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ODONTOLOGÍA MÍNIMAMENTE INVASIVA EN EL PACIENTE ODONTOPEDIÁTRICO

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RESUMEN

En los últimos años un nuevo abordaje en cariología ha cambiado el enfoque de la odontología hacia un tratamiento de la caries dental menos invasivo, gracias a materiales dentales cada vez mas innovadores y avanzados sistemas de diagnostico.

En este trabajo se analizaron los diferentes aspectos de la Odontología Mínimamente Invasiva (OMI) en el paciente pediátrico: una filosofía que integra la evaluación del riesgo de caries, la prevención, la remineralización y la eliminación de la mínima cantidad de tejido sano para la posterior colocación de las restauraciones.

Se analizaron también las características de las diferentes técnicas y sus aplicaciones en la practica clínica diaria.

Se realizó una búsqueda bibliográfica con el auxilio de recursos web utilizando Medline, Pubmed y Google Scholar con las palabras claves : “Minimally Invasive Dentistry”, “Minimal Intervention Dentistry”, “MID”, “Prevention”, “Caries”, “Tooth Preservation”, “Restorative Dentistry”, “Pediatric Dentistry”, “Atraumatic”, “Restorative treatment”.

Los resultados encontrados de la búsqueda fueron concordes a los objetivos propuestos, y se dio preferencia a artículos mas recientes.

Las conclusiones mostraron que las técnicas de odontología mínimamente invasiva analizadas tienen múltiples ventajas aplicadas al tratamiento del paciente infantil y muestran la misma eficacia comparadas al tratamiento restaurador tradicional.

ABSTRACT

In recent years, a new approach in cariology, increasingly innovative dental materials and advanced diagnostic systems have changed the approach of dentistry towards a less invasive dental caries treatment. In this work, the different aspects of Minimally Invasive Dentistry (OMI) in pediatric patients were analyzed: a philosophy that includes caries risk assessment, remineralization, prevention and the elimination of the minimum amount of healthy tissue for subsequent placement of restorations. Were also analyzed the characteristics of the different techniques and their applications in daily clinical practice.

A bibliographic search was carried out with the help of web resources using Medline, Pubmed and Google Scholar with the keywords: "Minimally Invasive Dentistry", "Minimal Intervention Dentistry", "MID", "Prevention", "Caries", "Tooth Preservation", "Restorative Dentistry", "Pediatric Dentistry", "Atraumatic", "Restorative treatment". The search results found were consistent with the proposed objectives, and preference was given to more recent articles.

The conclusions showed that minimally invasive dental techniques have multiple advantages applied to the treatment of children and show the same efficacy compared to traditional restorative treatment.

Indice:

OBJETIVOS

Objetivo principal:

El objetivo principal de este trabajo es valorar las posibilidades terapéuticas que abarca la odontología mínimamente invasiva (OMI) respecto a su aplicación en el paciente pediátrico, tanto de carácter preventivo como restaurador.

Objetivos secundarios:

- Analizar las diferentes ventajas y desventajas de cada técnica propuesta
- Comparar las técnicas de odontología mínimamente invasiva, a las técnicas tradicionales de remoción de caries
- Identificar los materiales aptos para cada técnica.

METODOLOGÍA

Se realizó una búsqueda bibliográfica en bases de datos electrónicas de contenido científico, y en una segunda fase, mediante una búsqueda manual. En la primera fase de búsqueda, se utilizaron las siguientes bases de datos electrónicas: “Medline”, “PubMed”, “Google Scholar” y “Up To Date”.

Las palabras claves usadas para la búsqueda fueron: “Minimally Invasive Dentistry”, “Minimal Intervention Dentistry”, “MID”, “Prevention”, “Caries”, “Tooth Preservation”, “Restorative Dentistry”, “Pediatric Dentistry”, “Atraumatic”, “Restorative treatment”.

Se completó con una segunda fase de búsqueda manual, consultando la bibliografia de los artículos previamente seleccionados en la primera fase.

Una vez obtenidos los resultados, se eliminaron todos aquellos artículos que tras su lectura se consideró que no aportaban información útil para la presente revisión bibliográfica.

De todos los artículos encontrados, se quedaron 52 en total, que van desde el año 1955 hasta el año 2020, provenientes todos de revistas indexadas.

Para verificar la calidad de los artículos, se pusieron en “SCImago journal & Country Rank”, una plataforma en internet que provee una serie de indicadores sobre la calidad y el impacto de las publicaciones y revistas a partir de información de “Scopus” y “Elsevier”. Los artículos así seleccionados en la búsqueda se introdujeron de forma secuencial en el gestor de referencias bibliográfica Mendeley, para ser posteriormente citados en Word.

INTRODUCCIÓN

En la primera mitad del siglo XIX, se desconocía la causa exacta de la caries dental y las preparaciones cavitarias se diseñaban según la propia opinión y experiencia del dentista. La amalgama de plata, muchas veces fabricada por los propios odontólogos, tenía poca estandarización, lo que resultó en materiales que mostraban un rendimiento deficiente. (1)

En esa época, Black, un dentista de considerable experiencia y capacidad de observación, notó como los márgenes de esas restauraciones en amalgama se desgastaban y se filtraban con caries muy frecuentemente. Las restauraciones de esa época usaban una aleación de plata que se corroía rápidamente y experimentaba problemas de expansión; por lo tanto, el fracaso era muy frecuente. (1)

Black escribió una serie de artículos que trataban esos problemas, y que hoy nos informan de como era la odontología restauradora de esa época.

Para intentar resolver este problema, Black creó lo que hoy en día se llama “Extensión por prevención” y desarrolló una aleación de amalgama con menos probabilidades de corroerse y sufrir una ruptura marginal. Esta fórmula permaneció sin cambios hasta la década de 1970 cuando se introdujeron las amalgamas con alto contenido de cobre y plata. (1, 2)

Durante los años 50-60-70, ocurrieron varios eventos que permitieron una ulterior mejora de las amalgamas de platas y la posterior introducción de las restauraciones adhesivas. (1,2)

En 1955, Buonocore describió una técnica para grabar superficies de esmalte para hacerlas retentivas para una restauración. (3)

En 1962 Bowen patentó un material plástico para realizar restauraciones del mismo color de los dientes, mas conocido hoy como Bis-GMA o monómero de Bowen. (4)

Estos dos descubrimientos empezaron a dirigir a los odontólogos hacía lo que hoy se conoce con el nombre de Odontología Mínimamente Invasiva (OMI) u odontología de mínima intervención. (1,2,5)

En los mismos años se empezó a poner flúor en las aguas y en las pastas de dientes, y en los países avanzados este llevó a una reducción del porcentaje de caries en la población. (5)

En la época de Black, se necesitaba mas o menos una hora para restaurar una lesión por caries de media complejidad. En los años 70, con la llegada de las fresas de alta velocidad, con el mismo tiempo se podían llegar a restaurar hasta cuatro dientes de un mismo cuadrante. Eso hizo posible una mejoría notable de los tiempos de trabajo. (5)

Solo quedaba un problema todavía; se seguía considerando a la caries como un simple problema quirúrgico, sin visualizarla como lo que realmente era: una enfermedad multifactorial. La cosa curiosa es que el mismo Black había considerado años antes a la caries como una enfermedad bacteriana. (5)

La invención del microscopio y el descubrimiento del lactobacilo en relación con la desmineralización dentaria, sugirieron de empezar a investigar sobre la caries como una enfermedad, y poderla así controlar con otros medios que no simplemente fresas y turbina. Desde entonces se investigó muchísimo sobre la etiología bacteriana de la caries, destacando bacterias como Estreptococcos, Actynomices, Lacobacilus, ecc.. Se entendió así la complejidad del medio oral y de la flora bucal, el papel que desempeña la saliva y los componentes de la placa bacteriana. (5, 6)

La FDI (World Dental Federation), en un informe de 1984, destacó la importancia de prevenir la caries y la enfermedad periodontal mediante la higiene bucal, el flúor y una correcta dieta. (7)

Desde ese momento, las mejoras tecnológicas de los instrumentos rotatorios, el diseño de las fresas, los nuevos materiales y la detección temprana de lesiones permitirán diseños de preparación mucho más conservadores que los enseñados en el pasado. (8)

La profesión estaba adoptando gradualmente esos avances tecnológicos y, con ellos, un enfoque que hoy en día llamamos “mínimamente invasivo”. (8)

Hoy en día, la odontología mínimamente invasiva u odontología de mínima intervención (OMI) puede ser definida como el manejo de la caries desde un punto de vista biológico y no solo puramente restaurador. (8)

La filosofía de la OMI se basa en todos los factores que inciden en la aparición y progresión de la enfermedad y por tanto integra los conceptos básicos de prevención, control y tratamiento. (8)

La prevención y el control de la enfermedad bucal

La filosofía de la OMI se basa en todos los factores que inciden en la aparición y progresión de la enfermedad y por tanto integra los conceptos básicos de prevención, control y tratamiento. (8,9)

Podemos definir tres tipos de prevención: la prevención primaria, la prevención secundaria y la prevención terciaria. (9)

La prevención primaria se centra en prevenir nuevos casos de enfermedades bucodentales. A nivel colectivo utiliza medidas como la floración artificial del agua o

los programas escolares de salud bucal, mientras que a nivel individual tiene como objetivo prevenir la colonización temprana de los dientes de los niños por las bacterias cariogénicas (por ejemplo, Estreptococo mutans, una de las especies asociadas con el inicio del proceso de caries). (9)

La prevención primaria también incluye el manejo de otros factores como el control de la dieta cariogénica rica en carbohidratos fermentables, junto a malos hábitos de higiene bucal. (9)

La prevención secundaria tiene como objetivo evitar que la enfermedad se establezca y progrese, esto incluye la detección de las caries en la etapa más temprana posible para que se pueda elegir el tratamiento adecuado. (9)

Esta segunda fase tiene como objetivo reajustar el equilibrio entre factores patológicos y protectores. Durante esta fase se implementarán las medidas necesarias para frenar los fenómenos de desmineralización y empezar la remineralización. (9)

Se hace otra vez hincapié en las recomendaciones relativas a los hábitos higiénicos y dietéticos, la prescripción de las medidas adecuadas de flúor y la colocación de selladores preventivos. También en el caso de pacientes con lesiones ya cavitadas que afecten a la dentina, estas herramientas podrán complementar el uso de las técnicas restauradoras. (9)

La prevención terciaria, por su parte, tiene como objetivo prevenir la recurrencia de la enfermedad, así como el fracaso de los cuidados preventivos y reparadores inicialmente usados. Esta tercera fase incluye se el seguimiento y el mantenimiento.

Durante las visitas de seguimiento, se irá monitoreando la situación y se podrá ajustar el intervalo entre las revisiones en función. (9)

La práctica clínica según los principios de la OMI se basa en cuatro elementos clave:

1. El diagnostico y la evaluación del riesgo de caries
2. La detección y remineralización de lesiones tempranas (fase preventiva)
3. Restauración mínimamente invasiva de las caries (fase restauradora)
4. Fase de seguimiento

El diagnostico:

La fase de diagnóstico permite comprender porqué se ha producido la enfermedad (la caries en nuestro caso) y se utiliza para evaluar la gravedad del daño causado. (9)

Incluye la determinación de los factores de riesgo del paciente y la detección de lesiones cariosas para seguir con el tratamiento conservador más indicado. (9)

La determinación del riesgo de caries del paciente se basa en la identificación y comparación entre los factores patológicos o de riesgo (la presencia de placa, sangrado gingival, pH salival bajo y xerostomía) y los factores protectores (aplicación de flúor, visitas regulares al dentista, correcta higiene oral y uso de xilitol, entre otras.) (9,10)

Estos factores influyen en lo que es el proceso de desmineralización y remineralización.

