2-step antrostomy (lateral approach),[6,7] *(2)* the 1-step antrostomy (lateral approach),[8,9] and *(3)* the osteotome technique (crestal approach).[10–12]

The 2-step antrostomy is the treatment of choice when the residual ridge bone height is less than 4 mm.[13] As part of this approach, the implants are usually placed after a healing period of 6 to 18 months

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CASO CLÍNICO

Elevación de seno maxilar y colocación simultánea de implantes utilizando plasma rico en factores de crecimiento (PRFC), hidroxiapatita y aloinjerto. Reporte de un caso de siete años

Maxillary sinus elevation and simultaneous implant placement using PRGF (plasma rich in growth factors), hydroxyapatite and allogenic graft. Seven year case report

Nayibe Hernández Tejeda,* Ma. del Carmen López Buendía§

RESUMEN

La elevación de piso de seno maxilar es un procedimiento quirúrgico predecible que se realiza con la finalidad de aumentar verticalmente la cantidad de hueso en la región posterior del maxilar para poder realizar una rehabilitación protésica implantosoportada. El propósito de este trabajo es describir un caso clínico donde se realizó elevación de piso de seno maxilar utilizando plasma rico en factores de crecimiento, hidroxiapatita absorbible y aloinjerto óseo como materiales de injerto subantral y la colocación simultánea de dos implantes de superficie tratada (Osseotite, 3i) y reportar los resultados clínicos y radiográficos obtenidos siete días, seis meses y siete años después de la cirugía, observando una cicatrización adecuada tanto clínica como radiográficamente. El procedimiento quirúrgico utilizado en este caso clínico resultó una buena opción para poder colocar implantes en áreas maxilares posteriores atróficas.

ABSTRACT

Maxillary sinus floor elevation is a predictable surgical procedure meant to vertically increase the amount of bone in the posterior region of the upper jaw to enable placement of a prosthetic rehabilitation device supported by implants. The aim of the present article was to describe elevation of the maxillary sinus floor using plasma rich in growth factors, absorbable hydroxyapatite and bone allograft as sub-antral graft materials with simultaneous placement of two surface treated implants (Osseotite, 3i). The present article also reported clinical and radiographic results obtained at seven days, six months and seven years after the surgery. From the clinical and radiographic standpoint suitable healing was observed. The surgical procedure used in the present clinical case was considered a suitable option to place implants in atrophic maxillary areas.

Palabras clave: Elevación de seno maxilar, injerto subantral, implantes dentales, plasma rico en factores de crecimiento.
Key words: Maxillary sinus elevation, sub-antral graft, dental implants, plasma rich in growth factors.

INTRODUCCIÓN

Los implantes oseointegrados han demostrado tener resultados predecibles a largo plazo. El mayor índice de fracaso de los implantes se encuentra en la región posterior del maxilar debido a las características anatómicas de la región que incluyen la calidad y cantidad de hueso.[1] La disponibilidad ósea de esta área se ve reducida por múltiples causas como pérdida prematura de los dientes, provocando la neumatización del seno, enfermedad periodontal y reabsorción ósea fisiológica o iatrogénica entre otras, imposibilitando la rehabilitación protésica implantosoportada.[2]

La elevación de piso de seno maxilar es un procedimiento quirúrgico que consiste en incrementar verticalmente la cantidad de hueso en esa región y fue diseñado y descrito por Hilt Tatum en 1976, en el encuentro de implantes dentales celebrado en Birmingham, Alabama; sin embargo, la primera publicación fue realizada por Boyne y James en 1980.[3]

La elevación de piso de seno maxilar está indicada en áreas edéntulas de la región posterior del maxilar con hueso inadecuado donde se requiere la colocación de implantes dentales para el tratamiento protésico.[4] Las distintas situaciones anatómicas y las diferentes topografías del seno respecto al reborde maxilar permiten establecer una clasificación en rela-

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UNIVERSIDAD COMPLUTENSE DE MADRID

FACULTAD DE ODONTOLOGÍA

DEPARTAMENTO DE MEDICINA Y CIRUGÍA BUCOFACIAL

TESIS DOCTORAL

ESTUDIO MEDIANTE EL SISTEMA COMPUDENT NAVIGATOR SOBRE LOS INJERTOS ÓSEOS REALIZADOS CON LA TÉCNICA DE ELEVACIÓN DE SENO CONVENCIONAL Y LA TÉCNICA DE CATÉTER-GLOBO

STEFANIA ARENA ETCHEVERRY

Madrid, 2015

Bone Augmentation Procedures in Implant Dentistry

Matteo Chiapasco, MD[1]/Paolo Casentini, DDS[2]/Marco Zaniboni, DDS[3]

Purpose: *This review evaluated (1) the success of different surgical techniques for the reconstruction of edentulous deficient alveolar ridges and (2) the survival/success rates of implants placed in the augmented areas.* ***Materials and Methods:*** *Clinical investigations published in English involving more than 10 consecutively treated patients and mean follow-up of at least 12 months after commencement of prosthetic loading were included. The following procedures were considered: onlay bone grafts, sinus floor elevation via a lateral approach, Le Fort I osteotomy with interpositional grafts, split ridge/ridge expansion techniques, and alveolar distraction osteogenesis. Full-text articles were identified using computerized and hand searches by key words. Success and related morbidity of augmentation procedures and survival/success rates of implants placed in the augmented sites were analyzed.* ***Results and Conclusion:*** *A wide range of surgical procedures were identified. However, it was difficult to demonstrate that one surgical procedure offered better outcomes than another. Moreover, it is not yet known if some surgical procedures, eg, reconstruction of atrophic edentulous mandibles with onlay autogenous bone grafts or maxillary sinus grafting procedures in case of limited/moderate sinus pneumatization, improve long-term implant survival. Every surgical procedure presents advantages and disadvantages. Priority should be given to those procedures which are simpler and less invasive, involve less risk of complications, and reach their goals within the shortest time frame. The main limit encountered in this literature review was the overall poor methodological quality of the published articles. Larger well-designed long-term trials are needed.* Int J Oral Maxillofac Implants 2009;24(suppl):237–259

Key words: *alveolar bone loss, alveolar ridge augmentation, atrophy, autogenous bone, graft material, oral implant*

Dental rehabilitation of partially or totally edentulous patients with oral implants has become a routine treatment modality in the last decades, with reliable long-term results.[1–12] However, unfavorable local conditions of the alveolar ridge, due to atrophy, periodontal disease, and trauma sequelae, may provide insufficient bone volume or unfavorable vertical, horizontal, and sagittal intermaxillary relationships, which may render implant placement impossible or incorrect from a functional and esthetic viewpoint.

Five main methods have been described to augment bone volume of deficient sites: *(1)* osteoinduction through the use of appropriate growth factors[13,14]; *(2)* osteoconduction, in which a grafting material serves as a scaffold for new bone formation[14,15]; *(3)* distraction osteogenesis, by which a fracture is surgically induced and the two bone fragments are then slowly pulled apart, with spontaneous bone regeneration between the two fragments[16,17]; *(4)* guided bone regeneration (GBR), which allows spaces maintained by barrier membranes to be filled with bone[18–25]; and *(5)* revascularized bone grafts, where a vital bone segment is transferred to its recipient bed with its vascular pedicle, thus permitting immediate survival of the bone and no need for a remodeling/substitution process.[26–29]

Whereas osteoinduction with growth factors such as bone morphogenetic proteins (BMPs) is still in an experimental phase and/or has extremely limited clinical applications, inlay or onlay bone grafts, GBR, split ridge/ridge expansion techniques, and alveolar distraction osteogenesis represent commonly applied

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A Wide-Body Implant as an Alternative for Sinus Lift or Bone Grafting

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Hugo De Bruyn, DDS, MD, PhD§

Purpose: The aim was to evaluate the outcome of a short wide-body implant in the atrophic posterior jaw without a grafting procedure.

Materials and Methods: Patients treated with a tapered wide-body implant measuring 8 to 9 mm in width and 7 to 9 mm in length (Max implant; Southern Implants, Irene, South Africa) were recalled to scrutinize implant survival. Preoperative cone beam computed tomography images were analyzed to measure bone height in reference to the mandibular canal and sinus floor.

Results: There were 57 implants inserted in 18 men and 24 women after a 2-stage procedure and delayed loading. The mean follow-up was 15 months (SD, 10; range, 1-32 months), with 63.2% of the implants having at least 1 year of follow-up and 26.3% having at least 2 years' follow-up. Forty-six implants were inserted in the posterior maxilla and eleven in the mandible. Fifteen were placed in an extraction socket and forty-two in healed bone. Thirteen implants were supporting a single crown. Two implants failed, resulting in a survival rate of 96.5%, with rates of 90.9% and 97.8% for mandible and maxilla, respectively. This was not affected by gender, jaw, immediate or delayed placement, implant diameter and length, or the use of a bone substitute. The mean preoperative bone height was 7.21 mm in maxilla and 8.76 mm in mandible. In 41 cases implant length surpassed available bone height.

Conclusions: Despite the compromised bone condition and height, the survival rate of 96.5% is comparable to normal implants and, therefore, placing a wide-body implant may be an alternative to avoid grafting procedures. This is probably related to the enlarged implant surface area and the good primary stability.

J Oral Maxillofac Surg 69:e67-e74, 2011

Good short- and long-term results have been reported with dental implants.[1-3] However, the posterior maxilla and mandible were considered to be "risk" zones because of the higher occlusal forces, the inferior bone quality, and the often-limited amount of bone.[4,5] In addition, the positioning of the maxillary sinus and the mandibular nerve often limits the available bone height for implant placement.

The first generation of implants—turned titanium implants—were dependent on their length to achieve enhanced stability and sufficient bone-to-implant contact. This was not always possible, especially in the posterior jaw, and thus short implants were related to an increased failure rate. The wide-diameter implant was introduced to increase the available contact surface for osseointegration and enhanced primary stability.[6-8] Unfortunately, the first results were disappointing, with failure rates of 9% to 24% being reported within 5 years.[9-12] Later studies, using an improved implant design with modified implant sur-

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SOCIEDAD ESPAÑOLA DE CIRUGÍA BUCAL

ELEVACIÓN DEL SENO MAXILAR MÍNIMAMENTE INVASIVA: TÉCNICA INTRALIFT.

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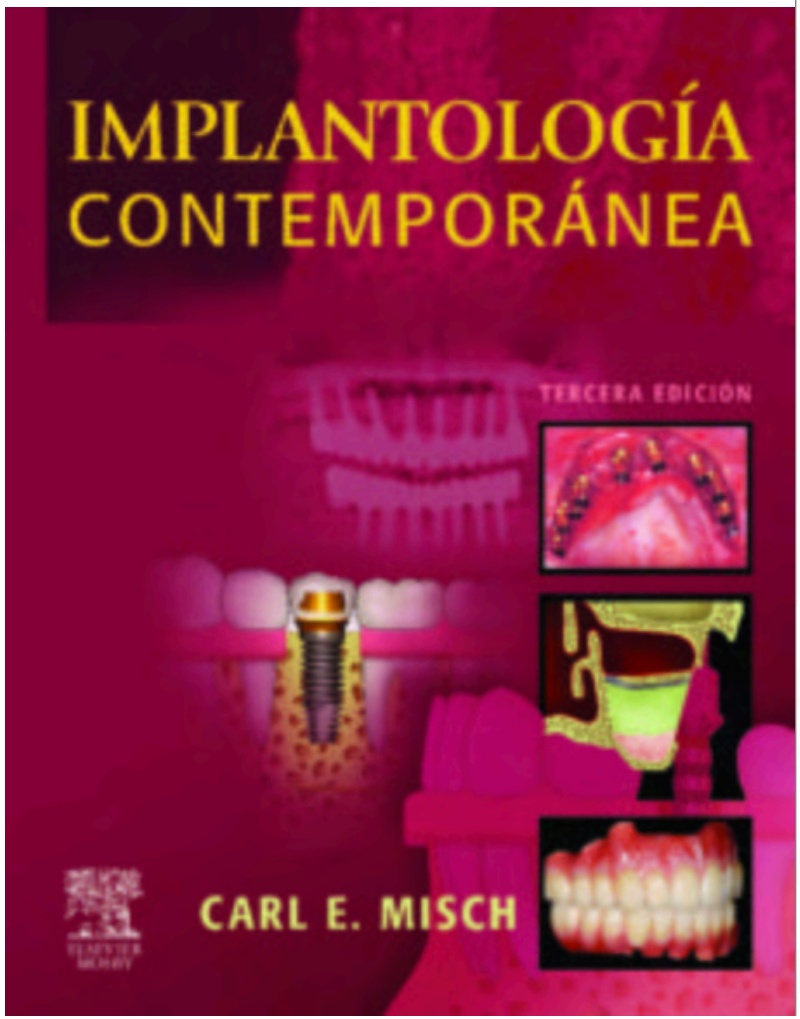

DENTAL IMPLANTS

Risk Factors of Membrane Perforation and Postoperative Complications in Sinus Floor Elevation Surgery: Review of 407 Augmentation Procedures

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Purpose: To test patient- and sinus-related risk factors for an association with intraoperative membrane perforation and postoperative complications after sinus floor augmentation surgery.

Materials and Methods: Sinus floor elevation procedures using a lateral approach were retrospectively analyzed for patients' medical history and sinus anatomy on computed tomographic scans. Complications per sinus after membrane elevation and augmentation using a mixture of autologous bone and deproteinized bovine bone substitute (Bio-Oss) were recorded. Logic regression (adjusted using the generalized estimation equation approach) was performed to analyze the influence of patient age, gender, smoking habits, sinus septa, residual bone height, and mesiodistal elevation width.

Results: Of 407 sinus grafts in 300 patients (mean age, 56 yr), perforation of the Schneiderian membrane occurred in 35 sinuses (8.6%) and was significantly associated to the presence of sinus septa (odds ratio [OR] = 4.8; $P = .002$) and decreased residual bone height (OR = 0.01; $P < .001$). Smoking increased the risk of membrane perforation (OR = 4.8; $P = .002$), sinusitis (OR = 12.3; $P < .001$), and wound dehiscence (OR = 16.1; $P = .005$). Cases of sinus membrane perforation had higher odds for postoperative sinusitis (OR = 10.5; $P < .001$). The probability of wound dehiscence increased with the size of the elevated area (OR = 3; $P < .001$).

Conclusion: The results of the study suggest that the presence of sinus septa and residual bone height less than 3.5 mm are the main risk factors increasing sinus membrane perforation rates. There was a higher prevalence for sinusitis in cases of membrane perforation (31.4%) despite intraoperative closure with resorbable membranes (Bio-Guide). Smokers generally exhibited greater chances for complications.

J Oral Maxillofac Surg 73:1275-1282, 2015

Implant-supported rehabilitation of the edentulous jaw represents a highly predictable and widely accepted therapy.[1] However, implant placement in the atrophic posterior maxilla is frequently complicated by sinus pneumatization and alveolar bone resorption after tooth loss. To increase available bone volume, guided bone regeneration using the sinus membrane as a natural barrier—sinus floor elevation

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DENTAL IMPLANTS

Anatomical and Surgical Findings and Complications in 100 Consecutive Maxillary Sinus Floor Elevation Procedures

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Purpose: To investigate the prevalence of anatomical and surgical findings and complications in maxillary sinus floor elevation surgery, and to describe the clinical implications.

Patients and Methods: One hundred consecutive patients scheduled for maxillary sinus floor elevation were included. The patients consisted of 36 men (36%) and 64 women (64%), with a mean age of 50 years (range, 17 to 73 years). In 18 patients, a bilateral procedure was performed. Patients were treated with a top hinge door in the lateral maxillary sinus wall, as described by Tatum (*Dent Clin North Am* 30:207, 1986). In bilateral cases, only the first site treated was evaluated.

Results: In most cases, an anatomical or surgical finding forced a deviation from Tatum's standard procedure. A thin or thick lateral maxillary sinus wall was found in 78% and 4% of patients, respectively. In 6%, a strong convexity of the lateral sinus wall called for an alternative method of releasing the trapdoor. The same method was used in 4% of cases involving a narrow sinus. The sinus floor elevation procedure was hindered by septa in 48%. In regard to complications, the most common complication, a perforation of the Schneiderian membrane, occurred in 11% of patients. In 2%, visualization of the trapdoor preparation was compromised because of hemorrhages. The initial incision design, ie, slightly palatal, was responsible for a local dehiscence in 3%.

Conclusion: To avoid unnecessary surgical complications, detailed knowledge and timely identification of the anatomic structures inherent to the maxillary sinus are required.