Los “predictores de riesgo” son todos aquellos factores que, aunque no están directamente relacionados con la caries, se ha demostrado que si pueden estar relacionados con la aparición de nuevas lesiones. (10)

Los principales predictores de riesgo son: caries previas, restauraciones recientes por caries y los hábitos de riesgo: mala higiene oral, dieta cariogenica, etc. (10)

La caries en el paciente infantil

Se sabe que la caries es una enfermedad infecciosa transmisible.

El grupo de bacterias principalmente involucradas son los Estreptococos, en particular el Estreptococo mutans y el Estreptococo sobrinus, debido a su habilidad en el adherirse a superficies lisas y producir ácidos. (10)

Se ha demostrado que existe una relación directa entre los niveles de Estreptococco en los padres y la prevalencia de caries en sus hijos. (10)

En general, la colonización de estas bacterias en la boca de los niños se debe a la transmisión de estos organismos desde los padres/cuidadores al niño, principalmente por hábitos que permiten la transferencia de saliva de los padres/cuidadores a los bebés. De echo se han identificado altos niveles de Estreptococos en la boca de bebés, incluso antes de la erupción del primer diente. (10)

Una evaluación del riesgo de caries individualizada de un bebé o de un niño sirve como base para que los padres/tutores identifiquen y comprendan los factores de riesgo del niño, y también sirve como guía para que los odontólogos diseñen un correcto plan de tratamiento y prevención. (10,11)

Para obtener resultados óptimos, la evaluación del riesgo de caries debe realizarse lo antes posible por el hecho de que la caries en la dentición temporal es un fuerte predictor de caries en la dentición permanente. (11)

Los factores de riesgo se determinan a partir de una entrevista con los padres y de una evaluación clínica del niño, con el auxilio del cuestionario CAMBRA (caries managment by risk assesment) (Anexo 1). (12)

La caries desde el punto de vista histológico:

En el esmalte, la desmineralización prolongada debida a los ataques ácidos en la boca da como resultado la formación de porosidades, que se van agrandando y si no se controlan en las primeras etapas mediante procedimientos de remineralización y/o higiene oral, se unen entre si y causan la cavitación. (13)

La dentina cariada se puede subdividir en dos zonas histopatológicas: La dentina infectada, dañada irreversiblemente, necrótica y blanda, que es debida a la contaminación bacteriana de larga duración, y la dentina afectada; más profunda, dañada reversiblemente y que tiene el poder de repararse en las condiciones correctas ya que el colágeno no se desnaturaliza. (13)

Las obturaciones se han considerado durante mucho tiempo, incorrectamente, como la solución única para eliminar y tratar la caries. (9,13,14)

Por supuesto, el componente restaurador es muy importante, cuando sea necesario, también en la OMI, pero no tiene ningún efecto sobre los factores etiológicos y no es un componente esencial a diferencia de las medidas preventivas descritas anteriormente. (9) Por lo tanto, optaremos por un tratamiento restaurador solo cuando debido al proceso de caries se ha perdido una cantidad significativa de tejido dental. (14)

Las técnicas restauradoras deben igualmente seguir un abordaje mínimamente invasivo, donde las cavidades son, por definición, de diseño conservador y superando el concepto ya mencionado de “extensión por prevención”. (14)

DISCUSIÓN

TECNICAS PREVENTIVAS

Hoy en día se sabe que es posible detener e incluso revertir la perdida de minerales producida por la caries en un estadio temprano, antes de que se produzca la cavitación.

La desmineralización del esmalte y de la dentina es un proceso discontinuo y parcialmente reversible: a través de una serie de ciclos de desmineralización y remineralización, el diente pierde y gana electrones de calcio y fosfato dependiendo de los cambios en el pH del medio bucal (15)

El flúor

El flúor es uno de los métodos de prevención mas importantes y eficaces para fortalecer el esmalte dental y prevenir la caries. (15)

Sin embargo, hay opiniones diferentes sobre los resultados en referencia a las diferentes recomendaciones para la frecuencia y periodicidad de la aplicación de flúor. (15)

La American Academy of Pediatrics recomienda para todos los niños, sean de bajo o alto riesgo de caries, la aplicación de un barniz de flúor cada 3 hasta 6 meses desde la erupción del primer diente, y el uso de pasta de dientes con flúor. (15)

La American Dental Association recomienda el uso diario de pasta de dientes con flúor para todos los niños, mientras que para los niños de alto riesgo es aconsejable barniz

cada 3 meses para los menores de 6 años, mientras que para los mayores de 6 gel de flúor cada 3 hasta 6 meses. (15)

Hay estudios que recomiendan los tratamientos con flúor cada seis meses, afirmando que es el método más rentable y con el mejor resultado. (15)

Otros afirman que la aplicación de barniz tres veces durante una semana, una vez al año, es más efectivo que administrar un tratamiento semestral. (16)

A pesar de la frecuencia, todos los estudios están de acuerdo en que el flúor es necesario para la prevención de la caries dental y una herramienta fundamental en el mantenimiento de la salud bucal de los niños. (15,16)

La clorhexidina

La clorhexidina es un agente antimicrobiano que, cuando se usa de forma intermitente, es muy eficaz contra Estreptococos Mutans.

Algunos estudios muestran un efecto cariostático cuando se utiliza junto con la higiene bucal, una dieta no cariogenica y aplicaciones de flúor.

El uso intensivo de clorhexidina es útil en pacientes con niveles elevados de Estreptococos mutans, pero debe ir acompañado de cambios en la higiene y la dieta para ser eficaz. (12)

Fosfato de calcio amorfo (CPP-ACP)

El fosfato de calcio amorfo Casein Phosphopeptide-Amorphous Calcium Phosfate (CPP-ACP), es un péptido derivado de la caseína con añadido calcio y fosfato. Fue desarrollado por la universidad de Melbourne y se puede encontrar en chicles o comercializado por la casa GC en gel y dentífricos. Se ha estudiado por su capacidad

de integrar iones fosfato y calcio, ayudando así la remineralización del esmalte dental. (17,18)

En la literatura hay cierta controversia sobre este tema.

En el estudio de ElSayad se ha demostrado que la combinación de CPP-ACP con flúor (CPP-ACFP) aumenta el grado de remineralización del esmalte, de manera significativa.(17)

En otro estudio de Huang no se ha encontrado ningún otro efecto añadido significativo en la prevención de caries cuando se añadió CPP-ACP a los normales protocolos de higiene con pasta con flúor. (19)

Vidrios Bioactivos

Los vidrios bioactivos se han introducido en la odontología hace unos años y se consideran un gran avance entre los agentes remineralizantes.

El fosfosilicato de calcio y sodio (Novamin R) es un vidrio bioactivo que libera fosfato, sodio y calcio, elevando el pH oral y permitiendo así remineralizar el esmalte. Aunque se conozca mucho como agente desensibilizante, los estudios afirman que su efecto de remineralizar el esmalte es igual o incluso mayor que el flúor. (20)

Xilitol

Aunque se necesita de mas estudios, la evidencia actual parece suficiente para afirmar que el uso regular de xilitol es eficaz para la prevención y la remineralización de caries superficiales del esmalte, especialmente en pacientes jóvenes de alto riesgo. (21,22)

Infiltraciones de resina: Técnica ICON

Mas recientemente se ha introducido una técnica de infiltración atraumática para tratar las lesiones superficiales del esmalte.

Esta técnica se basa en difundir el esmalte con una resina de muy baja viscosidad por capilaridad, deteniendo así el proceso de desmineralización y estabilizando la lesión por caries. (23,24) Este principio puede ser comparado con el mojar un cubo de azúcar en café. (figura 1)

Al principio se usó para disimular las manchas blancas de fluorosis, ya que aportaba resultados estéticos muy satisfactorios. Hoy en día, esta técnica está dirigida principalmente a lesiones interproximales incipientes y para lesiones de desmineralización en superficies lisas no proximales, como por ejemplo lesiones blancas opacas derivadas del uso de ortodoncia fija. (23,24)

Esto se permite siempre que la lesión no esté cavitada, y esté rodeada de esmalte intacto.

En la figura 1 podemos ver la aplicación de la resina ICON en la superficie interproximal de molares inferiores.

Figura 1: 1a) Ilustración del concepto de infiltración a baja viscosidad: el cubo de azúcar simula el esmalte poroso; 1b)La resina liquida es depositada en la zona demineralizada con el auxilio de unas puntas especiales; 1c)El área infiltrada por la resina es fotopolimerizada. (24)

La resina infiltrante es comercializada por la marca DMG y lleva el nombre de ICON. Todos los elementos (jeringuillas, gel acido y resina de infiltración) vienen dentro de un kit. (figura 2)

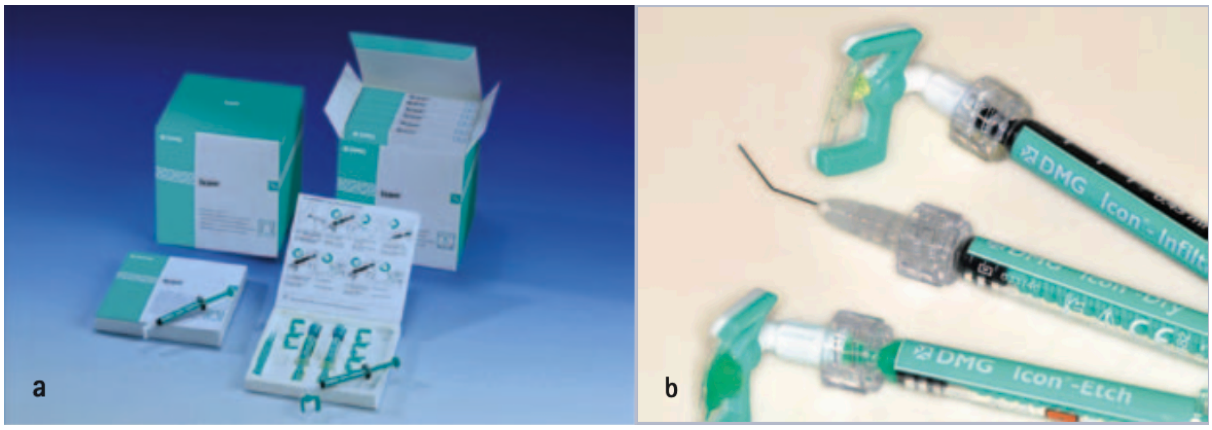

Figura2: 2a) Kit de tratamiento ICON para superficies lisas y proximales 2b)Detalle de las jeringas usadas para el grabado, secado y infiltración de la resina. (24)

Si comparamos los estudios sobre el uso de selladores y la técnica de infiltración (ICON) en el tratamiento de la lesión inicial de caries, se puede afirmar que los selladores actúan formando una barrera superficial contra la penetración de bacterias, mientras que la infiltración de resina (ICON) crea una barrera interna a la lesión, al reemplazar los minerales perdidos con resina de baja viscosidad. (24)

La diferencia de resultado entre estas dos técnicas depende del entorno de la lesión. En un paciente con bajo riesgo de caries es mas probable que la lesión tratada no progrese, mientras es mas probable que en un paciente con riesgo incontrolado de caries la desmineralización continúe o reaparezca en la periferia del área infiltrada de resina. (23)

Como ya dicho, la técnica con resina infiltrada no se recomienda para el manejo de lesiones cavitadas y hay que tener en cuenta que, si no se ha detectado previamente

una cavidad proximal, la infiltración puede ser defectuosa y la inhibición de la caries puede fallar. (24)

La relación riesgo-beneficio de esta técnica no invasiva y estética es favorable pero la experiencia clínica es limitada y surgen dudas sobre el envejecimiento de la resina y su durabilidad en el tiempo. (23,24)

Existe poca información sobre la resistencia al desgaste de la zona impregnada y sobre la estabilidad del color y la estética después de la infiltración.

Otra desventaja de esta técnica está en el hecho que su realización no es muy simple. Requiere que los dientes estén limpios y secos, y aislados perfectamente por el dique de goma. Sobre la cantidad de resina a colocar no hay una guía precisa, lo que también puede llevar el operador a errores dependientes de la técnica. (24)

Además, la ausencia de radioopacidad, ya que es una resina sin relleno, no permite ver el resultado final en la radiografía. Por estos motivos no se puede evaluar la supuesta eficacia del tratamiento ya que la detección o eventual progresión de la lesión no se pueden apreciar en las posteriores revisiones. (23,24)

Fluoruro diamino de plata (SDF)

El fluoruro diamino de plata (SDF) es un líquido transparente e inodoro indicado para la desensibilización de lesiones dentales no cariosas y las hipomineralizaciónes. También es útil para detener lesiones cariosas en niños con alto riesgo de caries y/o con lesiones de caries difíciles de controlar. (25)

Su uso resulta muy eficaz para tratar lesiones que son demasiado extensas de restaurar, pero que no están asociadas a dolor y/o infección. (25)

Esto puede ser importante, especialmente cuando las extracciones pueden estar contraindicadas por motivos médicos o de conducta.

El SDF se presenta en concentración de 38% y un alto contenido de flúor (44.800 ppm)

Cuando se coloca sobre tejido dental cariado, una serie de reacciones químicas desensibilizan el diente bloqueando los túbulos dentinarios, con consecuente muerte bacteriana y remineralización del diente. (25,26)

Todas estas reacciones químicas tienen el efecto secundario de endurecer la superficie y teñir las lesiones cariosas (esmalte y dentina) permanentemente de negro, sin teñir el esmalte sano. (figura 3) Por lo tanto, también es útil como agente de detección de caries.

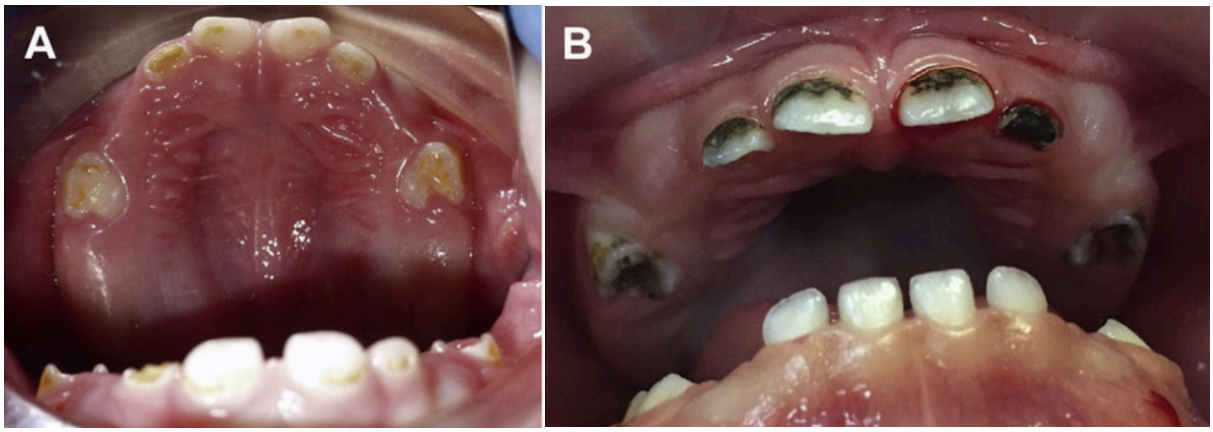

Figura 3: 3a) Caries de esmalte y dentina en dientes temporales 3b) Las mismas lesiones con aspecto teñido después del tratamiento con SDF (25)

Respecto al fluoruro diamino de plata (SDF), aunque no hay una gran cantidad de ensayos clínicos, existe un progresivo aumento de estudios que confirman la efectividad de SDF para detener las lesiones cariosas coronales en niños en la dentición temporal. (25,26,27)

Sin embargo, estos ensayos de SDF para prevenir las lesiones de caries coronales en los niños fueron cuestionables respecto a su numero. (25,26)

Además, hay muy pocos estudios y evidencia insuficiente para sacar conclusiones sobre el uso de SDF en dientes permanentes en niños.

Todos los estudios demuestran la eficacia de SDF para detener la caries en los dientes temporales en comparación con un tratamiento placebo y con varias otras modalidades de tratamiento. (26,27)

Según el meta análisis de Gao la detención de caries a los 12 meses gracias al SDF fue 66% mayor que la de otros materiales. (27)

Los estudios muestran también una diferencia en las tasas de arresto en los niños que recibieron aplicaciones de SDF dos veces al año versus una vez al año. (26,27)

Selladores

Los selladores de fisuras proporcionan una barrera física que evita que las partículas de alimentos y las bacterias se acumulen en fosas y fisuras profundas.

Sin duda, cuando está debidamente indicado, el uso de un sellador ha demostrado ser eficaz para prevenir o controlar la progresión de la caries en las superficies oclusales de los molares permanentes. (28)

Sin embargo, existe cierto debate sobre qué material sellador elegir. Los materiales más utilizados para sellar fosas y fisuras son dos: los cementos de vidrio ionomero convencionales y compuestos a base de resina. (28,29)

Los estudios que comparan estos dos tipos de materiales, tienen resultados diferentes según el criterio de evaluación que se considera: la prevención de caries o la retención del sellador.

Respecto al efecto preventivo, el estudio de Yengopal no encontró evidencia de que ninguno de los materiales selladores fuera superior al otro respecto a la prevención de la caries dental. Mientras respecto a la retención, se ha demostrado que los selladores de resina tienen una tasa de supervivencia más alta que los cementos de vidrio ionomero. (30)

La cosa cambia en los dientes parcialmente erupcionados. El mayor riesgo de contaminación salival condiciona la técnica adhesiva que se usa para la aplicación de los selladores a base de resina, por lo que se ha visto que los selladores de cemento de vidrio ionomero pueden dar mejores resultados en la eficacia de la prevención de caries. (31)

Otra cuestión es la necesidad o no de sellar los dientes temporales. Sobre la base de la evaluación del riesgo de caries, se puede considerar que los dientes temporales están en riesgo debido a la anatomía propia de esos dientes. Por lo tanto, los selladores de fosas y fisuras están indicados en dientes temporales, si dichos dientes tienen fosas y fisuras profundas, retentivas o con signos de descalcificación o si el niño tiene caries o restauraciones en el molar temporal contralateral o cualquier otro diente temporal. (31)

En fin, el sellado de las piezas temporales se debe considerar de especial importancia para niños con discapacidad médica, física o psíquica.(28,31)

TECNICAS RESTAURADORAS

Para discutir el tratamiento de las lesiones de dentina cavitadas, es necesario diferenciar entre dentición temporal y permanente. Teniendo en cuenta que un

diente temporal permanecerá en la boca por un 'período de tiempo relativamente corto', que debido a su peculiar anatomía, una lesión de caries progresa más rápido y que las posibilidades de llegar a la pulpa durante un procedimiento invasivo son mayores que en un diente permanente, las opciones para el manejo de las lesiones cariosas en estas dos denticiones también difieren. (32)

Las preparaciones mínimamente invasivas

La pregunta es: ¿Cuánta caries de dentina se debe remover?

La respuesta a esta pregunta no es universal. Depende del diente, del paciente y del odontólogo ya que hay numerosas variables que se deben tener en cuenta. (9, 13, 32)

A la hora de hacer la restauración, se debe evaluar la restaurabilidad funcional y estética del diente, y se prefiere en todo caso eliminar solo la dentina infectada, conservando así más estructura dental que puede ayudar a retener y apoyar la restauración definitiva. (9, 32)

La preservación de la estructura del diente debe ser el factor mas importante de tener en cuenta tanto para la cavidad más pequeña como para la más grande.

El diseño de la preparación de la cavidad y la selección del material de restauración dependerán del diente a restaurar y de la extensión de la caries.

Como puede verse en la Tabla 1 hay varios mecanismos de remoción de caries en la actualidad. La mayoría no son selectivos para dentina infectada y eso puede ir contra los principios de la OMI, pero los odontólogos están altamente capacitados para usar fresas y instrumentos rotatorios, así como instrumentos manuales, y por eso un buen operador aún puede realizar la remoción de la dentina infectada de manera efectiva y no invasiva usando estos instrumentos. (13, 14)

Los mecanismos de remoción de caries que existen hoy en día, se pueden dividir en cuatro grupos:

- Remoción mecánica rotatoria
- Remoción mecánica no rotatoria
- Remoción mecanico-quimica
- Foto ablación

Una mención a parte va a los desinfectantes cavitarios, entre los cuales destacamos el PAD (photo active desinfection) y el ozono.

MECANISMO	**SUBSTRATO DE ACCIÓN**	**TECNICA DE REMOCIÓN**
MECANICO-ROTATORIO	*Esmalte y dentina*	Instrumentos rotatorios con fresas diamantadas, fresas de carburo de tungsteno y fresas de acero inoxidable
MECANICO-NO ROTATORIO	*Esmalte y dentina*	Instrumentos manuales, técnica ART, abrasión por aire, instrumentos ultrasónicos y sono-abrasión.
MECANICO-QUIMICO	*Dentina*	Caridex, Carisolv, Papacarie, Carie-care
FOTO-ABLACIÓN	*Esmalte y dentina*	Laser
OTROS	*Bacterias odontopatogenas*	Ozono, PAD(Photo Active Desinfection)

Tabla 1) Tabla de elaboración propia obtenida con el ayudo de los artículos (32,39)

Remoción mecánica rotatoria

Como ya mencionado, el diseño de la cavidad en la OMI es mas bien preventivo que restaurador. Para eso, se aconseja el uso de magnificación a la hora de preparar una cavidad. (32)

Las fresas serán de tallo largo y con una superficie activa lo mas reducida posible. Las formas serán esféricas, cónicas y elípticas, o a veces pequeñas fresas cilíndricas que denominamos de fisurotomia. Estas fresas permiten limpiar la lesión de los surcos de un diente, sin dañar el tejido alrededor. (Figura 4)

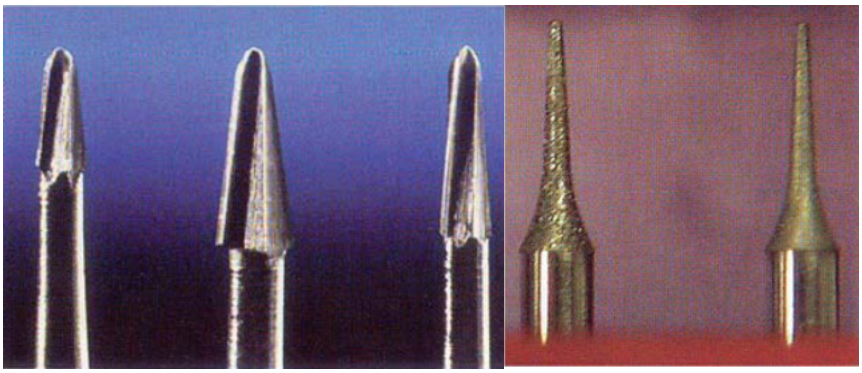

Figura 4: Fresas de fisurotomia para preparaciones de cavidad mínimamente invasivas.