J Oral Maxillofac Surg 66:1426-1438, 2008

Maxillary sinus floor elevation with autogenous or synthetic grafting material has proven to be a reliable method that enables the insertion of endosseous implants in patients with a severely resorbed maxilla. The classical sinus floor elevation consists of a top hinge door in the lateral maxillary sinus wall, as invented by Tatum,[1] but first described by Boyne and James 1980.[2] The variety of anatomical modal-

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Benign Paroxysmal Positional Vertigo During Lateral Window Sinus Lift Procedure: A Case Report and Review

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Purpose: *Benign paroxysmal positional vertigo (BPPV) is a possible and well-documented complication after the osteotome internal sinus lift technique. But we report a case of unexpected BPPV complication after direct sinus lift by lateral approach for implant placement that was not reported till date.*

Methods: *A 30-year-old woman had undergone direct sinus lift procedure by lateral window technique to replace her missing right molar with dental implant. The patient suffered with intense vertigo with nausea, vomiting, and aggravated when she changed the position of her head towards right immediately after procedure and was diagnosed with BPPV after the referral.*

Conclusion: *We assume that prolonged hyperextended head position of iatrogenic origin can be the reason, in this case, for BPPV after direct lateral sinus lift procedure. There is also a possibility that the temporal relationship with the surgical area and surgical action by rotating tools during window preparation are also contributing factors.*

(Implant Dent 2015;24:106–109)

Key Words: benign paroxysmal positional vertigo, sinus lift complication, sinus floor augmentation

The use of dental implants for oral rehabilitation has revolutionized and become a clinical routine[1] with overall success rate[2] of more than 90%. Placement of dental implants in resorbed posterior maxilla is often a challenge to the implantologist, and treatment depends on the amount of bone present in the subsinus region. Many techniques developed since the first description of subantral augmentation by Tatum.[3] Regardless of surgical procedure selected, sinus lift procedure has complications like postoperative infection, injury to neighboring vessels, acute or chronic sinusitis,[4] implant failure, Schneiderian membrane perforation, and benign paroxysmal positional vertigo (BPPV). BPPV mainly occurs by the dislodgment of otoliths due to an indirect or direct trauma of the posterior labyrinth by use of chisel and hammer. The otoliths are also sensitive to tilts of the head about gravity and strike against sensitive nerve endings (the cupula) within the balance apparatus at the end of each semicircular canal (the ampulla) and produce position or motion-induced vertigo and disequilibrium. We report a rare appearance of BPPV during direct sinus lift procedure by lateral window technique and discussed about the possible etiology.

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Case Report

A 30-year-old woman visited our unit in cosmetic and dental implant center for implant placement in the edentulous region of the maxillary right first molar. The patient was in good physical health with no history of sinus disease, vertigo, and allergies. She was not on any other medications. The maxillary right first molar had been extracted due to severe dental caries about 5 years back. A clinical history and examination was completed. Orthopantomograph (Fig. 1) showed right maxillary sinus pneumatization with low bone height. Cone beam computed tomographic scan (Fig. 2) showed a height of 2.8 mm and width of 8 mm. Bone regeneration technique was proposed because of increased maxillary sinus size, consequent decreased alveolar crest, and lack of bone mass. We carried out a direct sinus lift procedure through lateral approach with implant insertion at same time.

Surgery was performed under local anesthesia (approximately 5 mL of 2% lidocaine hydrochloride with 1:80,000 epinephrine, Lignox; Warren, Indoco, Navi Mumbai, India). A mucoperiosteal flap was raised to expose the lateral wall of the maxillary sinus that was initiated slightly palatal to the crest of the ridge.

Planned window was outlined using a round diamond bur, and osteotomy

Case Report
Medicine

An unusual complication of osteotome sinus floor elevation: benign paroxysmal positional vertigo

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S. Vernamonte, V. Mauro, S. Vernamonte, A. M. Messina: An unusual complication of osteotome sinus floor elevation: benign paroxysmal positional vertigo. Int. J. Oral Maxillofac. Surg. 2011; 40: 216–218.

Abstract. Maxillary sinus floor elevation in cases of reduced vertical bone height in the posterior maxilla allows predictable implant placement. The osteotome sinus floor elevation (OSFE) technique has shorter healing and waiting times because the fixture can be placed in the implant recipient site simultaneously with the ridge augmentation. Implant site preparation is more comfortable for the patient when performed with spiral drills than with continuous malleting of the osteotomes. Membrane perforation is the most frequent complication with the OSFE technique; postoperative infection is rare. Benign paroxysmal positional vertigo (BPPV) may be a complication of OSFE and may cause stress if not identified correctly and managed properly. The available treatment options, diagnostic strategies and the pathophysiology of this unusual complication are discussed. The authors present a case in which intense BPPV developed during OSFE, focusing on dental and maxillofacial surgery as risk factors for this pathology.

Keywords: osteotome sinus floor elevation; benign paroxysmal positional vertigo; unusual complication; implant; malleting.

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Oral rehabilitation with an implant-supported prosthesis is considered the therapeutic procedure of choice for partially or completely endentulous patients. The presence of a pneumatized maxillary sinus is often a contraindication to the placement of implants in the lateral upper jaw without prior surgical procedures. An alternative to the most commonly used lateral window approach (major sinus lift) involves the apical displacement of crestal bone using the osteotome sinus floor elevation (OSFE) technique (minor sinus lift).

OSFE involves shorter healing and waiting times because the fixture can be placed in the implant recipient sites simultaneously with the ridge augmentation. Complications described with this procedure, involve local problems such as tearing of the sinus membrane, infection, bleeding, sinusitis and benign paroxysmal positional vertigo (BPPV).

The authors present a case in which intense BPPV developed during osteotome

ID

Comparison of 2 Crestal Sinus Floor Lift Techniques Performed on Human Cadavers

Julien Llopet, DDS,* Michel Montaudon, MD, PhD,† Etienne Guillaud, PhD,‡ and Bruno Ella, DDS, PhD§

Purpose: *To compare the effectiveness of 2 different techniques to lift the maxillary sinus floor through a crestal approach on fresh human cadaver heads: the Intralift technique using Piezosurgery and the Summers technique using osteotomy.*

Materials and Methods: *Two different protocols were simulated on 11 fresh human cadaver heads or 22 maxillary sinuses. Inclusion criteria were: bilateral edentulous maxilla with a residual ridge height between 3 and 9 mm. CT scans were performed before and after surgery on all fresh cadaver heads. Both Intralift and Summers techniques were performed on the same maxilla on the 2 sinuses. The surgical procedure was performed by 2 independent operators, 1 experienced and 1 novice to compare the 2 results. The parameters assessed were the procedure duration and the sinus membrane preservation.*

Results: *The procedure duration was shorter when the operator was more experienced (P = 0.03). There was a correlation between the operator dexterity and the time required for surgery. The Intralift technique seemed safer for sinus membrane preservation.*

Conclusion: *The Intralift technique is an interesting alternative to the Summers technique. (Implant Dent 2014;23:626–632)*

Key Words: osteotomy, sinus lift, Intralift, Summers, piezosurgery

The development of implant dentistry in the recent years has led to adopt increasingly technically sophisticated surgical procedures. The implant-supported prosthetic rehabilitation of the posterior maxilla can be hindered by scarce and poor quality bone. Several advanced surgical techniques have been developed to overcome these limitations, and they have shown predictable results.[1]

For decades, many surgical techniques have been developed to lift the sinus membrane when the residual maxillary ridge height is small. Already in 1994, Summers[2] had described a technique, the Osteotome sinus Floor Elevation (OSFE) wherein an osteotome is used to fracture the sinus floor and to lift the sinus membrane, then grafting materials and implants can be inserted in the subantral space through the osteotomy site. The implants placed with OSFE have comparable success rates than those inserted in nonaugmented sites.[3] Comparing OSFE with lateral window sinus lift, less morbidity,[4] and faster treatment is reported with OSFE.[5]

To reduce the morbidity of OSFE, several modifications have been made to the initial protocol.[6–8] In 2001, Vercellotti[9,10] proposed a lift technique based on the use of ultrasounds. The latter was subsequently proved to be minimally invasive for sinus floor lift.[11,12] In the same vein, in 2012, Troedhan et al[12] developed a Hydrodynamic Ultrasonic Cavitational Sinus Lift (HUCSL) so called Intralift for Piezotome I. This technique showed promising results in preclinical and clinical studies. The aim of this study on fresh human cadaver heads was to compare the Intralift technique with the Summers technique to determine whether it represented a real surgical progress in terms of sinus membrane preservation and procedure duration.

MATERIALS AND METHODS

Different protocols were simulated on 11 fresh human anatomical specimens from cadavers aged on average of 70 years at the Anatomy Laboratory of Bordeaux 2 University. On each anatomical specimen, a sinus floor lift was performed using the Intralift technique (Satelec Actéon, Mérignac, France) on one sinus and the Summers technique on the other sinus to compare the 2 results.

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Hydrodynamic Ultrasonic Sinus Floor Elevation—An Experimental Study in Sheep

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Purpose: The aim of the present study was to evaluate the pressure forces appearing to elevate the sinus membrane by comparing the hydraulic and pneumatic pressure. Also, the relation between the time and volume of the applied liquid and the achieved lift-volume were determined.

Materials and Methods: A total of 190 fresh, half sheep heads were used for the present investigation. An ultrasound surgical device (Piezotome; Acteon, Bordeaux, France) was tested to evaluate the pressure increase at different flow rates. The elevation volume at different flow rates and activation times of the ultrasound hand piece were measured.

Results: To detach the sinus membrane pneumatically from the sinus floor, a mean average pressure of 29.54 millibars was required. Using the hydraulic technique, a mean average pressure of 19.8 millibars was determined. Comparing the different flow rates, the elevated volume increased to 0.52 mL when a flow of 60 mL/minute was used. Using an activation time of 20 seconds, a lifted volume of 3.92 mL could be measured on average. If the flow was set to a maximum of 60 mL/minute, the created volume increased to 5.58 mL. A comparison using the χ^2 test showed a significant correlation ($P = .03$) between the application time and the created sinus lift volume. Even at high flow rates of 60 mL/minute of the activated Piezotome for a 20-second period, no rupture of the sinus membrane of the sheep heads occurred in 190 experiments.

Conclusion: From these results, we have concluded that hydrodynamic ultrasound could be used as an alternative method for sinus floor elevations of any size and volume with a mere 3-mm-diameter transcrestal approach, if findings from clinical investigations confirm the results of the present animal study.

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Bone loss occurs in the maxilla for varying reasons, including failures in periodontal therapy,[1,2] orthodontic treatment,[3] and general bone diseases in adult patients.[4-6]

Furthermore, the long-term success rate of sinus floor elevations is superior to that of onlay grafts in the maxilla.[7,8] The published data have described a variety of more or less time-consuming and expensive surgical techniques for voluminous sinus floor elevations with a lateral approach[9-12] or small, minimally invasive, transcrestal augmentations.[13-21] The lateral approach provides more security and rupture control compared with the sinus lift procedure but is more invasive and leads to an interruption of bone nutrition on a large scale by dissecting the periosteum from the bone in large areas. The minimally invasive techniques provide little or no control over possible ruptures of the sinus membrane.[22] All described sinus floor elevation techniques, such as the lateral approach and crestal approach (ie, Summers' or Bass balloon assisted-technique),[18,19] have in common a tearing force on the sinus membrane while elevating the membrane in the osteotomy site.

The absence of a high risk of perforation of the membrane is outstanding in hydraulic procedures,[23,24] with a total lack of any tearing forces on the sinus membrane (Fig 1). The hydrodynamic ultrasonic cavitational sinus lift (HUCSL) was designed to elevate the sinus mem-

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Clinical Study

Biological Principles and Physiology of Bone Regeneration under the Schneiderian Membrane after Sinus Lift Surgery: A Radiological Study in 14 Patients Treated with the Transcrestal Hydrodynamic Ultrasonic Cavitational Sinus Lift (Intralift)

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Introduction. Sinus lift procedures are a commonly accepted method of bone augmentation in the lateral maxilla with clinically good results. Nevertheless the role of the Schneiderian membrane in the bone-reformation process is discussed controversially. Aim of this study was to prove the key role of the sinus membrane in bone reformation in vivo. *Material and Methods.* 14 patients were treated with the minimal invasive tHUCSL-Intralift, and 2 ccm collagenous sponges were inserted subantrally and the calcification process followed up with CBCT scans 4 and 7 months after surgery. *Results.* An even and circular centripetal calcification under the sinus membrane and the antral floor was detected 4 months after surgery covering 30% of the entire augmentation width/height/depth at each wall. The calcification process was completed in the entire augmentation volume after 7 months. A loss of approximately 13% of absolute augmentation height was detected between the 4th and 7th month. *Discussion.* The results of this paper prove the key role of the sinus membrane as the main carrier of bone reformation after sinus lift procedures as multiple experimental studies suggested. Thus the importance of minimal invasive and rupture free sinuslift procedures is underlined and does not depend on the type of grafting material used.

1. Introduction

Although subantral augmentation procedures (Sinus lifting) can be considered as an established and highly successful method to multiply bone prior to implant insertion into the lateral maxilla site, the biological mechanisms of subantral bone regeneration are still focus of controversial scientific discussions.

While in the eighties and nineties of the past century the discussion on graft material inserted subantrally focused on free autologous bone grafts the mainstream research turned over to heterologous, allogenic, xenogenic and synthetic bone graft materials.

Concerning free autologous bone grafts most questions were already answered in the late sixties of the past century by Scandinavian scientists.

Puranen [1] proved free autologous bone grafts stored in room air to lose all biological activity within 90 minutes, when kept in saline solution within 3 hours. Bohr et al. [2] investigated the osteogenic potency of freshly harvested autologous bone grafts in comparison to deproteinized cadaver bone: although he reported a better reossification of the fresh free autologous transplants in the augmentation site in the first five days following surgery, the overall advantage of fresh autologous bone grafts was beyond any experimental and clinical significance after the standard healing period.

The key role of the periosteum in bone healing and regeneration was proven in other disciplines of medicine for quite a time [3–5] and was verified again only lately [6, 7] but mostly neglected in dentistry and oral surgery.

Lundgren et al. [8] 2004 found sufficient bone regeneration after Sinus lift surgery without the insertion of any bone

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Hydrodynamic ultrasonic maxillary sinus lift: Review of a new technique and presentation of a clinical case

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Abstract

Objectives: Placing implants in the posterior maxillary area has the drawback of working with scarce, poor quality bone in a significant percentage of cases. Numerous advanced surgical techniques have been developed to overcome the difficulties associated with these limitations. Subsequent to reports on the elevation of the maxillary sinus through the lateral approach, there were reports on the use of the crestal approach, which is less aggressive but requires a minimal amount of bone. Furthermore, it is more sensitive to operator technique, as the integrity of the sinus membrane is checked indirectly. The aim of this paper is to review the technical literature on minimally invasive sinus lift and compare the advantages of different techniques with Intralift™, a new technique.

Study Design: The present study is a review of techniques used to perform minimally invasive sinus lift published in Cochrane, Embase and Medline over the past ten years and the description of the crestal sinus lift technique based on minimally invasive piezosurgery, with the example of a case report.

Results: Only eight articles were found on minimally invasive techniques for sinus lift. The main advantage of this new technique, Intralift, is that it does not require a minimum amount of crestal bone (indeed, the smaller the width of the crestal bone, the better this technique is performed). The possibility of damage to the sinus membrane is minimised by using ultrasound based hydrodynamic pressure to lift it, while applying a very non-aggressive crestal approach.

Conclusions: We believe that this technique is an advance in the search for less traumatic and aggressive techniques, which is the hallmark of current surgery.

Key words: *Sinus lift, surgical technique, minimally invasive surgery, ultrasound surgery.*

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The transcrestal hydrodynamic ultrasonic cavitational sinuslift: Results of a 2-year prospective multicentre study on 404 patients, 446 sinuslift sites and 637 inserted implants

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ABSTRACT

Introduction: In 2006 an ultrasound-surgery-based method to hydrodynamically detach the sinus-membrane utilizing the ultrasonic cavitation effect—the tHUCSL—was developed and a surgical protocol established. The aim of the study was to determine the indication-range and success-rate of this novelty procedure. Materials & Methods: Between 2007 and 2009, 404 patients were treated by 6 oral surgeons of different experience-levels with the tHUCSL in 446 sinus-sites. 637 implants were inserted and then prosthodontically treated and observed and documented until December 2011. The subantral space was augmented via the 3 mm transcrestal approach with an augmentation volume of 1.9 ccm (+/− 0.988 ccm) and an augmentation height of 10.7 mm (+/− 2.85 mm). Results: Within the survey-period 15 (2.35%) of the 637 inserted implants were lost, mostly before implant loading due to postsurgical infection and non-osseointegration in the augmentation site. 1 implant was lost after implant loading and prosthetic treatment within 1 year after loading. The overall success rate with functional implants in site is 97.65% evenly distributed among the participating surgeons. 86% of the patients were observed with no postsurgical swelling and 87% no postsurgical pain. Discussion: The results suggest the tHUCSL to be a safe minimal-invasive alternative to traditional lateral approach and transcrestal osteotome sinuslift-procedures applicable to all anatomical situations.