Algunos diseños modificados incluyen preparaciones internas y de túnel para lesiones de la superficie proximal, utilizando instrumentos rotatorios de alta velocidad y fresas pequeñas para hacer la cavidad. (32)

La preparación en túnel se realiza accediendo a la dentina cariada desde la superficie oclusal, conservando así el reborde marginal. (32)

Este tipo de preparación es técnicamente difícil de realizar debido al acceso, a la poca visibilidad y a la pequeña cantidad de estructura dental que se elimina. (31,32)

Un estudio mostró que después de tres años, las preparaciones del túnel tenían mejores resultados a largo plazo que las restauraciones de clase II. (33)

Remoción mecánica no rotatoria: Técnica ART

El tratamiento restaurador atraumático (ART) es un método de manejo de la caries dental basado en 2 pilares: selladores para prevenir caries en fosas y fisuras, y obturaciones para caries en dentina cavitada. (34)

Respecto a la eliminación del tejido cariado, la técnica ART utiliza únicamente instrumentos manuales y la cantidad a eliminarse depende principalmente de la profundidad de la cavidad. La estrategia de la eliminación “parcial” de la caries ya fue propuesta por Massler en los años 60. El aspecto innovador del método ART está en el hecho que todo el procedimiento debe realizarse únicamente con instrumentos manuales, y su uso dé lugar a una preparación mínima de la cavidad. Por lo tanto, se puede afirmar que las cavidades preparadas con ART siguen los principios de la OMI de mínima intervención. (34,35)

En cavidades de poca y media profundidad, el tejido cariado se elimina hasta la dentina afectada, mientras que, en cavidades profundas o muy profundas, en las que no hay signos de exposición pulpar, inflamación pulpar y/o antecedentes de dolor espontáneo, se puede dejar algo de dentina infectada con el objetivo de evitar la exposición pulpar. (34)

En el articulo de Leal y Bonifacio se evidencia como este abordaje puede ser indicado tanto para lesiones ya cavitadas de grande o media extensión, como para lesiones con accesos más pequeños. (36) (figura 5)(figura 6)

Figura 5: En esta secuencia de imágenes vemos 5a) un primer molar temporal con una lesión cavitada de esmalte y dentina y un acceso pequeño; 5b) Apertura de la cavidad con el instrumento manual; y 5c) la misma cavidad después de haber sido limpiada.

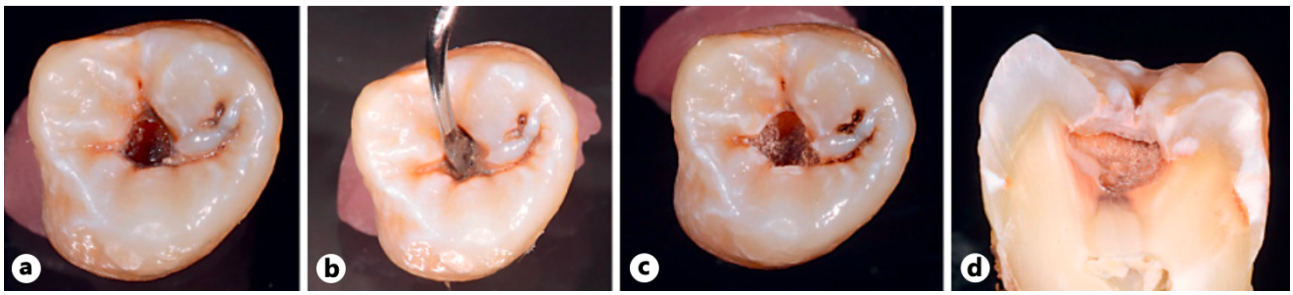

Figura 6: En esta secuencia de imágenes vemos 6a) una lesión cavitada de esmalte y dentina de media profundidad, 6b) Excavador manual insertado en la cavidad, 6c)la cavidad después de haber sido limpiada solo con el instrumento manual y 6d) el mismo diente seccionado donde se aprecian las paredes de dentina afectada. (36)

Al principio el uso de esta técnica estaba limitado al tratamiento de la caries en países y/o comunidades donde otros tratamientos no estaban disponibles. Tras varios años y muchos estudios, se ha visto que existe una fuerte evidencia sobre la calidad y durabilidad a largo plazo de esta técnica, y se empezó a usar también en países económicamente más avanzados. (35)

El factor principal por considerar a la hora de usar esta técnica es la elección correcta de la caries a restaurar. Las restauraciones con técnica ART están indicadas principalmente para caries de una sola superficie en dientes temporales y permanentes. También para caries de mas superficies en dientes temporales se puede considerar de un tratamiento eficaz cuanto el tratamiento convencional. Pero

hay información insuficiente sobre la calidad de las restauraciones ART en superficies múltiples en dientes permanentes. (34)

Respecto al tratamiento restaurador a utilizar, se ha visto que casi en todos los estudios sobre el método ART, el material de elección fue el cemento de vidrio ionomero, tanto para los selladores como para las obturaciones. (34,35,36)

Algunos estudios compararon la eficacia a largo plazo de los vidrios ionomeros respecto a las resinas compuestas. En la mayoría no había diferencias significativas entre los dos materiales, aunque algunos estudios mostraron un efecto preventivo mayor usando ionomero de vidrio respecto a las resinas compuestas. (36)

Las revisiones sistemáticas muestran también que la longevidad de las restauraciones con el método ART en los dientes temporales no es menor respecto a los métodos tradicionales con resina compuesta. (36)

Abrasión por aire

La abrasión por aire es una técnica de preparación dental que se utiliza para la eliminación del esmalte y la dentina. Los aparatos de abrasión por aire son capaces de realizar una preparación dental mínimamente invasiva utilizando óxido de aluminio de 27 μm (α- alúmina). (32, 37,38)

Una primera diferencia de esta técnica está en el hecho que los odontólogos están acostumbrados a la sensación táctil a la hora de hacer una cavidad para apreciar los limites y la profundidad de corte. Sin embargo, al usar un chorro abrasivo de aire, esa sensación desaparece. (38)

Esto hace que el uso de la abrasión con aire sea una técnica altamente sensible al operador y requiere unas precauciones para que no se sobrepase la preparación de la cavidad.

Los estudios clínicos han indicado una buena aceptación de esta técnica por parte del paciente por la ausencia de vibración, la ausencia de generación de calor y la reducción de necesidad de anestesia local ya que el tratamiento es casi indoloro. (39)

Algunos autores aconsejan por el uso de magnificación como complemento a esta técnica. (32, 38)

Su uso en la OMI está recomendado en restauraciones de resina preventivas mínimamente invasivas. La superficie porosa que se crea gracias a la abrasión por aire, no debilita los prismas, y por esto favorece la adhesión dentinaria. (39)

Otra ventaja se debe al echo de que las preparaciones de cavidades realizadas con abrasión por aire tienen paredes internas más redondeadas que las preparadas con instrumentos rotatorios. (figura 7)

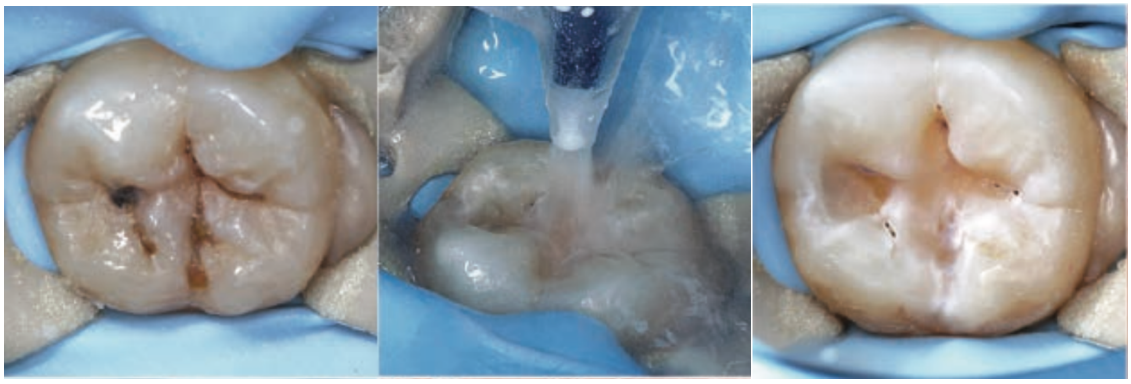

Figura 7: Secuencia de imágenes que ilustra la preparación mínimamente invasiva de una lesión por caries oclusál con abrasión por aire. En la imagen final se aprecian las paredes redondeadas de la cavidad. (32)

Esto puede aumentar la longevidad de las restauraciones colocadas porque reduce la incidencia de fracturas, y consecuente disminución de las fuerzas internas en comparación con las observadas en las preparaciones cavitarias clásicas.

La innovación en el desarrollo de nuevos polvos abrasivos ha dado como resultado la creación de un polvo de vidrio bioactivo capaz de eliminar las manchas dentales

extrínsecas, desensibilizar la dentina expuesta y permitir una remoción eficaz de la caries. (39)

Se está investigando en el desarrollo de un polvo abrasivo selectivo para la dentina infectada.

El control del polvo es una componente para tener en cuenta y requiere el uso de diques de goma y aspiración constante.

La abrasión por aire no se puede utilizar para todos los pacientes. Debe evitarse en casos de alergia grave al polvo, asma, enfermedad pulmonar obstructiva crónica, extracción reciente u otra cirugía oral, heridas abiertas, colocación reciente de aparatos de ortodoncia y ulceras orales. (32,39)

Instrumentos ultrasónicos y sono-abrasión:

Los instrumentos ultrasónicos se empezaron a usar en los años 50 para eliminar las caries proximales tanto en diente anteriores como posteriores, con el objetivo de lograr una preparación cavitaria más conservadora posible. (40)

Esta técnica no elimina mecánicamente la dentina como los instrumentos de alta velocidad, sino que la desgasta utilizando una punta diamantada que oscila con una frecuencia elevada. Las piezas de mano ultrasónicas funcionan a alta frecuencia, alrededor de 20.000 Hz a 40.000 Hz (en comparación, las frecuencias utilizadas por un instrumento de limpieza ultrasónico son alrededor de 100.000 Hz). (41)

Recientemente se ha desarrollado la sono-abrasión como una alternativa al método ultrasónico original. (figura 8)

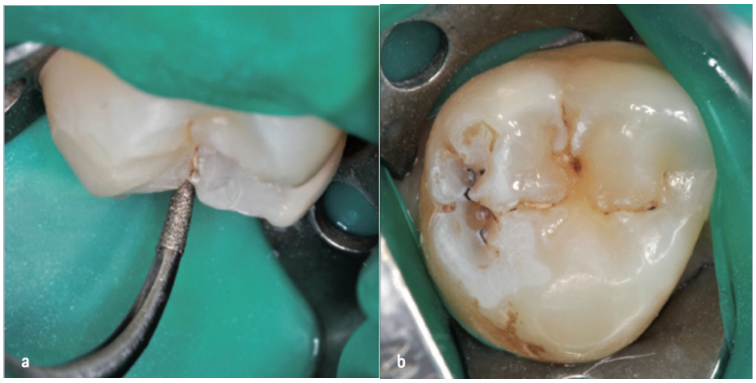

Figura 8: 8a)Instrumento ultrasónico con punta para fosas y fisuras; 8b)resultado final (38)

Esta técnica utiliza ultrasonidos de alta frecuencia aplicados a unas puntas abrasivas modificadas, que generan una mezcla entre movimiento elíptico y movimiento longitudinal. (38)

Las puntas son diamantadas en el lado de corte, y son enfriadas con agua 20/30ml por minuto. Existen de varios tamaños y formas para preparar los diferentes tipos y formas de cavidad, y se ha visto su eficacia también en la eliminación de la dentina cariada blanda.

Los estudios están de acuerdo en que la principal ventaja de las técnicas con ultrasonidos está en minimizar o eliminar el ruido, la vibración, el calor y la presión causadas normalmente con los instrumentos rotatorios. También son eficaces para las preparaciones proximales con el fin de proteger los dientes adyacentes contra el daño iatrogénico causado por el uso de fresas dentales. (40) (figura 9)

Figura 9: Eliminación mínimamente invasiva de una caries interproximal en un molar superior con el uso de sono-abrasión (38)

Donde hay mayor debate es sobre la correcta eliminación de caries en esmalte y en dentina.

Se ha visto que la sono-abrasión tiene una eficacia limitada sobre el esmalte sano y aumenta el tiempo de trabajo en comparación con los instrumentos rotarios tradicionales. (38,41)

Los estudios demuestran que se puede utilizar de manera satisfactoria solo para la eliminación selectiva de esmalte alterado (displasias del esmalte, amelogénesis imperfecta, hipoplasia incisivo-molar), ya que la remoción resulta mas fácil que en esmalte sano.

Otra ventaja respecto a los sistemas tradicionales está en el acabado de los márgenes, que resultan así libres de escalones y grietas. (41)

Otra controversia está en la calidad de la adhesión después de preparar las cavidades mediante estas dos técnicas. La preparación por sono-abrasión deja una superficie más homogénea que la preparación por abrasión con aire y varios estudios in vitro muestran superficies que carecen de smear layer (barrillo dentinario) y que retienen los tags de resina solo en el principio del túbulo dentinario. (40,41)

En 2007, Tavares de Oliveira demostró que las superficies de dentina tratadas por sono-abrasión proporcionan una retención eficaz, sea cual sea la naturaleza del sistema adhesivo que se usará. (41)

Remoción mecanico-quimica

Con la llegada de los materiales adhesivos, las técnicas para preservar cuanta más dentina sana han ganado popularidad. Entre ellas, destacan los métodos mecanico-quimico de remoción de caries: Caridex, Carisolv, Papacarie y Carie Care. (43)

Todos estos sistemas implican la remoción selectiva de la dentina infectada, mediante la aplicación de un agente natural o sintético, seguida de una remoción mecánica atraumática dejando dentina afectada para que se remineralize. (44)

Aunque actualmente obsoleto, el Caridex se desarrolló en los años 70 a partir de una fórmula hecha de N-monocloroglicina y ácido aminobutírico. Consistía en un depósito para la solución (pH 11), un calentador y una bomba que hacia pasar la solución calentada a través de un tubo a un instrumento de pieza de mano. Sin embargo, debido al sabor desagradable, al largo tiempo de actuación (10-15min) y a los grandes volúmenes de solución necesarios (200-500ml), se dejó de usar. (43)

Después de la desaparición del sistema CaridexTM las técnicas de eliminación de caries mecanico-quimicas volvieron con la comercialización del gel CarisolvTM a finales de la década de 1990.

Este sistema de gel a base de hipoclorito y aminoácidos permite junto a la instrumentación manual, la eliminación selectiva de dentina infectada, mientras que el tejido sano no se afecta.

Las principales desventajas se deben al tiempo de aprendizaje largo para los profesionales y a su alto coste debido a los instrumentos específicos que se necesitan para su uso. Está todavía en comercio, aunque su uso no es muy extenso. (44)

Más recientemente, en 2003 se desarrolló en Brasil un gel a base de papaína que contiene cloramina y azul de toluidina llamado Papacarie DuoTM.

Se pueden encontrar varios estudios en la literatura que evalúan la eficacia de este material respecto a la remoción de dentina infectada. (43,44)

Una alternativa a Papacarie DuoTM, denominada Carie CareTM se lanzó en la India en 2011 con la intención de ser más rentable. Está compuesto por papaína, aceite de clavo y cloramina. El ingrediente principal, la papaína, tiene acción proteolítica. Actúa degradando el colágeno sin dolor, además te poseer propiedades antisépticas y antiinflamatorias gracias a los aceites terapéuticos esenciales contenidos. (43)

En 2017 Thakur y col. hicieron un estudio en dientes temporales poniendo en comparación el Papacarie con el Carie Care. Analizando las muestras con un microscopio, vieron como en los dientes tratados con Carie care quedaba una mínima cantidad de dentina infectada, mientras que aquellos tratados con papacaries presentaban una mejor morfología de la superficie tratada. Concluyeron así que la adhesión en dientes tratados con papacarie, resultaría mejor. (44)

Otro estudio de 2015 comparó los métodos de remoción mecanico-quimica de caries, con los métodos tradicionales rotatorios, analizando la eficacia, el tiempo empleado, la superficie de la dentina tratada y la microfiltración de las restauraciones posteriores. Vieron que, en cuanto a la eficacia de eliminación de caries, los dos métodos no tenían diferencias significativas. Sin embargo, los métodos de remoción mecanico-quimica necesitaron de un tiempo de excavación más largo y las superficies de dentina

quedaron mas rugosas e irregulares, y con menor dureza de dentina residual. (45) Además, la microfiltración marginal de las restauraciones fue mayor en las técnicas mecanico-quimicas. Por lo tanto, concluyeron que si son útiles en eliminación de caries, pero carecen de eficacia en cuanto a la durabilidad de las posteriores restauraciones. (45)

Foto ablación: Laser

La preparación cavitaria usando el láser Erbium: YAG fue descubierta por primera vez en los años 80.

Se han investigado varios láseres para determinar su idoneidad en la preparación de cavidades y se ha visto que los de tipo Erbio (Er: YAG y Er, Cr: YSGG) son los más eficaces. (46,47,48)

El mecanismo de eliminación de tejido duro se debe a una expansión muy brusca del agua atrapada en los tejidos del diente, seguida de una rápida expulsión de partículas dentales en la dirección opuesta al rayo láser. Esto se basa en el principio de que la estructura del diente cariado tiene un mayor contenido de agua que el diente sano.

Hoy en día se ha visto como los láseres tienen muchos beneficios para el tratamiento dental en niños, y por sus ventajas son unas de las herramientas que se aplican en la OMI. (46)

El tratamiento sin contacto directo y sin vibración permite una preparación de la cavidad más cómoda reduciendo la ansiedad y el miedo en los niños. Además, los láseres Erbium pueden eliminar la caries de forma eficaz con una mínima afectación de la estructura dental alrededor y tienen un efecto analgésico sobre los tejidos duros, reduciendo o eliminando el uso de anestesia local durante la preparación de los

dientes. Por lo tanto, la terapia con láser mejora el cumplimiento del paciente al influir positivamente en los factores objetivos y subjetivos que afectan la percepción del dolor. También se produce un efecto analgésico irradiando con láser de erbio a bajo nivel de energía la zona antes del tratamiento. Como resultado, el grado de aceptación por parte del paciente es mayor respecto a las técnicas tradicionales con instrumentos rotatorios. (47)

Sin embargo, el láser carece de sentido táctil (al igual que la abrasión por aire) y la remoción de la caries es un poco más lenta que con los instrumentos rotatorios de alta velocidad.

Desinfectantes cavitarios

Destruir las bacterias presentes dentro de una lesión cariosa o modificar la microbiota para favorecer la remineralización, son temas de investigación actuales.

Esto es de particular interés en las lesiones expuestas como la caries radicular que no se puede sellar y donde el proceso de caries progresa mas rápidamente.

Las dos técnicas mas empleadas son el ozono y la técnica PAD (Photo activated disinfection)

El ozono (O3) es un agente oxidante que neutraliza los ácidos y sus efectos sobre las estructuras celulares y los microorganismos están demostrados tanto en odontología como en medicina (49,50)

En la odontología, se ha demostrado que el ozono descompone los productos ácidos de las bacterias cariogénicas, que sabemos son importantes en la etiología del desarrollo de la caries. (49,50)

En un estudio de Baysan de 2000, se demostró que la aplicación de ozono durante 10 o 20 segundos fue eficaz para lograr una muerte del 99% de las bacterias en las lesiones cariosas in vitro e in vivo. (50)

La desinfección fotoactivada (PAD) es un método para desinfectar o esterilizar una superficie aplicando tópicamente un agente fotosensibilizante (un tinte) e irradiándolo con luz láser.

La destrucción de los microbios ocurre sin dañar otros tejidos.

La energía del láser de baja potencia en sí misma no es particularmente letal para las bacterias, pero es útil para la activación del tinte.

Se ha demostrado que la PAD es eficaz para matar bacterias, que típicamente son resistentes a la acción de agentes antimicrobianos.

Puede usarse eficazmente en lesiones cariosas, ya que la luz roja visible se transmite bien a través de la dentina, incluso en caries profundas.

La técnica HALL

La técnica Hall coge su nombre de la Dra. Norma Hall. Es un método para el manejo de molares temporales cariados donde la caries se sella bajo coronas metálicas preformadas sin anestesia local, sin preparación del diente y sin remoción de caries.(51,52)

La secuencia clínica es bastante sencilla: después de haber hecho un correcto diagnostico y selección del caso se procede a la colocación de un separador de ortodoncia en la parte distal del diente para crear un espacio interproximal y permitir el correcto asentamiento de la corona metálica tres días después. A los tres días, después de haber quitado el separador, se elige la corona del tamaño correcto, y se

cementa con un cemento de ionómero de vidrio y se coloca en el diente. Se pide al niño que muerda y se retiran los excesos de cemento. Se mantiene mordiendo hasta que el material haya fraguado. (52) (figura 10)

Figura 10: Secuencia clínica para la colocación de una corona metalica con tecnica ART en un primer molar inferior derecho (52)

La selección del caso a tratar es muy importante, de hecho, no se puede aplicar a todo diente temporal cariado.

Los casos en los cuales está indicada esta técnica son:

- Dientes con caries oclusales no cavitadas, en el caso de que el paciente no pueda aceptar un sellador de fisuras, una remoción parcial de caries o una restauración convencional.
- Dientes con caries proximales cavitados o no cavitados en el caso de que el paciente no pueda aceptar la remoción parcial de la caries o la restauración convencional.

El caso tipo sería un molar temporal con caries activa en dentina, moderadamente avanzada, que afecte la superficie proximal, y sin signos o síntomas (clínicamente o radiográficamente) de afectación pulpar irreversible. (51)

Las principales contraindicaciones son:

- Dientes con signos o síntomas de afectación pulpar irreversible.
- Dientes con grandes destrucciones por caries, considerados no restaurables.
- Niños muy pequeños que no entiendan bien el procedimiento o que no toleren morder para asentar la corona en su posición sin anestesia.

Como ya se ha anticipado, la técnica Hall no requiere anestesia, ni remoción previa de la caries. Eso conlleva una serie de ventajas:

- Es una técnica que se puede considerar menos traumática para el niño en la cual se reduce el nivel de ansiedad y/o estrés
- Sella la lesión por caries deteniéndola o ralentizándola
- Disminuye el porcentaje de caries no tratadas y proporciona una restauración que permite la correcta exfoliación del diente

En resumen, podemos afirmar que es un procedimiento no invasivo en línea con los principios conservadores de la OMI. (51,52)

A pesar de las múltiples ventajas, la técnica Hall provoco en los años cierto debate respecto a su uso.

Primero requiere mucho tiempo respecto a otras técnicas, ya que se necesitan separadores de ortodoncia para generar espacio suficiente para asentar la corona metálica.

En segundo lugar, ya que el diente no precisa de preparación oclusal para la cementación de la corona, algunos autores afirman que esto pueda provocar contactos prematuros y aumentar la dimensión vertical oclusal (DVO). Sin embargo, otros autores afirman que la oclusión se equilibraría adecuadamente en las siguientes

revisiones y ningún paciente demostró problemas en la articulación temporomandibular. (52)

Aunque la evidencia no es concluyente sobre este tema, no se puede descartar el riesgo y se necesita más investigación a largo plazo.

La evidencia muestra también tasas de supervivencia similares entre muchas restauraciones tradicionales y las coronas colocadas con la técnica de Hall. Esto es digno de especial atención, ya que, en la técnica de Hall, no hay ni siquiera una excavación parcial de caries antes de la colocación de la corona metálica. Como ya se ha dicho, las caries se sellan debajo de la corona. (51)

La supervivencia de las coronas Hall parece ser mayor que la observada en restauraciones de ionómero de vidrio y casi comparable al éxito observado en las restauraciones de composite.(51)

MATERIALES

Respecto a la elección del material restaurador en la OMI, es aconsejable retrasar la decisión final hasta que se complete la preparación de la cavidad. La histología de la superficie de la cavidad preparada junto al grado de profundidad de la caries y a las características propias de cada paciente, permitirán seleccionar el material mas apropiado para cada caso.(32)

Si bien hay una continua investigación sobre biomateriales innovadores diseñados para minimizar la preparación de los dientes, reforzar su estructura y estimular la curación de la pulpa, los composites hoy en día son el material de restauración directo más comúnmente utilizado en el mundo, seguidos del cemento de ionómero de vidrio y de sus derivados.(32)

Según los principios de la OMI, hay varios materiales que se pueden utilizar: cementos de ionómero de vidrio (CVI), compuestos de resina, y una combinación de ambos, que consiste en la laminación. (29,30)

Los cementos de vidrio ionómero (CVI) y sus derivados poseen la capacidad de crear enlaces químicos con el esmalte y la dentina. Si bien se sabe que poseen cierta capacidad antimicrobianas y remineralizante, por su potencial para liberar iones de fluoruro, la relevancia clínica de esta característica sigue siendo objeto de debate.