Keywords: Transcrestal; Hydrodynamic Sinuslift; Bone Augmentation; Implants; Ultrasound Surgery; Maxillary Sinus

1. INTRODUCTION

The basic principle of subantral bone augmentation ("Sinuslift") in the lateral maxilla is a commonly accepted, well documented and established procedure for bone augmentation in the posterior maxilla to allow implant insertion in the atrophic maxillary alveolar crest since the 80's of the past century. Various surgical techniques have been developed, described and scientifically evaluated over the centuries with clinically good results [1-10].

Various authors published different results and preferences on the grafting material subantrally inserted (autologous, heterologous, xenogenic, allogenic bone, synthetic bone grafts) [11-19]. Nevertheless a survey over the current literature and systematic reviews [20] suggests the success of sinus floor augmentation procedures to be related more to the medical history of the augmented sinus and the skills of the surgeon than the used bone graft material [21].

The success of bone augmentation procedures especially in sinus-floor augmentation can be considered scientifically proven as to be more related to intact anatomical and physiological structures of the periosteum and a sufficient blood supply of the augmentation site than to any specific bone graft material [22-26].

Minimally Invasive Sinus Augmentation Using Ultrasonic Piezoelectric Vibration and Hydraulic Pressure: A Multicenter Retrospective Study

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Purpose: *The purpose of this study was to evaluate the success rate of implants and vertical bone gain of edentulous posterior maxilla using ultrasonic piezoelectric vibration and hydraulic pressure, namely the hydrodynamic piezoelectric internal sinus elevation (HPISE) technique through a crestal approach.*

Materials and Methods: *A total of 250 maxillary sinuses were augmented using HPISE and 353 implants (averaging 11.8 mm in length and 4.5 mm in diameter), with 12 different systems, were placed simultaneously with or without additional bone grafting. Plain radiograms and cone beam computed tomograms were taken in all patients to evaluate sinus augmentation.*

Results: *Membrane perforation was recorded at 10 of the 353 implant sites. The perforation rate was 2.83%. The total success rate of implantation was 97.2% after an average of 69.3 weeks of loading.*

Conclusion: *The crestally approached sinus augmentation using ultrasonic piezoelectric vibration and hydraulic pressure is an additional method of maxillary sinus augmentation. (Implant Dent 2012;21:536–542)*

Key Words: crestal approach, hydraulic pressure, hydrodynamic piezoelectric internal sinus elevation

In the edentulous posterior maxilla, the presence of the maxillary sinus often limits the available bone height for implant placement. To overcome vertical deficiency of atrophic posterior maxilla, sinus floor elevation using a crestal approach and the lateral window technique have been used.[1,2] Even though the lateral window technique has been considered to be a predictable method for sinus augmentation, this technique can cause more postoperative discomfort, such as postoperative swelling and pain, and a longer edentulous healing period than does the crestal approach. The crestal approach is considered to be a less invasive procedure than the lateral approach.[3,4] Thus, to overcome the disadvantages of sinus augmentation using the lateral window approach, variable crestal approaches, such as osteotome-mediated sinus floor elevation (OMSFE),[1] piezoelectric internal sinus elevation (PISE),[5,6] hydraulic sinus condensing (HSC),[7] internal sinus manipulation,[8] and hydrodynamic piezoelectric internal sinus elevation (HPISE)[9,10] and the crestal window technique (CWT),[11] have been introduced. Most of these techniques, except HPISE, rely on bone compaction to elevate the sinus membrane, so that the crestal approaches that depend on bone compaction have some limitations, such as possible sinus membrane perforation from bone packing. In addition, vertical augmentation limited by inaccessibility and postoperative vertigo, from the mallet striking the sinus floor, has been reported.[12,13] Unlike other crestal-approached sinus augmentation methods, HPISE does not require the osteotome to break the sinus floor and usually does not depend on bone compaction to elevate the sinus membrane. HPISE breaks the sinus floor with ultrasonic vibration and elevates the sinus membrane using hydraulic pressure, without bone compaction. The aim of this study was to evaluate the predictability of the HPISE through clinical success rates and radiographic analysis.

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Flapless Transcrestal Sinus Augmentation Using Hydrodynamic Piezoelectric Internal Sinus Elevation With Autologous Concentrated Growth Factors Alone

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Purpose: *The purpose of this retrospective study was to evaluate the success rate of implants and the amount of sinus augmentation using the flapless hydrodynamic piezoelectric internal sinus elevation (HPISE) technique with autologous concentrated growth factors (CGF) alone.*

Materials and Methods: *A total of 11 maxillary sinuses were augmented using the HPISE technique through the flapless transcrestal approach. Sixteen implants (average 11.38 mm in length and 4.83 mm in diameter), with 2 different surfaces, were placed simultaneously with CGF alone. Plain panoramic radiograms and cone-beam computed tomograms (CBCT) were taken in all patients to evaluate the sinus augmentation preoperatively and postoperatively.*

Results: *The sinus membranes were successfully elevated, averaging 13.95 ± 6.61 mm in immediate postoperative CBCT without any iatrogenic perforation. After an average 23.8 weeks, the average bone gain above the sinus floor was 8.23 ± 2.88 mm in the axial aspect of CBCT. No complications were recorded in any patients during the follow-up period.*

Conclusion: *The flapless transcrestal approach to the sinus augmentation using the HPISE technique with autologous CGF alone could be an alternative to the lateral approach, even at severely resorbed edentulous posterior maxilla with insufficient bone height. (Implant Dent 2014;23:168–174)*

Key Words: internal sinus elevation, flapless surgery, transcrestal approach, piezoelectric bone surgery, hydrodynamics

In the edentulous posterior maxilla, the presence of the maxillary sinus often limits the available bone height for dental implant placement. To overcome vertical deficiency of atrophic posterior maxilla, sinus floor elevation either through a transcrestal approach or a lateral approach has been used for several decades.[1,2] The transcrestal approach is considered to be a less invasive procedure than the lateral approach.[3,4] However, the transcrestal approach with traditional flap surgery is associated with several drawbacks, such as postoperative discomfort, unexpected gingival recession, and alveolar crestal resorption due to diminished supraperiosteal blood supply by intraoperative flap reflection.[5–8] Thus, to overcome the drawbacks of the flap transrectal approach, various flapless transcrestal approaches, such as the use of osteotomes, gel pressure, hydraulic pressure, and balloon elevation have been reported.[9–13] In most of these techniques, numerous pieces of equipment were needed to elevate the sinus membrane. Unlike other transcrestal approaches to sinus augmentation methods, the hydrodynamic piezoelectric internal sinus elevation (HPISE) technique does not require osteotomes or the sinus membrane elevation equipment. Furthermore, it does not rely on bone compaction to elevate the sinus membrane.[14,15] The HPISE technique can break the sinus floor with ultrasonic vibration and elevate the sinus membrane using the hydraulic pressure of

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Multicenter clinical study on the hydrodynamic piezoelectric internal sinus elevation (HPISE) technique

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Abstract (J Korean Assoc Oral Maxillofac Surg 2012;38:85-9)

Objectives: This study was to evaluate the effect of vertical bone gain and success rate and analyze the failure cases using the hydrodynamic piezoelectric internal sinus elevation (HPISE) technique.

Materials and Methods: Patients who had been operated in the three centers including Daegu Catholic University Medical Center were selected for this study. The mucoperiosteal flap was elevated, and the sinus floor was then broken by specially designed piezoelectric insert, with hydraulic pressure applied to the sinus membrane for even elevation. Afterward, implants were placed. Panoramic radiogram or computed tomogram was taken before and after surgery and at the second operation and prosthesis placement. Later, changes in vertical height were measured and compared. The survival rate was based on the criteria of Buser et al. and Cochran et al.

Results: In this study, 8 implants failed out of a total of 169 implants, resulting a success rate of 95.3%. These failure cases were due to insufficient initial stability or sinus membrane perforation. The mean of radiographic vertical height change at prosthesis placement was 5.7 mm (0.5-10.5 mm).

Conclusion: In this study, HPISE technique was found to be a predictable treatment for atrophic maxilla and an alternative technique to the lateral approach.

Key words: Hydrodynamic piezoelectric internal sinus elevation, Hydraulic pressure, Crestal approach, Piezosurgery

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I. Introduction

Recently, dental implant placement is widely used from the restoration of a single tooth to the full-mouth reconstruction. However, it has been limited by the absorption of the alveolar bone and location of important anatomical structures. In particular, placing implants in the maxillary posterior region is very difficult due to the pneumatization of sinus and fast absorption of alveolar bone. To address such problems, various techniques have been used for atrophic alveolar bone, with sinus bone graft using various bone graft materials[1-3].

Since Boyne and James[4] reported the clinical result of sinus bone graft through osteotomy on the sinus lateral walls, sinus bone graft has been investigated aggressively for its clinical skill and results, reporting many successful clinical outcomes and high predictability[5-7]. Osteotome-mediated sinus floor elevation (OMSFE), developed by many clinicians since it was suggested by Summers, has been widely used because there were less injuries and symptoms after the surgery such as pain and edema compared to bone graft through osteotomy of the sinus lateral walls[8-10]. However, this technique can also cause sinus membrane perforation due to the initial bone preparation and the pressure when pushing of bone graft material and many complications such as benign paroxysmal positional vertigo caused by internal ear damage when using osteotome and mallet were reported[11,12]. Moreover, since bone graft material must be used for this technique, there is high chance of infection by bone graft material on the perforated sinus membrane.

The hydrodynamic piezoelectric internal sinus elevation (HPISE) technique using ultrasonic device with a specially designed ultrasonic wave surgery insert causes neither benign

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Maxillary Sinus Floor Elevation Using the Lateral Window Osteotomy Versus Crestal Window Technique with Endoscopy and Hydraulic Pressure

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Abstract

To compare the effects of maxillary sinus elevation with simultaneous implant placement using hydrodynamic piezoelectric internal sinus elevation(HPISE) with endoscopy and lateral window osteotomy (LWO) .16 consecutive patients withing residual crestal height of 2 to 5 mm were randomly divided into two groups based on the technique. 8 patients with 15 implants were allocated to the LWO group, the other 8 patients with 14 implants were allocated to the HPISE group. Clinical examination, radiographic assessment, resonance frequency analysis (RFA), surgical duration and patients' evaluation of postoperative swelling and pain were assessed between two groups at different time points. 2 membrane perforations in the LWO group and 1 membrane perforation in the HPISE group were noted. After an average 9-month' healing, mean bone height gain in the LWO group was 5.37±1.16 mm while that of the HPISE group was 5.27±1.07mm. Osstell values increased over time and no differences of the mean ISQ changes between groups were found at any time points. No significant difference was recorded concerning the duration of the surgery. However, the patients showed a preference for the HPISE technique on behalf of the postoperative swelling and pain ($P < 0.05$=. After mean 3-year post-loading, no implants and prostheses failed in both group. HPISE technique could be an alternative method to traditional sinus augmentation using LWO technique for reducing postoperative swelling and pain. Frequent membrane perforations in HPISE could be avoided when endoscopy was used.

Key words: Crestal Approach, Maxillary Sinus Augmentation, HPISE, LWO

1. Introductions

Insufficient bone height of the posterior maxilla, due to excessive maxillary sinus pneumatization and alveolar ridge resorption, is often a major challenge for placement of dental implants [1, 2]. Several techniques have been proposed to overcome these challenges, including the use of short implants and maxillary sinus floor augmentation (MSFA) [3, 4]. The MSFA has been demonstrated as a predictable technique to restore adequate bone for successful osseointegration [5, 6]. The lateral window approach is widely documented and supported by several longitudinal studies, which was traditionally used in cases where alveolar ridge height is less than 5 mm. Although this technique attests to an average implant survival rate at approximately 92% [7, 8],it always cause inevitable postoperative sweling and pain since a large full periosteal flap must be raised [7-9]. Thus, to overcome the drawbacks of the lateral window approach, various crestal approaches for sinus elevation including osteotome techniques [10], hydraulic pressure techniques and ballon techniques [11, 12] have been reported. These techniques generally imply a minimally invasive crestal drilling for sinus membrane elevation and simutaneous implant placement when 2 mm of residual crestal hight presents, with a considerable implant survival rate ranging from 92.7% to 98.1% at different follow-up years [15-17]. However, these crestal approaches seem to present a high perforation rate up to 26%. [13, 14]

The hydrodynamic piezoelectric internal sinus elevation (HPISE) technique uses ultrasonic piezoelectric microvibration to remove the sinus bony floor and hydraulic pressure from internal irrigation to elevate the memebrane through crestal approach. The HPISE technique was considered as a predictable crestal method avoiding the mechanic extend approach of sinus membrane, because ultrasonic piezoelectric microvibrations may induce a minimal trauma to the soft tissue and reduce the rate of sinus membrane perforation. [17, 18], However, limited visual field still might hamper a designed elevation of sinus membrane and extending of the

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RESEARCH ARTICLE

The effect of osseodensification and different thread designs on the dental implant primary stability [version 1; peer review: 2 approved, 1 approved with reservations]

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Abstract

Background: It is difficult to achieve good primary stability of dental implants in soft bone, such as that in the posterior maxillae. Osseodensification (OD) burs, working in a non-subtractive fashion, condense the implant osteotomy bone in lateral direction and increase in the bone implant contact. Also, dental implants with deeper threads, and decreased thread pitch can increase initial bone implant anchorage.
Methods: This study utilized 48 custom-made machined surface dental implants that were 13 mm long, with a major diameter of 4.5 mm and a minor diameter of 3.5 mm, a thread pitch of 1 mm, a thread depth of 0.5 mm, and a 4 mm long cutting flute at the apex. The implants were divided into 4 groups, each group was made of 12 implants with a different thread design; V-shaped, trapezoid, buttress, and reverse buttress. The implants were inserted in 4-mm thick cancellous bone slices obtained from the head of Cow femur bone. The ostoetomies were prepared by conventional drilling and by OD drilling. Each inserted implant was then tested for primary stability using the Periotest. The Periotest values (PTVs) for the implant stability were tabulated and analyzed using a chi square test at significance level $p < 0.05$.
Results: The results of this this study revealed no statistically significant difference between the Periotest readings for the implants in each category placed in either the OD or the regular osteotomies. However, it has been found that the implants placed in regular drilling ostoetomies had a significantly better primary stability than the implants placed in OD osteotomies.
Conclusions: It was concluded that OD is not necessary in situations where there is bone of good quality and quantity.

Keywords

Implant primary stability, osseodensification, implant thread designs, Periotest.

Open Peer Review

Referee Status: ? ✓ ✓

	Invited Referees 1	2	3
version 1 published 05 Dec 2018	? report	✓ report	✓ report

1 **Khalid Almas**, Imam Abdulrahman Bin Faisal University, Saudi Arabia

2 **Jun Lee**, Wonkwang University, South Korea

3 **Zachary Evans**, Medical University of South Carolina, USA

Any reports and responses or comments on the article can be found at the end of the article.

Review

Influence of different implant placement techniques to improve primary implant stability in low-density bone: A systematic review

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Abstract

Aim: The aim of this study is to assess the influence of different implant placement techniques to improve primary implant stability (PIS) in the low-density bone.
Materials and Methods: Citations published in English and those available in full text were searched from electronic databases (PubMed and Google Scholar) from the year 2000–2017 by which 75 manuscripts were revealed. After applying inclusion and exclusion criteria, seven were selected for the present review. The whole process was conducted by the following preferred reporting items for systematic reviews and meta-analyses guidelines.
Results: The measurement of primary stability showed significant correlations with different bone densities and with implant outcome; however, these two parameters have not been investigated at the same time frequently. Of the seven manuscripts, three discussed standard drilling protocol, two used undersized drilling, one used guided drilling, and one compared standard drilling with undersized drilling. Several intraoperative methods of jaw bone-density assessment were reported, and resonance frequency analysis, periotest, and insertion torque values were used to quantify PIS.
Conclusion: The use of undersized drilling has proven advantageous for increasing initial implant stability in the low-density bone. Although the PIS may be lower, the secondary implant stability is found to be correlated to acceptable values.