Además, el CVI fijado es "recargable"; esto significa que puede absorber flúor del medio oral mediante la exposición a tratamientos con flúor o pasta de dientes.

En teoría, esta absorción y liberación lenta de flúor puede tener un efecto anticariógeno, aunque hay estudios clínicos que han demostrado como esto no es clínicamente significativo. (38)

Funcionan bien en áreas poco sometidas a cargas oclusales, por eso las recomendaciones actuales limitan su uso a restauraciones que no soportan carga, por ejemplo, cavidades de clase V, restauraciones con técnica ART en dientes temporales, restauraciones provisionales, en la técnica de laminación o como protección pulpar indirecta.(30,32)

Las desventajas de los CVI incluyen la sensibilidad de la técnica.

Las propiedades de manipulación y la fragilidad del material se pueden superar añadiendo resina al material. Los cementos de ionómero de vidrio modificados con resina (CVI-R), son más fáciles de colocar, se fotopolimerizan y tienen mejores propiedades estéticas.

Sin embargo, la introducción de la resina tiene la desventaja de introducir también contracción por polimerización.

Otro material de largo uso en la odontología restauradora son las resinas compuestas. Los materiales de resina compuesta (RC) son el pilar de las técnicas de restauración directa en la OMI y son aptos para muchas situaciones clínicas. (29,30)

Como ya se ha dicho, son el material restaurador directo más usado ya que ofrecen unas ventajas significativas:

- Promover una preparación de la cavidad de tipo mínimamente invasivo
- Las técnicas adhesivas aumentan la resistencia a las fracturas
- Reducir el riesgo de microfiltración bacteriana.
- Alta estética
- Eficacia para la restauración conservadora reduciendo significativamente o incluso eliminando la necesidad de restauraciones indirectas

La unión química de las resinas al esmalte es un factor clave en la selección de estos materiales.

Gracias al grabado acido del esmalte y de la dentina, esta unión química ha mejorado mucho en los años, pero la contracción de polimerización y la adaptación marginal siguen siendo un problema, especialmente cuando los márgenes de la cavidad se sitúan en la dentina. (30,32)

El proceso de laminación, también llamado técnica sándwich, aprovecha las propiedades físicas tanto del CVI como de los composites de resina.

El CVI se coloca en primer lugar debido a su adhesión a la dentina y la liberación de fluoruro. Luego, el composite a base de resina se aplica en laminas sobre el CVI con el fin de disminuir el desgaste y mejorar la estética oclusal.

CONCLUSIONES

Se ha visto como la metodología tradicional de remoción de caries ha demostrado ser en muchas ocasiones demasiado invasiva para el tratamiento en el paciente infantil.

Por el otro lado, la filosofía de la OMI pretende ayudar el odontólogo a mantener los dientes de los pacientes infantiles sanos centrándose en los principios de la prevención del diagnostico precoz y, en el caso de que se haya desarrollado una caries, actuar mediante enfoques menos invasivos.

Respecto a las lesiones incipientes, la remineralización es posibles y tiene que ser una prioridad. Además del uso del flúor, se han destacado las múltiples ventajas de nuevos productos como el fosfato de calcio amorfo, los vidrios bioactivos, el fluoruro diamino de plata y la técnica ICON.

Respecto al tratamiento restaurador, esto se realizará en función de la profundidad de la caries y las técnicas restauradoras mínimamente invasiva que se han analizado están indicadas en la mayoría de los casos, tanto en dientes temporales como permanentes. La mayoría de las técnicas analizadas, mostro una eficacia igual o superior respecto al tratamiento restaurador tradicional.

El futuro de la odontología mínimamente invasiva en los niños está hacia el desarrollo de agentes que tengan la capacidad de remineralizar las lesiones más profundas, así como en nuevos materiales restauradores que simplifiquen su usó en la practica diaria con el paciente infantil.

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Anexo 1

CUESTIONARIO CAMBRA MODIFICADO PARA EDADES DE 0 A 5 AÑOS				
NOMBRE:				
EDAD:	FECHA:___/___/___	SÍ	NO	NOTAS
1A ¿HA TENIDO LA MADRE O CUIDADOR PRINCIPAL CARIES EN EL ÚLTIMO AÑO?				
1B ¿SE LE HA REALIZADO AL NIÑO ALGUNA OBTURACIÓN RECIENTEMENTE?				
1C ¿TIENE LA MADRE O CUIDADOR PRINCIPAL NIVEL SOCIOECONÓMICO O CULTURAL BAJO?				
1D ¿TIENE PROBLEMAS DE DESARROLLO?				
1E ¿NO REALIZA VISITAS AL DENTISTA DE FORMA PERIÓDICA?				
2A ¿TOMA SNACKS O BEBIDAS AZUCARADOS ENTRE HORAS MÁS DE TRES VECES DIARIAS?				
2B ¿TIENE REDUCCIÓN DE LA PRODUCCIÓN DE SALIVA POR MEDICACIÓN U OTRAS CAUSAS?				
2C ¿BEBE HABITUALMENTE EN BOTELLA O BIBERÓN BEBIDAS QUE NO SEAN AGUA?				
2D ¿DUERME CON BIBERÓN O TOMA PECHO A DEMANDA MIENTRAS DUERME?				
3A LA MADRE O CUIDADOR NO HA TENIDO CARIES EN LOS ÚLTIMOS TRES AÑOS				
3B REALIZA REVISIONES Y CONTROLES PERIÓDICOS CON UN DENTISTA				
4A VIVE EN UNA ÁREA CON AGUA FLUORADA O DESHACE EN BOCA COMPRIMIDOS FLUORADOS				
4B SE CEPILLA CON PASTA FLUORADA DIARIAMENTE (TAMAÑO LENTEJA O GUISANTE)				
4C LA MADRE UTILIZA CHICLES O PASTILLAS CON XYLITOL 2-4 VECES AL DÍA				
5A EL NIÑO PRESENTA LESIONES BLANCAS, DESCALCIFICACIONES O CARIES				
5B SE HAN REALIZADO OBTURACIONES AL NIÑO EN LOS ÚLTIMOS DOS AÑOS				
5C ¿PRESENTA PLACA DE FORMA CLARA Y/O LAS ENCÍAS SANGRAN FÁCILMENTE?				
5D ¿EL NIÑO ES PORTADOR DE ORTODONCIA?				
5E ¿SE OBSERVA VISUALMENTE UN FLUJO SALIVAL DEFICIENTE?				
PUNTUACIÓN TOTAL DEL RIESGO DE CARIES (2 PUNTOS POR CASILLA ROJA, 1 PUNTO POR RESTO DE CASILLAS)		A=	B=	TOTAL (A-B): PUNTOS
SI EN UNA CASILLA (1A,1B, 5A, 5B) O DOS CASILLAS DEL SECTOR 1, 2, Ó 5 SE MARCA "SÍ" VALORAR REALIZACIÓN DE CULTIVOS BACTERIANOS				
ESTREPTOCOCOS ALTO MEDIO BAJO		LACTOBACILOS ALTO MEDIO BAJO		
¿SE HAN DADO RECOMENDACIONES ESCRITAS? SÍ NO		PRÓXIMO CONTROL:___/___/___		
OBJETIVOS DE AUTOCUIDADO: 1._____ 2._____				
BAJO RIESGO (-5 A 5 PUNTOS)		ALTO RIESGO (6 A 18 PUNTOS)		

CUESTIONARIO CAMBRA MODIFICADO PARA EDADES A PARTIR DE 6 AÑOS

NOMBRE:				
EDAD:	FECHA: ___/___/___	SÍ	SÍ	SÍ
(A) INDICADORES DE LA ENFERMEDAD				
LESIONES DE CARIES EN DENTINA (DIAGNÓSTICO VISUAL O RADIOGRÁFICO)				
LESIONES DE CARIES EN ESMALTE (DIAGNÓSTICO VISUAL, DIAGNOCAM O RADIOGRÁFICO)				
LESIONES BLANCAS DE CARIES EN SUPERFICIES LISAS				
OBTURACIONES REALIZADAS EN LOS ÚLTIMOS TRES AÑOS				
(B) FACTORES DE RIESGO (EFECTUAR "PRUEBAS" SI EXISTE ALGÚN INDICADOR DE ENFERMEDAD)				
GRAN CANTIDAD DE PLACA EN LOS DIENTES				
FACTORES QUE REDUCEN EL FLUJO SALIVAL (MEDICACIÓN, RADIACIÓN, ENFERMEDAD)				
FLUJO SALIVAL ESTIMULADO INADECUADO (POR OBSERVACIÓN O POR MEDICIÓN MENOR A 1 ML/MINUTO)				
CONSUMO MAYOR A TRES INGESTAS ENTRE HORAS (PICOTEO)				
RAÍCES EXPUESTAS				
EN TRATAMIENTO DE ORTODONCIA FIJA				
FOSAS Y FISURAS OCLUSALES PROFUNDAS				
USUARIO DE DROGAS DE DISEÑO				
PRUEBA: CULTIVO DE LACTOBACILOS Y DE ESTREPTOCOCOS CON NIVEL MEDIO O ALTO				
PRUEBA: BAJA CAPACIDAD TAMPÓN DE LA SALIVA				
(C) FACTORES PROTECTORES				
VIVE EN UNA ÁREA CON AGUA FLUORADA				
UTILIZA UN ENJUAGUE FLUORADO DIARIAMENTE				
SE CEPILLA CON PASTA FLUORADA COMO MÍNIMO UNA VEZ AL DÍA				
SE CEPILLA CON PASTA FLUORADA COMO MÍNIMO DOS VECES AL DÍA				
SE CEPILLA DIARIAMENTE CON UNA PASTA DENTAL FLUORADA CON 5000 PPM DE FLÚOR				
UTILIZA UNA PASTA DENTAL QUE CONTIENE UN 1,5% DE ARGININA				
RECIBE UNA APLICACIÓN SEMESTRAL DE BARNIZ DE CLORHEXIDINA Y TIMOL				
RECIBE UNA APLICACIÓN SEMESTRAL DE BARNIZ O GEL PROFESIONAL DE FLÚOR				
HA TOMADO 1 MGR DE XYLITOL 5 VECES AL DÍA DURANTE LOS ÚLTIMOS SEIS MESES				
PUNTUACIÓN TOTAL DEL RIESGO DE CARIES (2 POR INDICADOR, MÁS 1 POR F. RIESGO, MENOS 1 POR F. PROTECTOR) A+B-C= ___ PUNTOS		___ X2(A)	___ X1(B)	___ X1(C)
CULTIVO DE ESTREPTOCOCOS ALTO MEDIO BAJO	CULTIVO DE LACTOBACILOS ALTO MEDIO BAJO			
FLUJO SALIVAL ESTIMULADO ___ML/MIN				
¿SE HAN DADO RECOMENDACIONES ESCRITAS? SÍ NO	PRÓXIMO CONTROL:___/___/___			
OBJETIVOS DE AUTOCUIDADO: 1._____ 2._____				
BAJO RIESGO (-9 A 4 PUNTOS)	ALTO RIESGO (5 A 18 PUNTOS)			

PRIMERAS PAGINAS DE LOS ARTICULOS:

CE 1

A 100-Year Journey from GV Black to Minimal Surgical Intervention

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Abstract

Over the past 140 years, dentistry has matured from the original tenets of GV Black by moving from "extension for prevention" to a minimal intervention approach. This is part of an evolution that stresses a medical, rather than a surgical model for caries management. This transition has been facilitated by the introduction and advancement of adhesive dentistry, which encourages preservation of tooth structure. Even with these changes, some of the original writings of Black are still relevant today: "The day is surely coming…when we will be engaged in practicing preventive, rather than reparative, dentistry."

Learning Objectives

After reading this article, the reader should be able to:

- explain the history behind "extension for prevention" and why it no longer applies.
- discuss why an indirect composite restoration may be a better choice than a crown when a single cusp is fractured.
- explain how the introduction of etching and bonding has played a key role in minimally invasive dentistry.
- describe the advances achieved based on the changes made to the composition of amalgam.

Minimally invasive dentistry (MID), or minimal intervention dentistry, is a dental care concept based on the assessment of a patient's caries risk and the application of the current therapies to prevent, control, and treat the disease.[1,2] It is often referred to as treating dental caries with a biologic, therapeutic, or medical model.[3] Tyas and colleagues state that the MID model has several tenets including, at a minimum, the following[3]: (1) remineralization of early lesions; (2) reduction in cariogenic bacteria to eliminate the risk of further demineralization and cavitation; (3) minimal surgical intervention of caries lesions; (4) repair rather than replacement of defective restorations; and (5) disease control. Although MID includes risk assessment, remineralization, and bacterial management, this article will discuss the operative aspects of MID. The minimal surgical procedures currently performed are different from the operative dentistry practiced a generation ago. This article will discuss how the new operative dentistry has been derived from the tenets of GV Black published over a century ago.

Black published a series of papers and texts on dental materials and preparation and restoration techniques between 1869 and 1915. Although many current authors have credited or blamed these tenets for overly aggressive preparations and restorations in modern dentistry,[2,4] the present authors contend that Black was the first dentist to propose treating dental caries using minimal intervention based on the knowledge and materials available at that time.

In the middle of the 19th century, the exact cause of dental caries was unknown. Dental preparations were

From Extension for Prevention to Prevention of Extension: (Minimal Intervention Dentistry)

F.J. TREVOR BURKE

Abstract: **Minimal intervention techniques cause less destruction of tooth substance than conventional techniques, with reduced risk of tooth fracture and pulpal problems. This article describes conventional cavity designs and discusses currently available minimal intervention techniques.**

Dent Update **2003; 30: 492–502**

Clinical Relevance: **Tooth and patient-friendly minimal intervention techniques should be employed at every opportunity.**

Traditional concepts for operative dentistry were largely drawn up by G.V. Black around 100 years ago,[1] these being based upon the need to retain non-adhesive materials such as dental amalgam, silicate cement or gold in a cavity in a tooth. The concept of 'extension for prevention' was widely taught, until relatively recently, as evidenced by this statement in a textbook published in 1983.[2]

Not only must the lesion be included in the outline, but any adjacent areas not at present carious, but likely to do so in the foreseeable future, should be included. By doing so, the risk of subsequent carious recurrence at or near the cavity margin is reduced. This is the principle of extension for prevention, and it is one that should be applied judiciously… with due regard to the patient's caries liability at the time and in the future. The outline must lie in areas which are self-cleansing,….for example where occlusal fissures are included the outline should lie approximately one-third of the distance up the slope of the cusp. In interproximal areas…., the margins must be placed far enough laterally to lie in an area subjected to natural or artificial cleansing.

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Figure 1 illustrates the concept of extension for prevention. This, along with the preparation of a retentive lock or key in the occlusal aspect of a posterior tooth in order to prevent displacement of the restoration in an interproximal direction, resulted in substantial loss of (sometimes sound) tooth structure and the resultant weakening of the tooth being treated. It is the aim of this paper to review the causes of tooth weakening and fracture, to suggest the concepts for minimally invasive dentistry and describe the clinical techniques which are appropriate when this philosophy is adopted.

CAVITIES WEAKEN TEETH

Partly as a result of the large amounts of tooth substance which are removed during traditional cavity preparation, fracture of posterior teeth is a common clinical entity. A variety of researchers have investigated this problem, finding that cavity size holds a strong correlation with the incidence of fracture, with the problem appearing to be on the increase as patients keep their teeth longer.[4] Previous research has shown that fractured cusps are the reason for replacement of 13% of amalgam restorations[5] and restoration of such cuspal fractures may present a difficult clinical problem.[6] It appears that cusp fractures may occur in almost any age and most frequently in molar teeth, although upper first premolars are also implicated.[7] Regarding size of cavity and frequency of fracture, Vale[8], as long ago as 1956, showed a decrease in the strength of a prepared tooth when cavity width increased from one-quarter to one-third of the isthmus width. Other researchers found that the least susceptibility to fracture was in teeth with narrow/shallow restorations.[9] Breaking the continuity of enamel has been demonstrated to weaken teeth,[10] with a narrow isthmus/deep pulpal floor weakening teeth more than wide/shallow preparation.[11] However, when all factors are evaluated, it is an MOD cavity/restoration which leads to the greatest numbers of cusp fractures in posterior teeth in general dental practices,[12,13] with

A SIMPLE METHOD OF INCREASING THE ADHESION OF ACRYLIC FILLING MATERIALS TO ENAMEL SURFACES

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ONE of the major shortcomings of the acrylics and other filling materials is their lack of adhesion to tooth structure.[1-4] A filling material capable of forming strong bonds to tooth structures would offer many advantages over present ones. With such a material, there would be no need for retention and resistance form in cavity preparation, and effective sealing of pits, fissures, and beginning carious lesions could be realized.

In our attempts to obtain bonding between filling materials and tooth structure, several possibilities are being explored. These include (1) the development of new resin materials which have adhesive properties; (2) modification of present materials to make them adhesive; (3) the use of coatings as adhesive interface materials between filling and tooth; and (4) the alteration of the tooth surface by chemical treatment to produce a new surface to which present materials might adhere.

This last approach is the subject of this paper, but since it concerns itself only with treatment of intact enamel surfaces, it has only limited application to the broader problems of restorative dentistry.

In industry, phosphoric acid and preparations containing it have been used to treat metal surfaces to obtain better adhesion of paint and resin coatings.[5] Although the increased adhesion is believed to be due primarily to the removal of surface and other contaminants, the conversion of the oxides or the surface of the metal itself to phosphates or the adsorption of phosphate groups on the metal surface may contribute to the effect. Since the enamel surface has probably reacted with various ions, saliva, and so on, to which it has been exposed for long periods of time, and its tiny imperfections filled in by a variety of adventitious materials, the composition of the superficial surface may be quite different than the underlying enamel.[6] As a result, any receptivity to adhesion which the original tooth structure may have had for acrylic materials may have been lost. It was felt that perhaps an acid treatment of the enamel surface might render it more receptive to adhesion in the same manner as it does for metals.

EXPERIMENTAL

Two methods were used for treating the enamel surfaces. The first involved the use of a 50 per cent dilution of a commercial phosphomolybdate

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Adhesive Bonding of Various Materials to Hard Tooth Tissues

XII. Adsorption of *N*-(2-Hydroxy-3-Methacryloxypropyl)-*N*-Phenylglycine (NPG-GMA) on Hydroxyapatite [1]

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Adsorption of an adhesion-promoting compound, *N*-(2-hydroxy-3-methacryloxypropyl)-*N*-phenylglycine (NPG-GMA), was studied on synthetic hydroxyapatite from ethanol solution. The adsorption isotherm is very steep initially, followed by a step and then a Langmuir-type isotherm. The nature of adsorption is irreversible up to the step and reversible thereafter. The maximum amounts of the irreversibly adsorbed and the reversibly adsorbed materials are about the same. The irreversibly adsorbed material may be chemisorbed. If the irreversibility is effected by the chelating ligand groups of the molecule which rotates about the calcium ion site (centered on the nitrogen ligand) in a fully extended configuration, the area of the hydroxyapatite thus obtained corresponds to its BET (N_2) area. An additional reversible adsorption may take place on the irreversibly adsorbed apatite at higher concentrations if the irreversibly adsorbed molecules are reduced in their areal domain by a folding of their methacrylate groups. Polymer filled with synthetic hydroxyapatite covered with the irreversibly adsorbed NPG-GMA has a tensile strength about 50% greater than that of the polymer filled with untreated apatite.

INTRODUCTION

Chemical bonds between polymers used in preventive and restorative dentistry and hard tooth tissues may be achieved through chemisorbing compounds if they possess suitable chemical and structural configurations and copolymerizable groups (1). A "surface-active comonomer," *N*-(2-hydroxy-3-methacryloxypropyl)-*N*-phenylglycine (NPG-GMA), shown in Fig. 1, was synthesized to test this hypothesis (2). This monomeric compound can enhance adhesion of polymers to enamel (3) or dentin (4) and improve margins of composites in clinical use (5).

The present study elucidates certain aspects of the adhesion mechanism by describing the adsorption characteristics of NPG-GMA from ethanolic solution onto synthetic hydroxyapatite, the structural prototype for the principal inorganic crystalline constituent of tooth and bone. The adsorption isotherm is very steep initially, followed by a step and then a Langmuir-type isotherm. The solute is irreversibly adsorbed up to the step and cannot be desorbed upon repeated washing with the solvent. The irreversibly adsorbed material is probably chemisorbed, and the rest physisorbed. The maximum amounts of adsorption by each mechanism are the same.

It seems reasonable to assume that the irreversibility is effected by the chelating ligand groups with the adsorbate molecule rotating

[1] This investigation was supported, in part, by Research Grant R01 DE02494-09 to the American Dental Association Health Foundation from the National Institutes of Health–National Institute of Dental Research, and is part of the dental research program conducted by the National Bureau of Standards in cooperation with the American Dental Association Health Foundation.

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This is the first of a series of articles by Dr Graham Mount concerning MI in dentistry that were first presented in the MI Compendium 3rd Edition, online: http://www.midentistry.com/compendium.html
As this version is now superseded by the new 'MI Compendium of systematic reviews' http://www.mi-compendium.org the JMID takes honour to reprint these interesting and clinically instructive articles in its forthcoming issues.

Minimal intervention (MI) in dentistry

Mount GJ.

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Abstract

The intention of minimal intervention dentistry is to treat the patient for the disease of caries in the simplest manner possible commensurate with the problems diagnosed in that patient's oral environment. The term does not define or limit the extent of the treatment in any way. It simply suggests that the least complex treatment is generally the most desirable and prevention is better than cure. The use of the word intervention covers all types and complexities of treatment without specifying the method. Specifically it allows for treatment both with and without surgical intervention and recognises that non-surgical treatment is just as important as preparation of a cavity.

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It is now one hundred years since acceptable standards for operative dentistry were first proposed by GV Black. Fifty years after he published his tome his principals were strictly adhered to with almost no variation. Since then there has been a considerable increase in our knowledge of the actions of the fluoride ion, improvements in local anaesthesia, progress with dental materials and the development of more sophisticated methods for surgical treatment of a caries lesion. In fact, by the 1970s the productivity of the average practitioner had more or less doubled. At the same time the effect of wider use of the fluoride ion in water supplies and in tooth paste were becoming obvious and the caries rates in the more advanced societies were reducing to some degree.

In Black's day it took an hour on average to restore a complex lesion involving both mesial and distal surfaces of a molar tooth. By 1970, with the advent of high-speed drills, this had become the average time to restore similar lesions in an entire quadrant of four posterior teeth. The profession had increased its efficiency.

There was only one problem. The continuing use of the surgical approach to the treatment of the disease of caries was all wrong and thoroughly out of date. It is interesting to note that GV Black himself drew attention to the fact that caries is a bacterial disease. Even though the microscope was only about 30 years old at the time he identified the lactobacillus as being related to the demineralisation of tooth structure and suggested the profession investigate caries as a disease if it was to succeed in controlling it by means other than surgical.