Keywords: Bone density, guided drilling, osseointegration, primary implant stability

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INTRODUCTION

Primary implant stability (PIS) is a critical factor that determines the long-term success of dental implants. PIS is defined as the absence of mobility in the bone bed after the implant has been placed.[1] According to the Glossary of Prosthodontic Terms, Ninth Edition, PIS is a contributing factor to the mechanical stabilization of a dental implant during the healing phase.[2]

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Original Article

Effect of Using Densah Burs on Implant Stability and Peri-implant Marginal Bone Loss in Maxillary Implant Supported Partial Overdentures

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ABSTRACT

Background: This study investigated the effect of Densah Burs on the primary and secondary implant stability, in addition to periimplant mean marginal bone loss in maxillary implant supported partial overdentures.
Materials and Methods: Ten patients with posteriorly edentulous maxillae following kennedy class I classification were selected. Each patient received two implants; one in each side. On one side, the implant osteotomy was prepared using conventional surgical drills while on the other side, Densah burs were used. Implant stability was measured at implant insertion and time of loading using Osstell device. Mean margial bone loss was measured at 6 and 12 month interval using Cone Beam CT scan.
Results: Statistical Significant difference was noted between both types of drills on primary implant stability but not on secondary implant stability or mean marginal bone loss at 6 and 12 month interval.
Conclusion: Densah drilling Burs may improve initial implant stability; a situation that may help when immediate loading of implants is planned especially if they are splinted. Moreover, they might not have a different effect rather than conventional drilling burs on marginal bone loss.

Key Words: Densah burs, Implant stability, Marginal bone loss and Osstell.

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INTRODUCTION

Dental implants are considered one of the most successful treatment options for completely or partially edentulous mandible and maxilla. In maxilla the nature of bone together with the atrophy which occurs after extraction present an obstacle in planning dental implants[1-2].

Osseointegration which is a must for implant loading is defined as the direct structural and functional connection between living bone and the titanium implant surface. Amongst all factors that affects implant success, primary stability is one of the most important ones[3-4].

Primary stability comes from mechanical anchorage between the fixture and the bone walls of the implant bed. Secondary stability is the progressive increase in stability achieved through bone formation and remodeling in contact with the implant surface during the healing period[5].

The primary stability of dental implants depends on bone quantity and quality, implant design, implant surface features and the surgical technique used for preparing the osteotomy[6].

Decreased primary stability may result in defective secondary stability, which is, osseointegration[7].

Poor density bone (D3-D4) is usually noticed in the maxillary posterior regions. This is why the insertion torque values of the implant placed is usually below the acceptable values. This will lead to a low success rate for implants placed in these areas[8-9].

Low bone density is usually noted in the posterior area of the maxilla. In 2015, a technique using a specially designed densifying bur was proposed for implant site preparation. This bur was claimed to improve bone density in the drilling site[8-10].

During the osseodensification process, bone is compacted into open marrow spaces during drilling and thus implant insertion torque is increased by densification of osteotomy site walls[11].

The densifying bur consists of cutting chisel and tapered shank allowing it to progressively increase the diameter as it is moved deeper into the osteotomy. Furthermore, drilling can be operated in two rotation directions; clockwise (CW) and counterclockwise (CCW) rotation directions that

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Update on Maxillary Sinus Augmentation

Natasha Bhalla, DDS*, Harry Dym, DDS

KEYWORDS

- Transcrestal sinus lift • Lateral window sinus lift • Osseodensification
- Schneiderian membrane

KEY POINTS

- Over time, the maxillary sinus undergoes a process called pneumatization.
- Over time, the alveolar bone of the posterior maxilla will undergo resorption.
- Augmentation of the maxillary sinus can be performed by using a transcrestal sinus lift or a lateral approach.

INTRODUCTION

A common clinical finding facing the implant surgeon when planning for implant placement in the posterior maxilla is lack of adequate bone height either due to low lying maxillary sinus or due to atrophy of the alveolous following extraction. Augmentation of the site can be performed by using a transcrestal sinus lift or a lateral approach. Both techniques are discussed in this chapter.

ANATOMY OF THE MAXILLARY SINUS

The maxillary sinus is an air space that occupies the maxilla bilaterally[1] and is surrounded by the nasal cavity mesially, the maxillary tuberosity laterally, the orbit superiorly, and the alveolar bone inferiorly.[1] The volume of the maxillary sinus is approximately 20 mL[1] and is usually present at birth completing its development at 18 years of age.[1]

The maxillary sinus is also lined with ciliated pseudostratified epithelium, and there are cilia lining the membrane of the maxillary sinus as well,[1] the purpose of which is to clear the paranasal sinus cavity of pathogens and debris that are continually inspired in normal respiration.[1]

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CASE STUDY

Enhancing implant stability with osseodensification — a case report with 2-year follow-up

Dr. Salah Huwais discusses how osseodensification facilitates ridge expansion with enhanced implant stability

Introduction

The medical profession has, with certain exceptions, adapted commercially available instruments that have been developed for drilling other materials (Jackson, et al., 1989). For more than a decade, clinicians have been asking for improvement in bone drilling and preparation (Natali, et al., 1996).

Standard drill designs used in dental implantology are made to excavate bone to create room for implant placement. They cut away bone effectively but typically do not produce a precise circumferential osteotomy. Osteotomies may become elongated and elliptical due to the chatter of the drills. In these circumstances, the implant insertion torque is reduced leading to poor primary stability and potential lack of integration. Furthermore, osteotomies drilled into narrow bone locations may produce dehiscence, buccally or lingually, which also reduces primary stability and will require an additional bone grafting procedure adding cost and healing time to treatment.

When standard drills extract enough bone to let strains in the remaining bone to reach or exceed the bone micro-damage (MDX) threshold, the bone-remodeling unit (BMU) needs more than 3 months to repair the damaged area, so maintaining bone bulk will enhance healing and shorten the healing period (Frost, et al., 1998).

Unlike traditional bone drilling technologies, osseodensification does not excavate bone tissue. Rather, it preserves bone bulk, so bone tissue is simultaneously compacted and autografted in an outwardly expanding direction to form the osteotomy. It is accomplished by using proprietary densifying burs. When the densifying bur is rotated at high speed in a reversed, non-cutting direction with steady external irrigation (Densifying Mode), a dense compacted layer of bone tissue is formed along the walls and base of the osteotomy (Meyer, Huwais, et al., 2014).

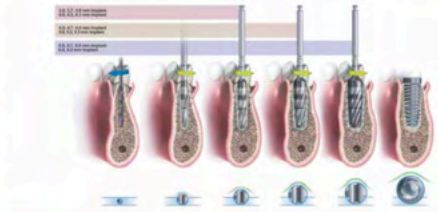
The goal in implant placement is to achieve primary implant stability. It is well established that implant stability is critical for osseointegration (Albrektsson, et al., 1986, Meredith, et al., 1998). This is more important in recent days due to popular immediate/early loading protocols being implemented into treatment by many clinicians. Removing bone bulk is contrary to achieving the primary stability desired.

Implant primary mechanical stability is directly related to surrounding bone quality and quantity. Maintaining and preserving bone during osteotomy preparation leads to increased primary mechanical stability, increased bone to implant contact (BIC), which then enhances implant secondary stability, and accelerates healing (Seeman, et al., 2008, Todisco, et al., 2005, Trisi, et al., 2009).

Case report

Osseodensification facilitates mandibular ridge expansion and placement of two implants.

The patient is a 62-year-old male presented with missing teeth Nos. 19, 20, and 21. Clinical and radiographic examination revealed a significant alveolar ridge resorption, which resulted in a Seibert Class I, ridge deficiency (Figure 1). The patient's medical history was noncontributory.



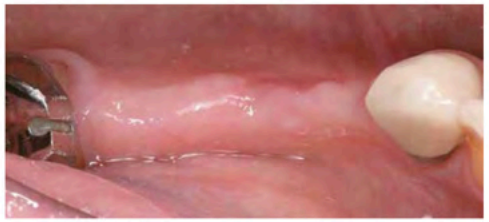


Figure 1: Occlusal view of lower left edentulous area of missing teeth Nos. 19, 20, and 21

Salah Huwais, DDS, maintains a private practice focusing on periodontics and surgical implantology in Jackson, Michigan. Dr. Huwais completed his periodontics and implantology surgical training at the University of Illinois at Chicago in 1997. He serves as an Adjunct Clinical Assistant Professor at the University of Minnesota, Dental Implant Program. Dr. Huwais has published in the *Journal of Periodontology* and lectures nationally and internationally on periodontal and surgical implantology procedures. He is Diplomate of the American Board of Periodontology and the American Board of Oral Implantology. Dr. Huwais is the founder of Osseodensification and the inventor of the Densah™ Bur technology.

CASE REPORT

Osseodensified Crestal Sinus Window Augmentation: An Alternative Procedure to the Lateral Window Technique

Nilesh Salgar, DDS

A novel minimally invasive technique, osseodensification, is proposed to facilitate maxillary sinus bone graft augmentation. The osseodensified crestal window overcomes the previous limitations of traditional crestal approaches with respect to residual bone height (RBH) of ≤1.5 mm as well as vertical height of augmentation (>10 mm). Three patients, healthy and non-smoking, with 3 distinct and difficult clinical situations requiring sinus augmentation and having a maximum of 1.5 mm RBH (0.4–1.5 mm) were selected for this procedure. Edentulous sections were large (entire posterior sextant, with and without sinus septa), and small (single hyperpneumatized maxillary molar site). All healing was rapid and uneventful with no instances of sinus membrane perforation or other complications seen. The vertical increase in sinus bone height ranged from 10.3 mm to 13.6 mm. The increase in bone height is comparable to that obtained with lateral window procedures. The osseodensified crestal sinus window technique may be thus be proposed as a possible alternative procedure for the lateral sinus window technique for maxillary sinus bone augmentation.

Key Words: dental implant, sinus graft, osseodensification, transcrestal, residual bone height, lateral window

Introduction

When assessing a potential future implant site, if the implant does not "fit" due to a deficiency of hard or soft tissue, then the clinician and patient must commit to a bone, tissue, or sinus graft to augment that site. The posterior maxilla poses several challenges for the placement of dental implants. Bone and tissue loss from periodontal disease, post-extraction bone atrophy in height and width, pneumatization of the maxillary sinuses, poor bone density, and very high occlusal forces are some factors leading to this difficulty. Bone grafting in the maxillary sinus is the solution to obtain adequate bone volume for implant placement.

High-resolution 3D cone-beam computed tomography (CBCT) is the gold standard for imaging and treatment planning dental implants in the maxillary sinus. Multiple factors such as residual bone height (RBH), presence of teeth, size and shape of the sinus, septa, and pathology, must be assessed.

The lateral sinus window technique has been the traditional method of choice to augment the sinus in patients presenting with a severely resorbed and atrophied posterior maxilla. The lateral window is the procedure of choice in cases presenting with a larger edentulous region of several teeth, a significant volume of bone grafting required, and a RBH < 5 mm. Implant placement is usually delayed in these cases where the RBH is less than 5 mm.[1] Several of the main disadvantages of the lateral window are the need to raise a large flap, Schneiderian membrane perforation, presence of septa, difficulty in design and preparation of the bony window, thick bony lateral wall, and injury to blood vessels found in the lateral bony wall.

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The maxillary sinus septum is an anatomical irregularity that poses a serious complication to the lateral sinus window procedure. The vast majority of septa, 87.6%, are transverse, or buccopalatal in orientation.[1] 3D CBCT diagnostic imaging must be done to evaluate the location, size, and orientation of the sinus and is septa. It is often necessary to modify the size and shape of the lateral window to compensate for the presence of the septum. Several of the strategies are as follows. If the septum is high, 2 windows, one posterior and the other anterior to the septum may be made. If the septum is low, a modified "W" shaped window may be created.[1,2] In either septum situation, the risk of perforating the Schneiderian membrane is very high and the buccal window of bone should not be inverted (trapdoor technique)[3] in the presence of the septum.

For the last 35 years, the main surgical approaches have been described by Tatum,[4] and Summers.[5,6] Several modified techniques have also been described: osteotomes,[7] balloon,[8] reamers,[9] hydraulic pressure,[10] and piezosurgery.[11]

The crestal sinus approach is indicated when there is at least 5 mm remaining crestal bone height, and primary implant stability can usually be achieved.[12,13] The crestal approach is generally considered to be a far less invasive procedure with less complications, less postoperative pain, and less swelling for patients. One main disadvantage of the transcrestal approach is that the procedure is relatively blind and there is the possibility of perforating the Schneiderian membrane due to reduced visibility, and not knowing that such a perforation has occurred. Although the transcrestal approach is a blind procedure, the frequency of Schneiderian membrane perforation is reported as less than the lateral approach.[14,15] Perforation of the Schneiderian membrane would lead to loss of the graft material into the sinus, and failure of the procedure. There is a very limited ability to repair a membrane perforation through the crestal approach compared to the lateral window procedure.

Traditional crestal sinus augmentation techniques, howev-

A Multicenter Retrospective Clinical Study with Up-to-5-Year Follow-up Utilizing a Method that Enhances Bone Density and Allows for Transcrestal Sinus Augmentation Through Compaction Grafting

Salah Huwais, DDS[1]/Ziv Mazor, DMD[2]/Andreas L. Ioannou, DDS, MS[3]/
Howard Gluckman, BDS, MChD (OMP)[4]/Rodrigo Neiva, DDS, MS[5]

Purpose: *To evaluate the effectiveness and predictability of a novel biomechanical, minimally invasive bone instrumentation technique that enhances bone density through compaction grafting, called osseous densification, and allows for transcrestal sinus membrane elevation and augmentation with simultaneous implant placement.* ***Materials and Methods:*** *Patients who were consecutively treated with the bone densification and transcrestal sinus augmentation technique and were followed up in three treatment centers between May 2012 and September 2017 were included in this retrospective study. The summary statistics are presented as means for continuous variables and percentages for categorical variables.* ***Results:*** *In total, 222 patients with 261 implants were included in the final clinical analysis. The included follow-up period ranged from 6 to 64 months with a mean of 35 months. The subsinus residual bone height at baseline was 5.4 mm (SD: 1.9). Following the sinus augmentation, a significant vertical increase of 7 mm (SD: 2.49) was observed. No sinus membrane perforations and no late implant failures were observed from 6 up to 64 months follow-up, yielding a cumulative implant survival rate of 97%.* ***Conclusion:*** *This osseous densification technique for maxillary implant site preparation with transcrestal sinus augmentation and simultaneous implant placement led to favorable clinical outcomes with up to 64 months of follow-up.* INT J ORAL MAXILLOFAC IMPLANTS 2018;33:1305–1311. doi: 10.11607/jomi.6770

Keywords: *atrophic maxilla, bone substitutes, compaction autografting, densifying burs, maxillary sinus, osseous densification, sinus augmentation, sinus elevation procedure*

Dental implant therapy is considered the "gold standard" for the rehabilitation of edentulous sites and has revolutionized the way dentistry is currently practiced.[1] Patients seek minimally invasive procedures and the timely delivery of implant-supported restorations.

Following tooth extraction in the maxillary posterior region, significant atrophy of the alveolar ridge and maxillary sinus pneumatization may occur. In such cases, sinus augmentation is required to create sufficient vertical bone volume for implant placement with adequate stability. Furthermore, implant placement in the posterior maxilla is additionally challenging due to poor bone quality and potentially narrow ridges. Osteotomy underpreparation is a commonly used method to enhance the implant primary stability.[2–4] However, this method may negatively impact osseointegration and lead to inadequate healing. According to Campos and coworkers, although osteotomy underpreparation may increase implant primary stability, a greater amount of necrotic dieback and interfacial remodeling may occur at the implant surface, potentially decreasing the implant secondary stability during healing.[5]

Numerous methods have been proposed to treat a vertically deficient, edentulous, posterior maxillary

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A novel trephine design for sinus lift lateral approach. Case report

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Abstract

Various techniques are described in the literature, either by crestal or lateral approach. Sinus augmentation has a high percentage of success, but presents a number of intraoperative and postoperative complications. The most frequent complication is the Schneiderian membrane perforation with a percentage of perforations between 11% and 56% according to authors. The aim of this study is to describe another membrane approach technique for the sinus lateral wall osteotomy that minimizes the risk of Schneiderian membrane perforation. We present a case of a 50 year old patient attended the University Dental Clinic (UDC) of International University of Catalonia for implant and crown treatment due to the loss of a right maxillary first molar. To insert an implant in position 1.6 a computerized tomography (CT) was requested to determine with greater accuracy the quantity of residual crestal bone. It showed a height of 5 mm and width of 8 mm. The lateral osteotomy was performed with a (SLA KIT® -Neobiotech) trephine mounted in the same implant handpiece with which the field for the implant and the implant itself were prepared. It can be concluded that in the case described, the use of trephine drills of the SLA system mounted in a handpiece allows better access to lateral approach due to its perpendicular position relative to the sinus wall minimizing the membrane perforation risk.

Key words: *Sinus lift, lateral approach, membrane perforation, trephine drills, dental implant.*

Sinus Membrane Elevation by the Crestal Approach Using a Novel Drilling System

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Purpose: *The purpose of this study was to evaluate the clinical outcomes of patients undergoing sinus membrane elevation by a minimally invasive crestal approach using a novel drilling system.*

Materials and Methods: *From May 2008 to November 2009, 21 implants were placed in 19 patients (10 men and 9 women) ranging from 23 to 69 years of age (average of 49.5 years). Implants were placed in maxillary premolar and molar areas that demonstrated insufficient residual bone quality; maxillary sinus membrane elevation was performed using a crestal approach with the sinus crestal approach kit (Neobiotech, Seoul, Korea).*

Results: *There was no sinus perforation or osseointegration failure. The implant survival rate was 100%. The postsurgical, augmented volume of the alveolar height ranged from 2 to 9.2 mm (average of 5.81 ± 2.06 mm). Six months after maxillary sinus elevation, the bone reduction volume ranged from 0.06 to 1.42 mm (average of 0.6 ± 0.38 mm). At final F/U, the amount of bone-height reduction ranged from 0.06 to 2.60 mm (average of 0.82 ± 0.63 mm).*

Conclusion: *Sinus membrane elevation by the crestal approach using special reamers is advantageous because of the noticeable reduction in the risk of perforation and the ability to perform the surgery rapidly. (Implant Dent 2017;26:351–356)*

Key Words: sinus floor augmentation, crestal approach, reamer

The cortical bone of the maxillary molar area is thin, with type 3 or 4 underlying cancellous bone, making the initial fixation of implants difficult in many cases. In addition, the maxillary sinus undergoes pneumatization after extraction, and the residual bone undergoes vertical and horizontal resorption. Consequently, available bone height is diminished; therefore, placement of the implant is difficult. To resolve such problems, sinus membrane elevation, bone grafting, vertical ridge augmentation, and other surgical procedures have been applied. Sinus membrane elevation is classified as follows: (1) a lateral window opening procedure, which allows for the formation of a bony window in the lateral wall, elevates the Schneiderian membrane and becomes filled with bone graft materials; (2) an osteotome technique proposed by Summers that involves the elevation of the sinus membrane by an intentional osteotomy of the sinus floor using the crestal route. The crestal approach is a simple procedure that is associated with fewer complications and has advantages over the lateral approach.[1] A wide array of modifications of the osteotome and/or drilling techniques has been reported in the literature.[2–5]

The purpose of this study was to evaluate the clinical outcomes of patients undergoing a sinus membrane elevation by the crestal approach using a uniquely designed drilling system.

Materials and Methods

Approval from the institutional review board (IRB), Seoul National University Bundang Hospital (approval number: B-1007-105-105) was obtained before the initiation of the study. The study subjects presented with a maxillary molar area that had insufficient residual bone volume. Sinus membrane elevation by the crestal approach using the sinus crestal approach (SCA) kit (Neobiotech) was performed before implant placement; these procedures took place between May 2008 and November 2009. In this study, surgery was performed using the uniquely designed S-reamer. The S-reamer has been given the name because the blade shape of the drill is S-shaped and it is a special drill for sinus surgery. The S-reamer can be used for effective bone removal with

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Minimally Invasive Crestal Sinus Lift Technique and Simultaneous Implant Placement

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Objective: *To evaluate the effectiveness and clinical results of a new crestal sinus lift technique used to elevate the sinus floor simultaneously with bone grafts and implant placement.*
Methods: *Eleven patients underwent this crestal sinus lift technique performed using an SCA KIT. The mean residual bone height was 6.4 mm (range: 4.1 mm to 8.6 mm). Bio-Oss collagen was used as the graft material, and 12 implants were simultaneously placed after sinus augmentation. Radiographic and clinical examinations were conducted during follow-up.*
Results: *All procedures were successfully performed with no obvious Schneiderian membrane perforation. The sinus floor was augmented with a mean height of 4.8 mm (range: 2.8 to 7.4 mm). Twelve implants healed uneventfully with healing abutments. Peri-implant marginal bone was stable, with a mean follow-up of 49.4 months (range: 33 to 71 months). No complications were observed during follow-up.*
Conclusion: *According to the limited data collected in this study, the novel crestal sinus lift approach could effectively lift the sinus floor and reduce the incidence of postoperative complications. Additional cases with long-term follow-up are needed to confirm and improve this crestal sinus lift technique.*
Key words: *bone graft, bone regeneration, dental implant, minimally invasive, osteotome, sinus lift*
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Deficient crestal bone is a common issue encountered in edentulous posterior maxillae owing to atrophy of the alveolar bone and maxillary sinus pneumatisation[1]. During recent decades, numerous studies have reported this issue, and many surgical techniques, as well as grafting materials used for maxillary sinus augmentation, have been evaluated[2,3]. Sinus augmentation with lateral access has been widely studied and is considered safe, with highly predictable outcomes[4-9]. The sinus grafting procedure with the lateral approach is often recommended to provide sufficient support for implants placed in extremely atrophic maxillary posterior ridges.

However, in cases where bone volume needs to be increased in order to regenerate bone for implant placement in a more conservative, less invasive and simpler manner, the crestal approach is preferred over the lateral approach. In 1994, Summers proposed the osteotome technique[10]. Afterwards, to perform maxillary sinus floor augmentation minimally, certain authors proposed modifications to the Summers' technique, essentially based on use of different bone grafts or novel instruments, as well as expansion and compression of the alveolar crest[11-17]. In addition, crestal approaches were demonstrated to be safe with highly predictable outcomes when the residual bone height was ≥ 5 mm[18].

In sinus augmentation procedures, different graft materials mixed with or without autologous bone have

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Investigación

EL TRATAMIENTO CON IMPLANTES MEDIANTE LA ELEVACIÓN TRANSALVEOLAR DEL SENO MAXILAR. TÉCNICA MISE (MAXILLARY INDIRECT SINUS ELEVATION)

IMPLANT TREATMENT BY TRANSALVEOLAR MAXILLARY SINUS ELEVATION. MISE (MAXILLARY INDIRECT SINUS ELEVATION) TECHNIQUE

NUNO MATOS GARRIDO, JESUS MORENO MUÑOZ, ALVARO JIMENEZ GUERRA, IVAN ORTIZ GARCIA, ENRIQUE NUÑEZ MARQUEZ, ANTONIO ESPAÑA LOPEZ, EUGENIO VELASCO ORTEGA

RESUMEN

Introducción. El objetivo del presente estudio era mostrar los resultados del tratamiento con implantes dentales insertados mediante la técnica de elevación transalveolar en el maxilar superior.
Pacientes y Métodos. 19 pacientes con pérdidas dentales maxilares fueron tratados con 20 implantes Premiun Kohno * Sweden-Martina con conexión interna y superficie arenada y grabada para la rehabilitación mediante la técnica de elevación sinusal transalveolar. Los implantes fueron cargados después de un periodo de cicatrización de 6 meses.
Resultados. Los hallazgos clínicos indican una supervivencia y éxito de los implantes del 95%. 1 implante se perdió durante el periodo de cicatrización. La ganancia media de hueso vertical fué de 4,4 mm. 45% de los implantes se insertaron en localización molar y el 55% en la localización premolar. Después de un periodo medio de carga funcional de 28,9 meses, no ha habido complicaciones tardías. El 94,4% de los pacientes fueron rehabilitados con coronas unitarias y el 5,6% con puentes fijos.
Conclusiones. Este estudio indica que el tratamiento con implantes dentales mediante su inserción con elevación transalveolar del seno maxilar superior constituye una terapéutica implantológica con éxito.

Palabras claves: Implantes dentales, elevación indirecta del seno maxilar, osteotomos, elevación transalveolar del seno maxilar, biomateriales, elevación transcrestal del seno maxilar.

ABSTRACT

Introduction. The aim of this study was to report the outcome of treatment with maxillary dental implants inserted by transalveolar sinus elevation.
Patients and Methods. 19 patients with maxillary tooth loss were treated with 20 Premiun Kohno * Sweden-Martina internal connection and sandblasted and acid-etched surface implants for rehabilitation by transalveolar sinus elevation. Implants were loaded after a healing free-loading period of 6 months.
Results. Clinical results indicate a survival and success rate of implants of 95%. One implant was lost during the healing period. The mean elevation height was 4.4 mm. 45% of implants were inserted in molar and 55% in premolar localization. After a mean functioning period of 36.4 months, no late complications were reported. 94.4% of patients were restored with single crowns and 5.6% with fixed bridges.
Conclusions. This study indicate that treatment with dental implants inserted in maxilla by ridge expansion constitute a successful implant treatment.

Key words: Dental implants, maxillary indirect elevation, osteotomes, maxillary transalveolar elevation, bone substitutes, maxillary transcrestal elevation.

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A case series on crestal sinus elevation with rotary instruments

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Key words *dental implant, sinus floor elevation*

Purpose: This case series aimed to evaluate the clinical outcome of a crestal approach technique in sinus floor elevation surgery with insertion of an alloplastic material.
Material and methods: A total of 50 edentulous patients received 64 implants and sinus floor elevation in posterior maxillae with residual crestal height 1.2 to 9.8mm, and larger than 7mm in width. Drilling perforation was performed until the sinus floor was felt. The sinus mucosa was then lifted. Hydroxyapatite granules were placed and implants were immediately inserted. Three months later, definitive crowns were cemented and patients were followed up for 18 months. Outcome measures were implant failures, complications and radiographic bone height gain measured 18 months after prosthetic loading.
Results: No patient dropped out and all implants were successfully osseointegrated. Only minimal postoperative patient discomfort was reported. Only one complication occurred: a minor perforation of the sinus membrane with no negative consequences. At the time of implant insertion, the residual bone height mean value was 6.20mm (±2.22). After surgery and at the last follow-up, the mean height of bone was 15.26 (±3.19) and 15.40mm (±4.21), respectively.
Conclusion: The procedure was able to obtain sinus elevation and implant osseointegration.

Conflict-of-interest statement: *No free materials were received and the authors do not have financial interest, either directly or indirectly, in the products listed in the study.*

■ Introduction

Sinus floor elevation is a reliable technique that allows implant insertion in the maxillary posterior region with either high pneumatisation or low crestal volume[1]. Several surgical techniques for sinus elevation have been studied in the literature, with a lateral or crestal approach, based on the remaining crestal height[2]. The lateral access technique offers a high possibility of success[3], which has contributed to its frequent use in sinus floor elevation surgery in spite of some disadvantages for the patients. An implant survival rate of 96% at 36 months regarding elevation with an osteotome technique was calculated by a systematic review of the literature[4].

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Crestal minimally-invasive sinus lift on severely resorbed maxillary crest: prospective study

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Abstract

Objectives: This case series aimed to explore the clinical outcome of sinus floor elevation surgery using a crestal approach technique in case of severely resorbed maxillae.
Material and methods: Seventeen edentulous patients received 20 implants and sinus floor elevation in posterior maxillae with residual crestal height of 1.2–5.0 mm and >7 mm. Drilling perforation was performed until the sinus floor was felt; the sinus mucosa was then lifted and magnesium-enriched hydroxyapatite granules (Mg-e HAP) were placed; and implants were immediately inserted. Four months later, definitive crowns were cemented, and patients were followed up for 24 months. Implant failures and complications 24 months after prosthetic loading were noted, and radiographic regenerated bone height was measured.
Results: No patient dropped out, and all implants were successfully osseointegrated. There was minimal postoperative patient discomfort, and the only complication was a minimal perforation of the sinus membrane with no negative consequences. At the time of implant insertion, the residual crestal height mean value was 4.12 mm. After surgery and at the last follow-up, the mean heights of bone were 13.51 and 12.98 mm, respectively.
Conclusion: The procedure was able to obtain sinus elevation and implant osseointegration.

Keywords: bone augmentation; bone stability; dental implant; minimal invasive; sinus floor elevation.

Introduction

Sinus floor elevation techniques allow implant insertion in the maxillary posterior region with either high pneumatization or low crestal volume [29], and it can be performed using a lateral or crestal approach [10].

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Lateral access technique offers a high possibility of success [19]; in fact, a survival rate of 97.5% at 24 months after surgery and a success rate of 96% at 36 months in terms of elevation with osteotomic technique were revealed by a systematic review of the literature [9].

The lateral access as well as a sinus crestal access using manual and osteotomic tools and a direct lifting of the sinus mucosa with curettes was developed by Tatum [27].

Summers [24, 25] later presented the osteotome sinus floor elevation and bone-added osteotome sinus floor elevation techniques with crestal access. Describing these procedures, the author stressed the importance of avoiding direct contact between tools and sinus mucosa, which must be dislocated with the interposition of compact crestal bone and/or biomaterials pushed in apical direction.

In 1998, Bruschi et al. [2] settled the localized management of sinus floor procedure – a crestal access on a partial thickness flap allowing sinus floor elevation as well as simultaneous horizontal expansion of edentulous crest using manual tools and hammer.

Similar techniques were subsequently introduced, using osteotomes and mallet to obtain mucosa dislocation and sinus floor elevation [7, 17, 22].

In 1998, Cosci and Luccioli [6] were the first to describe drilling tools especially designed for sinus elevation procedure with crestal access, i.e., lifting burs with a flat extremity and measuring 1–8 mm long. In this technique, the sinus cortical bone was reached with a trephine and perforated using a lifting bur 1 mm longer than the depth reached by the core bur. Mucosa was therefore exposed and elevated with an osteotome, which pushed the biomaterial. At the same time, the "modified trephine/osteotome approach" allowed mucosa elevation using an osteotome to dislocate the bone cylinder obtained with a trephine carried at 1–2 mm from the sinus floor. Fugazzotto [12] concluded that implant length should not exceed a double measure of the residual crest. In fact, even if controversial [3, 5], all crestal access techniques are suggested to be adopted in combination with immediate implant insertion after sinus elevation, when residual bone height is 5–6 mm, because of the lack of implant primary stability [22].

Finally, literature has proven the high reliability of crestal techniques when residual crestal bone is higher than 5 mm, with implant success ranging from 85.7% to 100% [8]. However, some clinical protocols recommend the lateral approach in case of residual bone height <5 mm or in case of elevation >5 mm because of high risks of mucosa laceration [8, 19, 26, 30].

The aim of this study was to evaluate, in a prospective case series, the clinical outcome of a crestal sinus lift technique

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DOCTORADO DE CIENCIAS DE LA SALUD

LA ELEVACION INDIRECTA DEL SENO MAXILAR EN EL TRATAMIENTO CON IMPLANTES. TECNICA MISE

Tesis Doctoral

KARIM NASSER NASSER

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Assessment of dentists' subjective satisfaction with a newly developed device for maxillary sinus membrane elevation by the crestal approach

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Purpose: The purposes of this study were to assess the dentists' subjective satisfaction with the crestal approach sinus (CAS) kit, a device for maxillary sinus membrane elevation by the crestal approach using a special drilling system and hydraulic pressure, and to summarize the subjective satisfaction of dental implants placed after a sinus lift procedure with the CAS kit.
Methods: Thirty dental clinicians who had experience with dental implant placement after a sinus lift procedure with the CAS kit from June 2010 to May 2012 were included in this study. The questionnaire for the evaluation of the dentists' subjective satisfaction with the CAS kit was sent to the respondents and returned. The questionnaire was composed of two main parts. The first part was related to the sinus membrane perforation rate. The second part was related to the dentists' subjective satisfaction with the CAS kit.
Results: A total of 28 dentists answered the questionnaire. Among 924 implant cases, sinus membrane perforation occurred in 38 cases (4.1%). Among the 28 dentists, 26 dentists (92.9%) were satisfied or very satisfied with the CAS kit. In particular, 24 dentists (85.7%) reported that safety, cutting performance, and user-friendliness of the CAS drill were advantages of the CAS kit. However, 7 dentists (25%) did not routinely use the hydraulic lifter for sinus membrane elevation.
Conclusions: From the survey, it was shown that the respondents were generally satisfied with the CAS kit and that the cutting performance and safety of the drill component were considered strengths of the CAS kit.

Keywords: Maxillary sinus, Questionnaires.

INTRODUCTION

Implant placement has become a widespread dental procedure to restore the edentulous jaw with functional defects. However, in many cases, insufficient vertical bone height of the residual ridge and poor bone quality give rise to difficulties in implant placement in the maxillary posterior area. This is partially due to the rapid progression of alveolar bone resorption and pneumatization of the maxillary sinus after tooth extraction. To overcome such anatomical and physiological problems, a sinus lift procedure, which was composed of a maxillary sinus membrane elevation step and bone graft step, was developed and has been applied widely in clinics. For maxillary sinus membrane elevation, either the lateral approach or the crestal approach is used depending on the bone height of the residual ridge.

When the crestal approach, which is known as the osteotome technique, was introduced, the crestal approach had the limelight among clinicians due to its many advantages in comparison with the lateral approach. First of all, the crestal

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Maxillary Sinus Membrane Elevation Using a Special Drilling System and Hydraulic Pressure: A 2-Year Prospective Cohort Study

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The purpose of this study was to evaluate clinical and radiologic outcomes using a newly developed device for maxillary sinus membrane elevation. Patients with a residual bone height of at least 3 mm were enrolled. Crestal sinus lift elevation and sinus graft were performed using the crestal approach sinus (CAS) kit. Graft was avoided if the residual bone crest was ≤ 2 mm less than the length of the planned implant. Outcome measures were implant and prosthesis failure, any biologic or technical complications, and marginal bone loss (MBL). A total of 35 consecutive patients underwent 49 crestal elevations of the sinus membrane. All the implants were followed for at least 2 years after placement (mean follow-up 37.3 months; range 24 to 54 months). No implants or prostheses failed during follow-up, and no membrane tears or other intraoperative or postoperative adverse events were observed. At the 2-year follow-up, mean MBL was 0.33 ± 0.24 mm (95% confidence interval: 0.08 to 0.30 mm). A total of 32 implants were placed after filling the sinus with anorganic bovine bone, while 17 implants were placed without grafting the sinus. Post-hoc analysis was performed using the sinus grafting remodeling index (SGRI) to evaluate radiographically the tissue remodeling patterns. The SGRI was statistically significantly higher when the sinus was grafted (P = .000). The CAS kit may provide a new option for minimally invasive crestal sinus surgery. Long-term randomized controlled trials with larger sample size are needed to confirm these preliminary results.
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Implant placement has become a widespread dental procedure to restore partially and completely edentulous patients.[1,2] However, the success rate of osseointegrated implants in the maxilla, especially in the posterior region, seems to be significantly lower when compared to the implant success rate in the mandible.[1] This is partially due to the poor quality and quantity of bone in the maxilla, as well as the pneumatization of the maxillary sinus after tooth extraction.

Sinus lift procedures using a lateral approach overcome this drawback, increasing bone volume in the sinus cavity.[3] However, this surgical procedure requires execution of a large mucoperiosteal flap, leading to significant postoperative morbidity.[4,5] Furthermore, sinus membrane perforations, nosebleed, infection, rhinosinusitis, and high postoperative pain, swelling, and hematoma have to be considered as possible complications.[6,7]

Crestal sinus lift approach was first described by Tatum[8] and modified by Summers.[9] Subsequently, various modifications to the original technique have been reported to improve the reliability and safety of the membrane elevation.[10,11] The major concern with the crestal sinus lift approach is that the elevation of the sinus membrane is performed without direct optical control. Moreover,

CASE LETTER

Trephine Core: An Alternative Sinus Lift Technique

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INTRODUCTION

Typically, the posterior maxilla demonstrates the lowest density of bone in the oral cavity. The posterior edentulous maxilla also presents special challenges in implant placement compared with other areas of the mouth due to progressive resorption that results in less available bone. This poor quality and quantity of available bone challenges the essential condition for successful implant placement.

The maxillary sinus is an air cavity located in the maxilla that enlarges after tooth loss, complicating implant placement in this region. It is pyramidal in shape and is frequently reinforced with internal vertical septa, creating further intrasinus cavities.[1] After tooth extraction, the initial decrease in bone is due to resorption of buccal bone plate that is of lower density and thinner in cross section than the palatal osseous plate. As the edentulous area continues to atrophy, there is a continuing loss of bone height and density and an increase in antral pneumatization.[2,3] As a result, the sinus floor enlarges in a crestal direction, decreasing available osseous height for implant placement over time. This finding is related to 2 phenomena: (1) the enlargement of the sinus at the expense of the alveolus after tooth extraction because of the increased osteoclastic activity of the periosteum of the schneiderian membrane[4] and (2) increased pneumatization of the sinus simply because of the increase in positive intra-antral pressure.[5] In addition, the maxilla is made of primarily spongy bone and is composed of the least dense bone in the oral environment. The amount of bone inferior to the sinus is often limited. Thus, treatment of the posterior maxilla depends on the amount of bone present in the subsinus region. The longer the site is edentulous or the higher the amount of periodontal inflammation present before tooth extraction influence how much available bone height and width will be present for implant placement. To achieve ideal height and width of posterior maxilla, sinus lift procedures are often required.[1]

Tatum[4] was the first to report penetration of the maxillary sinus with a modified Caldwell-Luc technique. This technique makes use of an unfinished fenestration osteotomy in the maxilla's external face to raise the sinus membrane, creating a hole in the floor of the antral cavity. This hole is then filled with a grafting material, providing required dimensions of the bone for implant placement. However, one of the most common complications of this technique is perforation of the Schneiderian membrane. Today, to overcome this complication many modifications are available, depending upon the available bone. Sinus lift procedure using trephine is one such procedure that was introduced by Emtiaz et al.[6]

In this technique, after raising a mucoperiosteal flap, by use of a trephine on a straight implant handpiece, a round bone cut is made 4–5 mm above the crest of the alveolar ridge and inferior to the sinus floor by several millimeters. A trephine drill is a hollow cylinder with a serrated terminal edge that creates a cylinder of bone in the osseous site (Figure 1). The outer bony cortex is removed gently to avoid tearing the membrane; this is important because the membrane can later be used for repositioning over the graft or crushed and used as particulate graft material in the site. The exposed membrane is then lifted from the sinus floor using osteotomes (Figure 2). Additional graft material is placed until the lateral wall of the maxilla is reconstituted. The mucoperiosteal flap is repositioned and sutured.[1]

When the trephine technique is to be used with simultaneous implant placement, a trephine is selected that has an outer diameter no greater than the implants core diameter (diameter minus

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Gradual and safe technique for sinus floor elevation using trephines and osteotomes with stops: a cadaveric anatomic study

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Objective. The aim of this study was to develop a new technique for maxillary sinus floor elevation through the crestal approach, using trephines and osteotomes with stops, and to assess the risk of sinus membrane lesion.
Study design. The study was performed on 30 heads removed from fresh nonpreserved cadavers with subsinus bone height ≥5 mm. The anatomic specimens were sectioned axially on a plane passing 1 cm below the infraorbital foramen, to be able to see and film the sinus floor covered by the membrane. A total of 112 implants were placed using this technique (48 without grafting material and 64 with grafting material).
Results. Using this technique, we obtained a 4-6 mm elevation of the sinus membrane without impairing the mucosa. In the 13 cases where membrane lesions were observed, 9 had been performed without grafting material. The greater the initial subsinus bone height, the higher the elevation observed.
Conclusions. The success of this technique was due to stops on the trephines and osteotomes, which reduced the risk of invading the sinus cavity and made it possible to lift the membrane gently, fully controlling movements. This technique is indicated for large crests of type III or IV bone and with a minimal bone height of 5 mm. **(Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2008;106:210-6)**

Successful maxillary molar dental implantation depends on the quality and quantity of alveolar bone available beneath the sinus. There are several reasons for low bone height, such as maxillary sinus morphology, alveolar bone resorption after dental extractions, and periodontal disease. Also, a mobile dental prosthesis may contribute to reduced bone height.[1]

Over the previous 20 years, many surgical methods have been developed to compensate for low subsinus alveolar bone height to permit implant-assisted prosthetic rehabilitation. These techniques include grafts and sinus lifts requiring a vestibular approach (Caldwell-Luc procedure).

However, more conservative approaches have been proposed with the intention of lifting the sinus floor by performing an osteotomy via the crestal route, with or without grafting materials, and immediate implant placement. In 1994, Summers described a minimally invasive technique for elevating the sinus membrane by specially developed osteotomes.[2,3] With these instruments, bone can be compacted on the implant site both laterally and apically. Compaction induces apical deformation of the maxillary sinus owing to the displacement of the subsinus cortical bone associated with osteotomy shavings which are collected and subsequently compacted. A bone substitute may be placed in the osteotomy site.[2,3] This then serves as a damper during floor fracture. The procedure is repeated several times, resulting in a gradual increase in pressure which lifts the sinus membrane.

With this technique, implants can be placed immediately on the alveolar crests with a height of 5 to 6 mm and type III or IV bone.[4]

The protocol of Summers was subsequently modified by several authors.[5,6] Davarpanah et al.[7] proposed a new surgical procedure using osteotomes, drills, and screw implants with rough surfaces.

Lalo et al.[8] described a technique using osteotomes and drills with stops which aimed to reduce failure related to sinus membrane impairment. The guard prevents the instruments from invading the sinus. The repeated impaction movement, with or without grafting material, causes a greenstick fracture of the sinus floor, resulting in membrane elevation. The implant can then be placed. This technique is indicated if the minimal subsinus bone height is 4 mm.

We propose a new technique for sinus membrane elevation which is minimally invasive and safe, using trephines with stops and the osteotomes used by Lalo et al.[8]

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The Modified Trephine/Osteotome Sinus Augmentation Technique: Technical Considerations and Discussion of Indications

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A technique is presented, which uses trephines of various external diameters followed by an osteotome to implode a core of maxillary posterior alveolar bone before placement of regenerative materials, in anticipation of subsequent implant placement. A mathematical formula is presented, which relates the depth of core displacement to the apico-occlusal dimension of alveolar bone coronal to the floor of the sinus presurgically. Seventy-one sites have been treated. All sites exhibited sufficient regeneration for implant placement. Two of the sites required additional augmentation at the time of implant placement. Fifty-one of the implants have been restored and are in function for up to 3 years. All are functioning successfully, as defined by the Albrektsson criteria. The technique and its indications and contraindications are described in detail. (Implant Dent 2001;10:259–264)

Key Words: sinus augmentation, osteotome, trephine, guided bone regeneration, implants

Unique challenges posed by the atrophic posterior maxilla often require hard tissue augmentation either before or in conjunction with implant placement, if an implant supported prosthesis is the final treatment goal. Buccolingual and apico-occlusal resorption patterns, in combination with sinus pneumatization, mandate three-dimensional conceptualization and an appropriate regenerative approach.[1]

Sinus augmentation therapy, with or without autogenous bone grafting, has been demonstrated to significantly increase the apico-occlusal bone volume of the atrophic posterior maxilla. Unfortunately, the temporal and financial commitments inherent in such a therapeutic approach often pose significant obstacles to acceptance of therapy by the patient.[2–6]

In an effort to shorten the course of therapy and lessen the financial challenge to the patient, Summers detailed the use of osteotomes to perform localized sinus augmentation therapy.[7,8] A modification of this technique, in combination with trephines, has been described for use at the time of maxillary molar extraction.[9]

The use of osteotomes to apically displace the floor of the sinus, generally begins in one of two manners. Either the narrowest osteotome is used to compress bone, lift the floor, and create an initial path of access for the use of subsequent wider osteotomes, or a 2-mm twist drill is first used to approach the floor of the sinus and prepare a channel for the use of osteotomes, when a significant amount of residual alveolar bone remains coronal to the floor of the sinus. If osteotomes are used without first preparing a channel in the bone with a bur, a significant amount of force must be applied to compress the residual alveolar bone. Such force application and repeated malleting may be disconcerting to the patient. However, if a 2-mm twist drill is first used to lessen the trauma to the patient, alveolar bone is prepared and removed from the site, which might otherwise be imploded when the floor of the sinus is lifted.

A technique that would lessen trauma to the patient, conserve the maximum amount of alveolar bone at the precise site of anticipated implant placement, and limit the incidence of sinus membrane perforation would offer clinical benefits. Herein are the rationale and subsequent protocol.

Materials and Methods

Patient Selection

After a thorough review of medical histories, patients were deemed unsuitable to receive augmentation therapy based upon the following criteria: (1) the presence of uncontrolled diabetes, an immune disease, or other contraindicating systemic conditions; (2) radiation therapy to the head and neck region in the 12 months before proposed therapy; (3) chemotherapy in the 12-month period before proposed therapy; (4)

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Immediate Implant Placement Following a Modified Trephine/Osteotome Approach: Success Rates of 116 Implants to 4 Years in Function

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Purpose: *A technique is presented which utilizes a trephine with a 3.0-mm external diameter followed by an osteotome to implode a core of maxillary posterior alveolar bone prior to immediate implant placement.* ***Materials and Methods:*** *The technique and its indications and contraindications are described in detail.* ***Results:*** *One hundred sixteen implants were placed and uncovered utilizing this technique. Two implants were mobile at the time of uncovering.* ***Discussion:*** *One hundred fourteen implants were restored and have been functioning successfully for up to 4 years according to the Albrektsson criteria, yielding a success rate of 98.3%.* ***Conclusion:*** *No implants have been lost or are failing in function.* (Int J Oral Maxillofac Implants 2002;17:113–120)

Key words: *guided bone regeneration, implants, osteotome, sinus augmentation, trephine*

The combination of buccolingual and apico-occlusal resorption patterns following tooth loss, pneumatization of the maxillary sinus, the final sinus position relative to the residual alveolar bone, and the often poor quality of remaining alveolar bone in the posterior maxilla frequently mandate hard tissue augmentation therapy prior to implant placement and subsequent prosthetic reconstruction.[1] Although sinus augmentation procedures with or without autogenous bone grafting have been demonstrated to result in significant increases in the apico-occlusal bone volume of the atrophic posterior maxilla, such therapies require a substantial commitment of time and expense.[2–8]

In an effort to shorten the length of treatment, lessen the financial challenge to the patient and decrease patient morbidity, Summers introduced osteotome techniques with or without the addition of particulate materials to achieve apical displacement of the sinus membrane and afford adequate dimension for implant placement.[9–10] Recent publications have discussed the utilization of modified osteotomes to simplify the technical aspects of the procedure, as well as use of the osteotome technique at the time of maxillary molar extraction.[11]

Utilization of osteotomes to apically displace the floor of the sinus generally begins in 1 or 2 ways. One approach has utilized the narrowest tapered osteotome to compress bone, lift the floor of the sinus, and create the initial path of access for subsequent wider osteotomes. When significant alveolar bone remains coronal to the floor of the sinus, a marked amount of force must be applied to compress the residual alveolar bone. Such repeated force application is often disconcerting to the patient. An alternative therapeutic approach employs a 2-mm twist drill to come within 1 or 2 mm of the floor of the sinus and then prepare a channel for the utilization of osteotomes. However, if a 2-mm drill is first utilized to lessen the trauma to the patient, alveolar bone is prepared and removed from the site, which might otherwise be imploded when the floor of the sinus is lifted.

A technique which would both lessen the trauma to the patient and conserve the maximum amount of alveolar bone at the precise site of anticipated implant placement would offer clinical benefits.

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REVIEW Open Access

Is antral membrane balloon elevation truly minimally invasive technique in sinus floor elevation surgery? A systematic review

Huda Moutaz Asmael

Abstract

Background: Minimally invasive antral membrane balloon elevation was introduced as a less traumatic technique in sinus floor elevation surgery. This is the first systematic review to assess the results of previous studies utilizing this technique.

Aims of the study: The objectives of this study were to assess the bone gain, sinus augmentation success rate, implant survival rate, and complications with minimally invasive antral membrane balloon elevation technique in comparison with the sinus floor elevation by traditional transalveolar technique (Summers' technique).

Materials and methods: An electronic search including MEDLINE (PubMed) and Cochrane database sites was conducted and supported by manual searching for articles on minimally invasive antral membrane balloon elevation from 1945 to 16 January 2017. Sometimes the researchers were contacted to fill the missing information which was not mentioned in their articles.

Results: The extracted articles which involved utilization of balloon technique in maxillary sinus floor elevation surgery were 27 articles, among which only 10 articles met the inclusion criteria. The average of schneiderian membrane perforation with minimally invasive antral membrane balloon elevation (MIAMBE) technique was 6.76%. The sinus augmentation success rate ranged from 100 to 71.4% with average of 91.6%. Bone gain with this technique could reach for more than 10 mm with an average of 6.96 mm.

Conclusions: Minimally invasive antral membrane balloon elevation combined the beneficial points of both lateral window approach and transalveolar approach in which it produced ≥ 10 mm of gained bone in minimally invasive manner. Anyhow, long follow-up period is needed to accurately identify the long-term success rate of dental implants placed with this technique.

Keywords: MIAMBE technique, Sinus augmentation, Sinus floor elevation surgery

Review

Several sinus floor elevation techniques had been introduced as a minimally invasive surgical procedure. Among which, minimally invasive antral membrane balloon elevation technique was developed to achieve better results with minimal trauma to the patient also to reduce complications and intra-operative time. Conventionally, sinus augmentation procedure is performed either via lateral approach (modified Caldwell-Luc approach) [1] or through more conservative transcrestal approach (Summers' technique) [2].

The antral membrane balloon elevation (AMBE) technique was introduced via lateral approach (direct sinus lift surgery) [3, 4].

After that, the minimally invasive antral membrane balloon elevation (MIAMBE) technique was described via transcrestal approach (indirect sinus lift) which involved utilization of balloon device through conservative 3-mm osteotomy site [5]. Since then, several articles were published utilizing this technique. This is the first systematic review for evaluation of the (MIAMBE) technique in sinus lift surgery.

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ANTRAL MEMBRANE BALLOON ELEVATION

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KEY WORDS

Sinus graft
Sinus lift
Sinus floor augmentation
Sinus membrane
Maxillary sinus
Dental implants
Balloon antral augmentation

Many edentulous posterior maxilla are found to be encumbered by alveolar resorption and increased pneumatization of the sinus. These factors limit the quantity and quality of bone necessary for successful implant placement in these areas. One solution is to use shorter implants, but this often results in an unfavorable crown-root ratio. To create an improved environment in such regions, the classic sinus floor elevation with bone augmentation is a well-accepted technique. However, when the edentulous area is limited to a zone between 1 and 2 teeth, lifting the membrane becomes difficult and may subject it to iatrogenic injury. The antral membrane balloon elevation technique, which is introduced in this preliminary report, is a modification of the currently used sinus lift. It elevates the membrane easily and makes the antral floor accessible for augmentation with grafting materials.

INTRODUCTION

The edentulous posterior maxilla presents special challenges to the implant surgeon that are unique compared with other areas in the mouth. After tooth extraction, the initial decrease in bone width is secondary to resorption of the buccal bone plate. As the edentulous area continues to atrophy, there is a continuing loss of bone height and density and an increase in antral pneumatization.[1,2] The maxilla is primarily trabecular or spongy bone enclosed within thin cortical layers. In addition, the posterior maxilla contains the least dense bone in the oral environment. In some cases, the alveolus may be 2 mm high or shorter and of poor quality. Even if an individual were to have a modicum of bone, the resulting short endosseous implants would lead to insufficient anchorage, questionable integration, and unfavorable crown-root ratios. It has been written that as much as a minimum of 10 mm of bone height is necessary for successful implant stabilization and integration.

The antral membrane balloon elevation (AMBE) technique lifts the sinus membrane with minimal trauma and is particularly useful in areas that are difficult to reach. It is beneficial when teeth are adjacent to the edentulous area that requires augmentation. The AMBE technique is accomplished with a limited incision, minimal mucoperiosteal flap reflection, and a small window. The membrane is elevated to the medial wall of the sinus cavity avoiding sharp dissection around the roots of adjacent teeth. Thus, morbidity, blood loss, operative

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Case Series

Minimally Invasive Antral Membrane Balloon Elevation: Report of 36 Procedures

Efraim Kfir,* Vered Kfir,† Eli Eliav,‡ and Edo Kaluski§

Background: *The posterior maxillary segment frequently has insufficient bone mass to support dental implants. This registry evaluated the feasibility and safety of minimally invasive antral membrane balloon elevation (MIAMBE), followed by bone augmentation and implant fixation.*

Methods: *Thirty-six consecutive patients referred for posterior maxillary bone augmentation underwent alveolar crest exposure and implant osteotomy followed by MIAMBE (>10 mm). Fibrin and bone particles were injected beneath the antral membrane, implants were placed into the osteotomies, and primary closure was executed at the same sitting.*

Results: *All 36 patients successfully concluded the procedure with no significant procedural complications or discomfort. Procedure time was 48 ± 15 minutes. Incremental bone height consistently exceeded 8 mm, and implant survival of 97% was observed at 6 to 8 months.*

Conclusions: *MIAMBE resulted in high procedural success and satisfactory bone augmentation implant survival and complication rates. Because it is minimally invasive, this procedure may be an alternative to the currently used surgical methods.* J Periodontol 2007;78:2032-2035.

KEY WORDS

Dental implants; maxillary sinus.

Candidates for dental implants of the posterior maxillary segment frequently have insufficient bone mass to support the implants.[1] Traditionally, clinicians have used two approaches to perform bone augmentation in the inferior aspect of the maxillary sinus: the lateral maxillary window approach ("hinge osteotomy") and the "osteotome technique,"[2] also called bone-added osteotome sinus floor elevation. The latter approach yields a modest bone height increment that can be estimated according to the initial bone height.[3] Moreover, this procedure can be complicated by membrane perforation and tear,[4] which can be minimized with expert technique and dedicated instrumentation.[5] Lateral maxillary window offers a satisfactory average implant survival of 91.8% (ranging from 61.7% to 100%).[6] Compared to the minimally invasive methods, the major shortcomings of this method are potential nerve and vascular injury, requirement of high surgical skills, and patient discomfort. Lateral bone fenestration[7] has limitations similar to hinge osteotomy. Minimally invasive antral membrane balloon elevation (MIAMBE) is a modification of the osteotome technique initially attempted 3 years ago.[8] The MIAMBE is executed via an osteotomy site ≤3.5 mm. This article summarizes the initial experience with this method using non-commercial dedicated prototype equipment.

MATERIALS AND METHODS

Patients

The registry included 36 consecutive patients (mean age: 42 ± 9 years) with edentulous posterior maxillary segment and insufficient bone mass who were referred for bone augmentation and treated between June 2004 and October 2005 in a specialized dental clinic in Petah-Tikva, Israel. Twenty-eight percent were smokers; 50% were female. Baseline bone height was 3.4 ± 2.1 mm. Patients received an explanation of the procedure and signed an informed consent. This was a second cohort treated with MIAMBE.

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Minimally Invasive Antral Membrane Balloon Elevation – Results of a Multicenter Registry

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ABSTRACT

Background and Purpose: Frequently, the posterior maxilla lacks sufficient bone mass to support dental implants. This multiphysician registry assessed the feasibility and safety of minimally invasive antral membrane balloon elevation (MIAMBE), followed by bone augmentation and implant fixation.

Materials and Methods: One hundred twelve consecutive patients were referred for MIAMBE. Following pre-procedural assessment and informed consent, patients underwent alveolar crest exposure, and 3 mm osteotomy followed by MIAMBE. Platelet-rich fibrin and bone substitutes were injected under the antral membrane; implant placement and primary closure were executed at the same sitting. Implant loading was carried out 6 to 9 months later.

Results: One hundred nine (97.3%) patients successfully concluded the initial procedure. Three patients had membrane tear requiring procedure abortion. One case of infection was documented at 4 weeks. Procedure time was 58 ± 23 minutes. Incremental bone height consistently exceeded 10 mm, and implant survival of 95% was observed at 6 to 9 months.

Conclusion: MIAMBE can be applied to all patients in need of posterior maxilla bone augmentation with high procedural success, low complication rate, and satisfactory bone augmentation and implant survival. As it is minimally invasive and associated with minimal discomfort, MIAMBE should be an alternative to the currently employed methods of maxillary bone augmentation.

KEY WORDS: antral membrane, bone augmentation, dental implants, maxillary sinus, posterior maxillary implants

INTRODUCTION

Patients with an edentulous posterior maxillary segment frequently lack adequate bone mass to support dental implants.[1] The challenge of bone augmentation of this segment has been traditionally addressed by two approaches: (1) lateral maxillary window ("hinge osteotomy") and (2) the "osteotome technique,"[2] also called bone-added osteotome sinus floor elevation (BAOSFE). The latter strategy yields modest bone-height increments, hence is not suitable for patients with markedly reduced initial bone height.[3] BAOSFE can be complicated by membrane perforation and tear,[4] which can be somewhat reduced with expert technique and dedicated instrumentation.[5] The lateral maxillary window offers average implant survival of 91.8% (ranging from 61.7 to 100%).[6] This method suffers from considerable shortcomings, including procedure complications (membrane tear, bleeding, infection, nerve laceration, and sinus obstruction), peri-procedural swelling and discomfort, and relative contraindications (sinus convolution septum or narrow sinus and previous sinus surgery). Lateral maxillary window also requires considerable surgical skills, equipment, and time. Lateral bone fenestration[7] suffers from similar shortcomings as lateral maxillary window. Minimally

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Sinus Membrane Lift Using a Water Balloon Followed by Bone Grafting and Implant Placement: A 28-Case Report

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Purpose: The objective of this study was to assess the efficacy and safety of a minimally invasive sinus lift using an inflatable water balloon followed by bone grafting and implant placement. ***Materials and Methods:*** A total of 28 patients with a single tooth missing in the posterior maxilla underwent a water balloon sinus lift, followed by bone grafting and implant placement. Baseline bone height was 4.92 ± 1.24 mm. Implant site preparation employed a pilot drill and osteotomy followed by water balloon elevation. The mean inflated balloon volume was 0.67 ± 0.17 mL. Bio-Oss was filled under the elevated sinus membrane using a dedicated instrument. Twenty-eight total implants (diameter: 3.8 to 5.0 mm) were placed. Pre- and postoperative panoramic films or computed tomographs (optional) were taken for every case to measure and compare the results of the sinus membrane lift using a water balloon. Postoperative patient reactions including swelling, discoloration, discomfort, hematomas, and disability were recorded. ***Results:*** Successful sinus membrane water balloon lifting procedures were performed in 26 cases; two procedures were aborted due to sinus membrane perforation. A total of 26 implants were placed. The mean inflated balloon volume was 0.67 ± 0.17 mL and radiographic examination showed the mean elevated height by balloon to be 10.9 ± 2.06 mm. Computed tomography showed the bone graft distributing evenly around implants. Patients were extremely pleased with the results and needed very little medical attention after surgery. The mean follow-up was 15.9 ± 2.94 months. One implant was lost due to infection. ***Conclusion:*** The use of a water balloon to elevate the sinus membrane is a truly minimally invasive technique and is associated with very little discomfort. This method has encouraging results, is easy to learn, and is associated with low complication rates. *Int J Prosthodont 2009;22:243–247.*

The widespread use of implants for the replacement of missing teeth has led to the use of more sophisticated surgical techniques in sites that previously were considered as contraindications to implant therapy. The posterior region of the edentulous maxilla frequently presents insufficient bone for rehabilitation by means of endosseous implants. Maxillary sinus lifting using a bone graft was first introduced by Boyne and James[1] and Tatum.[2] This technique has been used to permit the placement of endosseous implants in edentulous or excessively pneumatized maxillae. Although the lateral maxillary window approach, also known as the Caldwell-Luc approach, may yield very successful clinical results for sinus grafting, this method has many shortcomings.[3] Limitations of the lateral maxillary approach include sinus membrane perforation (10% to 35%),[4] bleeding, infection, infraobital nerve laceration, and the need for extensive surgical expertise.[5] Postoperative discomfort including swelling, discoloration, disability, hematoma, and pain occur very often.[5]

The other technique currently in practice is a limited sinus elevation using an osteotome, which yields an average bone height of 3 ± 0.8 mm.[6] According to standard protocol, the osteotome technique can only be used when the ridge height is more than 5 mm and implants are placed simultaneously with the elevation of the sinus floor.[7] Moreover, this procedure can also be complicated by membrane perforation and tear.[8]

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Sinus Floor Augmentation with a Hydropneumatic Technique: A Retrospective Study in 40 Patients

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*Tiziano Testori, DDS, MD***/Felice Roberto Grassi, MD, DMD, PhD*****

The use of a hydropneumatic balloon for the elevation of the sinus membrane is a new technique for sinus floor augmentation procedures. Few cases using such a technique are reported in the English medical literature. This report describes 40 patients who were treated with this technique and studied retrospectively. Forty consecutive patients with an alveolar crest–sinus floor distance (bone height) ≤ 12 mm were enrolled. Under microscopy (40×) and using piezosurgical instruments, hydropneumatic sinus membrane elevation was performed, and a calcium sulphate solution was injected under the elevated antral membrane using a syringe. In the same surgical session, 4.00- to 6.50-mm-diameter implants were placed. Bone height at 12 months, complications related to the surgical technique, and implant failure were all recorded. Bone height at 12 months was 14.66 ± 1.48 mm, with a sinus membrane elevation of 9.01 ± 3.01 mm. Fifty-six implants were placed, and no failures were observed after 1 year. One macrolaceration and two microlacerations were the only complications related to the technique. Minimal invasiveness and reduced trauma characterize this new approach. In fact, gradual balloon inflation provides a controlled and atraumatic preparation of the sinus floor membrane. Piezoelectric instruments and microscopy make this technique predictable and safe. The relatively short learning curve of this approach for sinus floor elevation allows for its use in private practice. (Int J Periodontics Restorative Dent 2012;32:205–210.)

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Implant rehabilitation of edentulous arches with conventional techniques has demonstrated great predictability when the remaining bone is sufficient, with success rates of 84% to 92%.[1–3] On the contrary, in patients with severe upper maxillary resorption, the scenario is more complicated. In fact, bone centripetal resorption, pneumatization of the sinuses, and the presence of the nasal fossae and the nasopalatal duct, together with bone of quality type 3 or 4 according to the classification of Lekholm and Zarb,[4] are factors that frequently complicate or make implant placement impossible. The Sinus Consensus Conference held in 1996[5] found that sinus floor elevation is effective in restoration of the maxilla and, in many cases, is the unique alternative that permits implant placement and prosthetic rehabilitation. Sinus floor elevation and augmentation should be considered an evidence-based and clinically established method for implant prosthetic rehabilitation of the atrophic posterior maxilla, with an overall cumulative survival rate of 90% within a mean observation

Flapless Approach to Maxillary Sinus Augmentation Using Minimally Invasive Antral Membrane Balloon Elevation

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In the atrophic posterior maxilla, successful implant placement is often complicated by the lack of quality and volume of available bone. In these cases, sinus floor augmentation is recommended to gain sufficient bone around the implants. Sinus elevation can be performed by either an open lateral window approach or by a closed osteotome approach depending on available bone height. This case series demonstrates the feasibility and safety of minimally invasive antral membrane balloon elevation, followed by bone augmentation and implant fixation in 20 patients with a residual bone height of 2 to 6 mm below the sinus floor. The surgical procedure was performed using a flapless approach. At 18 months follow-up, the implant survival rate was 100%. Absence of patient morbidity and satisfactory bone augmentation with this minimally invasive procedure suggests that minimally invasive antral membrane balloon elevation should be considered as an alternative to some of the currently used methods of maxillary bone augmentation. (Implant Dent 2011;20:434–438)

Key Words: antral membrane, posterior maxillary implants, bone augmentation, dental implants, maxillary sinus

Posterior maxillary implant placement is often complicated by the lack of quality and volume of available bone. Types 3 and 4 bone tend to predominate in the posterior maxilla, generally exhibiting the least dense bone of the oral anatomy.[1] The height and width of the residual ridge can significantly be reduced or eliminated by postextraction resorption patterns, use of a removable prosthesis, physical trauma, periodontal disease, and pneumatization of the sinus. In the atrophic posterior maxilla, longer and wider implants are needed to enhance long-term survival. This often requires bone augmentation beneath the sinus to increase the vertical bone height.

Tatum[2] was the first to report the subantral augmentation or "sinus lift" procedure, which has evolved over the past 25 years. A lateral window (modified Caldwell-Luc) approach to the maxillary sinus is used. Because this has shown favorable results, the posterior maxilla is often considered one of the most predictable regions for grafting before or simultaneously with implant placement.[2–7] Basically, a hinged window is created in the lateral wall of the maxilla.[8] When completed, the window is gently pressed inward and upward into the sinus cavity, which lifts the Schneiderian membrane and serves as a new sinus floor. The void between the elevated tissues and the original sinus floor is filled with bone graft material. Implants may be simultaneously placed or the graft may be allowed to heal before implant placement.[9–12]

The "osteotome technique,"[13] also called bone-added osteotome sinus floor elevation (BAOSFE), is an alternative approach for sinus elevation where a small amount of bone height is missing. It is not suitable for patients with markedly reduced initial bone height.[14] BAOSFE can be complicated by membrane perforation and tear,[15] which can be reduced with expert technique and specially designed instrumentation.[16] The lateral maxillary window offers an average implant survival rate of 91.8% (range, 61.7%–100%)[6] but involves potential complications (membrane tear, bleeding, infection, and sinus obstruction), swelling and discomfort, and relative contraindications (sinus convolution septum or narrow sinus and previous sinus surgery). Considerable surgical skills, equipment, and time are also required. A modification of the BAOSFE method is the minimally invasive antral membrane balloon elevation (MIAMBE). Antral membrane elevation is performed through the osteotomy site (≤3.5 mm) using a specially designed balloon. The use of this technique as an alternative to conventional procedures has been shown.[17–20]

Advantages of using a flapless approach for dental implant placement

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A pilot-study of a minimally invasive technique to elevate the sinus floor membrane and place graft for augmentation using high hydraulic pressure: 18-month follow-up of 20 cases

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Objective. To evaluate medical efficacy and safety of crestal, minimally invasive sinus floor augmentation (MISFA) using an innovative method based on high hydraulic pressure.
Study design. Twenty MISFA using the novel Jeder-System were performed in 18 patients at 2 study sites in Vienna, Austria. The Jeder-System consists of the Jeder-drill, the Jeder-pump, and a connecting tube-set. The pump generates high hydraulic pressure (1.5 bar) pushing back the sinus membrane from the drill at the first perforation. The pump also monitors the whole procedure by constantly measuring pressure and volume.
Results. Five percent membrane perforation rate (1/20) only detected in the postoperative computed tomography scan and without implication for implant placement. Height gain of 9.2 ± 1.7 mm achieved (from 4.6 ± 1.4 mm to 13.8 ± 2.3 mm). Average patient satisfaction was 9.82 on scale from 1 to 10 (10 = very satisfied). Mean duration of sick leave was 0.19 days. 18-month survival rate was 95% (1/20 implant lost).
Conclusions. Within the limits of a prospective open cohort study with 20 cases, our data demonstrate the safety and medical efficacy of the novel method. (Oral Surg Oral Med Oral Pathol Oral Radiol 2013;116:293-300)

Although the lateral window technique using a modified Caldwell-Luc approach still represents the standard procedure for sinus floor augmentation in the posterior maxilla region, patients frequently suffer from considerable postoperative pain and swelling.

Therefore, substantial efforts have been made to develop less invasive techniques in order to reduce patient discomfort. As a first improvement of that kind a transalveolar technique with subsequent implantation was introduced by Tatum[1] and further developed as an osteotome technique by Summers.[2] The controlled primary entry of the drill into the maxillary sinus and the safe elevation of the Schneiderian membrane without perforation are the major challenges of this method. The shortcomings of the Summers technique have motivated the development of a great variety of new methods over the past 15 years. Recent publications on these modifications cover the use of balloons[3–5] and hydraulic pressure in humans,[6] the appliance of a hydraulic sinus condensing technique,[7] a gel-pressure technique,[8,9] as well as the use of "intelligent" drills.[10,11]

In a systematic review of 10 transcrestal sinus lift studies, Tan[12] identified a reported membrane perforation rate of 0%-21.4% (mean 3.8%). However, in a parallel review of 33 clinical studies using the lateral approach, Pjetursson[13] reported a perforation rate of 0%-58.3% (mean 19.5%). Based on this, Watzek[14] rightly doubts the validity of the numbers reported by Tan. As the lateral window technique is done with visual control, it seems unlikely that the perforation rate should be much lower for "blind" procedures in which there is no more than the surgeon's tactile perception to go by. Rather, we agree with Watzek[14] and Rosen[15] that using the transcrestal approach clinically insignificant perforations are generally not detected. Therefore,

Statement of Clinical Relevance

Currently there are only a few techniques for flapless minimally invasive sinus floor augmentation available. We present a novel procedure, which tackles shortcomings of other techniques, like secure entry into the maxillary sinus and controlled elevation of the Schneiderian membrane.

A potential conflict of interest is declared by P. Jesch, A. Bayerle, K. Eder, and M. Bayerle-Eder since these authors have commercial associations with the Jeder GmbH, Dental Technology, Vienna, Austria.

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ELEVATION OF THE MAXILLARY SINUS FLOOR WITH HYDRAULIC PRESSURE

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KEY WORDS

Maxillary sinus elevation
Sinus lift
Hydraulic pressure
Osteotomes

This study describes a new method using hydraulic pressure to elevate the antral floor for bone grafting between the sinus floor and the schneiderian membrane before placement of endosseous osseointegrated implants. The method was first modeled experimentally in hen eggs, acting as a surrogate sinus, and then in human cadaver preparations. Several clinical case reports are also presented. This technique successfully combines the advantages of the Caldwell-Luc window approach, which permits the placement of high bone graft volume, and the simplicity of the osteotome technique by way of the alveolar ridge crest.

INTRODUCTION

The insertion of osseointegrated implants in the posterior maxilla, in patients who have lost their posterior maxillary teeth, often presents difficulties for the following 3 reasons: (1) deficient alveolar bone width, (2) increased pneumatization of the maxillary sinus resulting in (3) close approximation of the sinus to crestal bone.[1] Alveolar bone loss that calls for elevation of the sinus floor to generate sufficient bone volume for implants at least 10 mm long[2] can be categorized by the following: (1) an alveolar ridge of 5 to 10 mm, (2) an alveolar ridge equal to or less than 5 mm,[3] and (3) a complete absence of alveolar bone between the sinus floor and alveolar crest. The first category is the most common and often permits simultaneous floor elevation and implantation.[4]

In 1970, Tatum developed the method of antral floor grafting, based on a modified Caldwell-Luc lateral approach to the antrum, through the creation of a window in the maxillary bone.[5–6] In 1980, Misch[7] performed an augmentation of the sinus with simultaneous implant placement.[2] Today the modified Caldwell-Luc approach is the most generally accepted method, allowing for the benefit of ready access to the sinus, significant elevation of the floor, and thus creation of sufficient bone volume to support the placement of implants. Another benefit of this method is the broad surgical field visibility it provides. The disadvantages of this technique are the relatively large surgical operation required, need for specialized instrumentation, risk of perforation of the schneiderian

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Dynamic Implant Valve Approach for Dental Implant Procedures

Oded NAHLIELI[1]

Objective: *To present the results of our current research involving the dynamic implant valve approach (DIVA) in cases with human patients.*
Methods: *The new kind of implant was designed with an internal sealing screw that might serve for drug delivery system and possible endoscopic direct observation via its channel. The DIVA was used in cases when the implant insertion should be combined with the maxillary sinus floor lifting and/or bone augmentation procedure. A total of 63 patients (female n = 31, male n = 32, age range 33–67 years old, mean age 49 years old) were treated with DIVA and 218 new type implants were inserted.*
Results: *Out of 218 inserted implants, 146 implants were inserted in the maxilla with bone level < 5 mm, and 72 implants were inserted in the maxilla with bone level > 5 mm. The number of implants per patients varied from one to eight. The failure consisted of seven implants (3.2%) in five patients. No correlation was found between failure cases and the bone density or quality. Follow up (4 to 18 months) showed that in 211 cases (96.8%), the implantation was totally successful both from objective clinical, imaging (cone beam computed tomography) and subjective patients' viewpoints.*
Conclusion: *The new dynamic implant valve approach simplified dental implantation procedure and postoperative treatment. The implant with an inner sealing screw could be considered for use in cases when elevation of the maxillary sinus membrane is needed, as well as in cases when bone augmentation procedures or future treatment might be suspected.*

Key words: *dental implant, maxillary sinus floor lifting, bone augmentation*

When dental restoration began to shift from fixed bridges to dental implants, contemporary dentistry appreciated the importance of anatomy of the maxillary sinus and the bone quality of the maxillary bone. The low position of the maxillary sinus could prevent effective dental implantology below the sinus. Fortunately, it soon became clear that maxillary sinus floor lifting procedure with bone augmentation might help to overcome this problem and dental implantology gained new stimulus. However, despite all recent improvements in dental implantology, complications are still unavoidable in this area of dentistry[1]. While blinded or endoscopically guided, an implant insertion procedure can damage of anatomical structures such as inferior alveolar nerve, other nerves the maxillary sinus, and to lingual perforation[2-4]. Loosening of implant or fracture of the implant head during insertion also can occur[3,5]. The sinus floor lifting/augmentation itself is not perfected yet and also can lead to further complications[6,7].

In the 1980s and '90s, several works of Tatum et al indicated possibilities to combine sinus floor augmentation with implant placement[8-10]. However, inflammatory diseases around the implant area presented a problem that has not yet been solved. This problem only appeared at the beginning of the 1990s[11,12] and was inevitably following the development of implantology. Researchers and clinicians are in need of finding predictable techniques to treat peri-implant bone loss and stop its progression, but up to now their results have

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Hadar Better

Patients' perceptions of recovery after maxillary sinus augmentation with a minimally invasive implant device

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Objective: Patients' perceptions of recovery following sinus augmentation procedures have scarcely been documented. The aim of the present prospective pilot clinical study was to evaluate the patient's perception of immediate postoperative recovery after sinus augmentation, using a minimally invasive implant device. **Method and Materials:** Eighteen patients (8 men, 10 women), average age 52 (median 48, range 38 to 72), who had been scheduled for sinus augmentation procedures, were asked to enroll in a prospective clinical study. A health-related quality-of-life questionnaire was given to the patient. The questionnaire was designed to assess patient's perception of recovery in four main areas: pain, oral function, general activity, and other symptoms. The questionnaire was compared to the surgical chart that described the surgical details and to the outcome. **Results:** Patients' perceptions of postoperative symptoms in the four tested areas: pain, oral function, general activity, and other symptoms were mostly scored "not at all" or "very little" from postoperative day (POD) 1. Most patients returned to work on POD 1. **Conclusion:** The current results offer a preliminary indication that patients undergoing sinus augmentation using a minimally invasive implant device can expect to experience minimum discomfort and immediate return to everyday activity. *(Quintessence Int 2014;45:779–787; doi: 10.3290/j.qi.a32510)*

Key words: bone augmentation, minimally invasive, quality of life, sinus floor elevation procedure, sinus lift

Maxillary sinus augmentation procedures are used extensively in everyday implant dentistry. They allow the placement of dental implants in atrophic posterior maxillae. Excellent long-term implant survival rates have been reported.[1-3] Maxillary sinus augmentation is generally considered to be predictable, with low rates of complications.[4-6] Nevertheless, concerns regarding postoperative morbidity and recovery still remain.

In recent years, patients' levels of interest, and their expectation to receive detailed information regarding surgical procedures in general and sinus augmentation in particular, and what can be expected during recovery, have been rising. As a result, the terms "quality of life" and "health-related quality of life" (HRQOL) have been used increasingly in the literature.[7-12] Therefore, many clinicians give increasing consideration to steps that can be taken to elicit a rapid postoperative recovery, thereby minimizing discomfort and inconvenience in the patient's everyday life.

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Oded Nahlieli

Four-years' experience with dynamic implants with internal port for minimally invasive sinus elevation

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Objective: The purpose of this article is to describe long-term results of the dynamic implant valve approach (DIVA) for the dental implant procedures when the implant system with internal ports was used. **Method and Materials:** During 2012 to 2015, 378 titanium-aluminum-vanadium implants (Ti_6Al_4V ELI; diameter 3.75 mm; length 11.5 and 13 mm) were implanted in 172 patients (one to nine implants per patient) using the DIVA technique. The DIVA implants were used in cases when sinus membrane and/or nasal floor elevation procedures were needed. The condition of the implants was assessed during the follow-up period up to 60 months. **Results:** Out of 378 inserted implants, 257 implants were inserted in the maxilla with the bone level < 5 mm, and 121 implants were inserted in the maxilla with the bone level > 5 mm. In 357 cases (94.5%), the implantation was totally successful both from objective CBCT clinical and subjective patients' viewpoints. The comparison of complication rates between the cases with the bone level < 5 mm and the cases with the bone level > 5 mm indicated no significant difference ($P = .32$). **Conclusion:** Preliminary results that the DIVA simplifies the dental implantation procedure and augmentation treatment were confirmed. The implant with an inner sealing screw can be used in cases with elevation of the maxillary sinus membrane, and simplifies the surgery and secures optimal dental implant placement. This new type of implant simplifies the maintenance phase of implant dentistry and helps to overcome possible complications. *(Quintessence Int 2016;47: 669–675; doi: 10.3290/j.qi.a36328)*

Key words: dental implant, implant maintenance, maxillary sinus floor elevation

During the 2000s, endoscopy was successfully introduced in endodontics and root canal treatment.[1-3] It was inevitably followed by the introduction of endoscopy in dental implantology.[4,5] The next logical step was to find means of using endoscopic observations after an implant was placed. The necessity of such an approach was obvious because implant failure, implant fracture, peri-implantitis, complications due to nerve perforation, sinus augmentation complications, and other implant complications remained unsolved problems, despite recent improvements in implantology.

For this purpose, and based on the authors' endoscopic maxillary sinus experience, a dental implant system with an internal port was developed. It was successfully tested in an animal model, and was introduced into implantology practice.[6-8] In short, the new

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Sinus Augmentation with Simultaneous, Non-Submerged, Implant Placement Using a Minimally Invasive Hydraulic Technique

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Abstract: *Background and objectives:* To evaluate whether sinus augmentation, using a minimally invasive implant device, via a non-submerged surgical approach, might negatively influence the outcome. *Materials and Methods:* A retrospective cohort study was conducted by evaluating patients' files, classifying them into two groups. Fifty patients (22 men 28 women) were included in the study, 25 in each group. The use of an implant device based on residual alveolar ridge height for sinus augmentation, radiographic evaluation, insertion torque, membrane perforation, post-operative healing, and a minimum of 12 months follow-up were evaluated. *Results:* The mean residual alveolar ridge height was 5.4 mm for the non-submerged group and 4.2 mm for the submerged group. There were no intraoperative or postoperative complications (including membrane perforations). The mean insertion torque was 45 N/cm for the study group and 20 N/cm for the control group. Complete soft tissue healing was observed within three weeks. Mean bone gain height was 8 mm for the study and 9.3 mm for the control group. All implants osseointegrated after 6–9 months of healing time. Mean follow-up was 17.5 months, range 12–36 months. Marginal bone loss at last follow-up was not statistically significantly different: 1 mm in the non-submerged vs. 1.2 mm in the submerged group. *Conclusions:* Submerged and non-submerged healing following maxillary sinus augmentation was comparable provided residual alveolar ridge height >5 mm and insertion torque >25 N/cm.

Keywords: sinus lift; Maxillent dental implant; sinus elevation; membrane elevation

1. Introduction

The first rule of medicine is "primum non nocere" [1]. Surgery is heading towards minimally invasive intervention resulting in minimal postoperative morbidity, loss of working days, improved

Minimally Invasive Sinus Augmentation Procedure Using a Dedicated Hydraulic Sinus Lift Implant Device: A Prospective Case Series Study on Clinical, Radiologic, and Patient-Centered Outcomes

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The aim of this study was to evaluate clinical and radiologic outcomes of a novel device that allows simultaneous hydraulic sinus membrane elevation, bone grafting, and implant placement. A sample of 18 consecutive participants with severe atrophy of the posterior maxilla underwent transcrestal elevation of the sinus membrane and implant placement. At the 6-month follow-up, the following parameters were assessed: implant success, any complications, marginal bone loss (MBL), three-dimensional (3D) graft measurements, implant stability quotient (ISQ), and graft density. No implants failed during follow-up (10.8 ± 2.8 months; range: 7–14 months). No membrane tears or other adverse events were observed. Mean residual alveolar ridge height was 4.78 ± 0.88 mm. Six months after the procedure, the mean MBL was 0.18 mm. The mean sinus membrane elevation was 12.78 ± 2.18 mm (range: 10.7–14.23). Along the basic 3D reference planes, the dimensions of grafted bone measured around implants were as follows: axial area = 239.7 ± 57.68 mm²; sagittal area = 257.0 ± 60.83 mm²; coronal area = 143.3 ± 29.46 mm². The mean volume of the graft was 2.38 ± 0.26 mL at baseline and 2.05 ± 0.24 mL 6 months after graft maturation (difference: 0.33 ± 0.29 mL, P = .0090). Graft density (in Hounsfield units [HU]), improved during healing from 322.0 ± 100.42 HU to 1,062.0 ± 293.7 HU; difference 740.0 ± 295.35 HU (P = .0001). The mean ISQ value was 65.5 at implant placement, and it increased to 74.1 at the 6-month examination (P = .0014). Of 18 patients, 12 experienced no pain (66.6%) and 10 experienced no swelling (55.5%). No severe pain or swelling was reported in any of the cases. The mean number of analgesic tablets consumed was 0.78 ± 0.67. Mean surgical time was 24.0 ± 4.07 minutes. The iRaise Sinus Lift System may provide a new option for minimally invasive transcrestal sinus surgery with minimal patient discomfort. A physiologic contraction of 13.9% of its original volume was experienced during healing. Long-term clinical studies are needed to confirm these preliminary results.
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Different approaches have been reported to augment the maxillary sinus cavity of the severely atrophied posterior maxilla, with simultaneous or delayed implant placement.[1–3] Pjetursson et al reported that implant placement in combination with a lateral window sinus lift is a predictable treatment option, showing high implant survival rates and low incidences of complications.[4] However, maxillary sinus floor elevation using a lateral approach implies execution of a large mucosal periosteal flap that inevitably affects postoperative recovery and the additional expense of the augmentation procedure.[5] Sinus membrane perforations, nose bleeding, postoperative pain, swelling, hematoma, and possible sinus infection could be considered as major risks.[6]

The elevation of the maxillary sinus floor through the alveolar crest (transalveolar) was first described by Tatum[7] and modified by Summers,[8] who introduced the osteotome sinus floor elevation approach. Fracture of the sinus floor can be performed by means of osteotomes[7–10] or burs, with[11,12] or without[7] stop drills. Various modifications to the original technique have been reported to improve the reliability and safety of the membrane elevation, including inflation of a balloon catheter[13] and hydraulic[14] or negative pressure.[15]