Since then there has been a continuum of researchers, both inside and outside the profession, who have paid attention to the bacteriology of caries. In 1949 Hurst [1] and his group at the University of California College of Dentistry offered a progress report on their programme of caries research suggesting that the actinomyces, streptococci and probably lactobacillus were involved in the development of caries in hamsters and later it was shown that strep mutans was certainly involved [2]. In 1972 Fitzgerald [3] was investigating the use of antibiotics for the control of caries and then in 1976 Jordan [4] was prepared to identify the complexities of the oral flora at that time recognising that it is a transmissible disease. The following year Rogers [5] confirmed this concept.

About this time the Royal Society of Medicine published an editorial signed by Prof. T Lehner confirming this relatively new line of research [6]. Subsequently both the pace and sophistication of research increased. As early as 1985 people like Krasse evolved the concept of the "specific plaque hypothesis" [7] and research continued with a number of well known names becoming more and more deeply involved.

Present and Future Approaches for the Control of Caries

Kenneth J. Anusavice, Ph.D., D.M.D.

Abstract: This article summarizes current and potential future approaches for the management of caries. Current surveys suggest that traditional "drill, fill, and bill" dentistry is still widely practiced in the United States in spite of considerable evidence that supports a minimally invasive treatment approach. Because there is a wide variability in treatment decisions on when and how to prevent new lesions, on how to arrest the progression of existing lesions, and on when and how to place initial and replacement restorations, the findings from some studies differ significantly from the results of other studies. While fluoride treatments are known to prevent a percentage of new lesions, they do not have the ability to prevent all caries lesions. Modern management of caries entails treating patients according to risk and monitoring early lesions in tooth surfaces that are not cavitated. Although we know that the dmfs score for children is a powerful predictor of caries increment in permanent teeth of these children a few years later, this score is rarely used in private practice as a measure of risk or as a measure of treatment success. Although these modern methods for caries management offer great promise for controlling the disease, they may take decades to apply in a standardized way so that the variability in treatment is reduced. However, during the next two decades, an alternative approach to caries prevention such as replacement therapy and a caries vaccine may become available as a more consistent method of controlling this disease.

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Key words: caries, restorative dentistry, dental materials, fluoride, prevention, dental sealants, caries vaccine

Although we have known for many years that caries is an infectious disease, the management of early and late stages of the disease are still treated identically on state and regional dental board exams and in dental practices, and treatment decisions for caries management vary considerably among practicing dentists.[1-9] Early lesions provide evidence of caries activity, which can be arrested and the tooth surfaces remineralized through appropriate treatment. However, because some clinicians are not confident of their ability to detect early lesions, to arrest the disease, and to remineralize demineralized enamel, restorations are often placed independent of the radiographic depth of the lesion. Other clinicians practice minimally invasive dentistry and monitor early lesions after initial treatment to ensure that the caries activity is arrested and that the enamel can be remineralized.[10-18] Thus, there is considerable variability in caries detection, caries activity assessment, caries risk assessment, the best treatment options for high-risk patients, decisions on when and how to treat teeth with carious lesions, and the best method for monitoring disease.

A shift in emphasis appears to have occurred in dental schools toward assessment of caries risk, modern management of the disease, and delayed restoration until the probability of cavitation has increased to a critical threshold level. Based on survey responses from forty-two of fifty-five dental schools on the threshold required for surgical intervention, Yorty and Brown[19] reported that only 30 percent of responding schools allowed teeth to be restored to satisfy clinical requirements and competencies when radiographs indicated evidence of enamel lesions. At 70 percent of the responding schools, restorations were not indicated until the lesions were classified either as being in the outer third of dentin (D1) (55 percent), the middle third of dentin (D2) (10 percent), or the inner third of dentin (D3) (5 percent). Also, 81 percent of the forty-two respondents reported having a formal caries risk training program for predoctoral dental students. Thirty-six percent of thirty-nine schools have caries risk assessment requirements for graduation, and 38 percent of the schools require caries risk assessment for clinical competencies. Multiple new or active caries lesions were given as the most commonly used criterion for classification of a patient at high risk.

However, a 2001 survey of requirements on state and regional board exams indicates that established clinicians responsible for dental board examinations still allow enamel lesions to be restored.[1] Approximately 72 percent of the states allowed teeth with lesions either in the outer half of enamel (E1) or inner half of enamel (E2) lesion to be restored. About 37 percent of these states allowed teeth with

PROYECTO DE DECLARACIÓN DE POLÍTICA DE LA FDI (revisión)

Odontología Mínimamente Invasiva (OMI) para el tratamiento de la caries dental

Aprobada por la Asamblea General de la FDI en septiembre de 2016 en Poznan, Polonia
Versión original aprobada por la Asamblea General de la FDI en octubre de 2002 en Viena, Austria

CONTEXTO

Desde la aparición de la primera declaración de política sobre OMI en 2002, se ha avanzado en su conocimiento y se han obtenido resultados científicos sobre tratamientos nuevos y existentes, tanto preventivos como restaurativos.

ALCANCE

Existen instrumentos de evaluación visual/táctil, así como dispositivos electrónicos para detectar caries, y evaluar su riesgo y alcance[1]. El desarrollo y el progreso de la caries pueden controlarse. El resultado de la evaluación del alcance de la caries, junto a la capacidad predictiva de instrumentos de evaluación de riesgos de caries, guiará al odontólogo en su decisión sobre qué medidas de control basadas en pruebas fehacientes debe utilizar, y qué calendario de revisiones personalizadas debe establecer.

El proceso de desmineralización de la caries dental puede detenerse reduciendo el consumo y la frecuencia de ingesta de azúcar en la dieta, así como eliminando biopelícula dos veces al día con un dentífrico que contenga flúor. Entre las medidas documentadas de prevención de caries se encuentran agregar flúor al agua, geles, barnices y dentífricos, así como a selladores de cavidades y fisuras. La infiltración de resina y el dentífrico CPP-ACP son algunas medidas prometedoras recientes[2].

Las operaciones mínimamente invasivas se limitan a la extracción de esmalte quebradizo y dentina blanda, lo que minimiza el tamaño de la cavidad. Sellar estas cavidades tratadas con un material adhesivo de calidad prolongará la supervivencia del diente[3]. Se ha demostrado que la supervivencia a largo plazo de restauraciones defectuosas reparadas es tan buena como la de restauraciones defectuosas remplazadas. Por tanto, el remplazo se considera en muchos casos como un tratamiento excesivo, mientras que la restauración se considera como una operación mínimamente invasiva apropiada[2,4].

DEFINICIONES

OMI es un concepto para el tratamiento de la caries dental, cuyo propósito es mantener vivo tejido dental sano y remineralizable, a fin de conservar los dientes hasta una edad avanzada. El tejido dental no debería extraerse innecesariamente. Los principales componentes de OMI incluyen: 1) detección precoz de caries y

A Century of Change towards Prevention and Minimal Intervention in Cariology

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Abstract

Better understanding of dental caries and other oral conditions has guided new strategies to prevent disease and manage its consequences at individual and public health levels. This article discusses advances in prevention and minimal intervention dentistry over the last century by focusing on some milestones within scientific, clinical, and public health arenas, mainly in cariology but also beyond, highlighting current understanding and evidence with future prospects. Dentistry was initially established as a surgical specialty. Dental caries (similar to periodontitis) was considered to be an infectious disease 100 years ago. Its ubiquitous presence and rampant nature—coupled with limited diagnostic tools and therapeutic treatment options—meant that these dental diseases were managed mainly by excising affected tissue. The understanding of the diseases and a change in their prevalence, extent, and severity, with evolutions in operative techniques, technologies, and materials, have enabled a shift from surgical to preventive and minimal intervention dentistry approaches. Future challenges to embrace include continuing the dental profession's move toward a more patient-centered, evidence-based, less invasive management of these diseases, focused on promoting and maintaining oral health in partnership with patients. In parallel, public health needs to continue to, for example, tackle social inequalities in dental health, develop better preventive and management options for existing disease risk groups (e.g., the growing aging population), and the development of reimbursement and health outcome models that facilitate implementation of these evolving strategies. A century ago, almost every treatment involved injections, a drill or scalpel, or a pair of forceps. Today, dentists have more options than ever before available to them. These are supported by evidence, have a minimal intervention focus, and result in better outcomes for patients. The profession's greatest challenge is moving this evidence into practice.

Keywords: caries, minimal intervention dentistry, diagnosis, dental care, evidence based dentistry, public health

Introduction

The concept of minimal (or minimum) intervention dentistry (MID) within oral health care (Kearns et al. 2015) has moved from a fringe topic, taken seriously by only a few, to the center of oral health care. The advances in understanding of dental diseases, human behavior, diagnostics, biomaterials, clinical operative techniques, and technologies have all contributed to our understanding of MID as a patient-centered, biological, and economic paradigm and a contemporary way to deliver dental care. This article focuses on the gradual shift from surgical to minimal intervention and preventive dentistry over the past century and the implications of this shift for public health. We present some MID milestones within the scientific, clinical, and public health arenas and consider the future prospects of MID.

Minimal Intervention Dentistry

For most of human history, the cornerstones of dentistry have been 1) removing carious enamel and dentin (Oxilia et al. 2015), 2) excising infected periodontal tissues, and 3) extracting teeth (and sometimes replacing them). With great foresight, in 1896 G.V. Black expressed a hope that "the day is surely coming, when we will be engaged in practising preventive, rather than reparative dentistry" (Joseph 2005). Yet, establishing the dental profession as a surgical specialty in the late 19th and early 20th centuries seems to have set the path for a mainly operative approach toward managing dental diseases. This surgical approach was initially grounded in the necessity to treat rampant caries, periodontal disease, and associated pain or infection with very limited means available. The growing

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Minimal intervention dentistry: part 1. From 'compulsive' restorative dentistry to rational therapeutic strategies

J. D. B. Featherstone[1] and S. Doméjean[2]

PRACTICE

IN BRIEF

- Explains the differences between minimal intervention dentistry, minimally invasive dentistry, micro-dentistry, atraumatic restorative treatment and selective tissue excavation.
- Examines the foundations of minimal intervention dentistry.
- Considers the implementation of modern concepts into everyday clinical practice.

VERIFIABLE CPD PAPER

The concept of minimal intervention dentistry is based on all the factors that affect the onset and progression of disease and therefore integrates concepts of prevention, control and treatment. The field of minimal intervention dentistry is wide, including the detection of lesions as early as possible, the identification of risk factors (risk assessment) and the implementation of preventive strategies and health education for the patient. When the effects of the disease are present, in the form of a carious lesion, other therapeutic strategies are required, but in this case the least invasive solutions should be chosen, for example remineralisation, therapeutic sealants and restorative care aimed at conserving the maximum amount of sound tissue. This article aims to enlighten dental practitioners as to the foundations of minimal intervention dentistry in order to help them in the implementation of modern concepts into everyday clinical practice.

INTRODUCTION

Cariology has advanced over the past 30 years with scientific advances in the knowledge of the caries process in terms of its pathogenesis, its transmission, the demineralisation and remineralisation continuum, the mode of action of fluoride, but also with respect to the great technological developments in biomaterials, equipment for the detection of caries lesions and methods for cavity preparation. This new scientific knowledge combined with developments both technological and technique related, impose that both medically and ethically, the sole pertinent therapeutic model that is relevant is one that is based on prevention and treatment using the least invasive of approaches. This 'rational' model of care is known as minimal intervention dentistry and is applicable not only to cariology but to periodontology and all other areas of dentistry.[1-3]

Studies conducted in France in the early 2000s indicated that dental practitioners had not yet integrated this concept of cariology into practise[4-7] even though, since the 1990s, Elderton had already denounced traditional approaches to conservative dentistry when considered in isolation.[8-10] Indeed, traditional oral care, which comprises largely conservative/operative dentistry, including scaling and polishing, has very little impact on the oral health of patients both in children and adults because the patient finds himself/herself caught in a repeat restoration spiral of care, where successive replacement of restorations results in the restoration increasing in size each time the restoration is renewed, leading to eventual loss of the tooth.[2,8,11,12] Figure 1 illustrates a patient, aged 33 at the time of the photograph, who has, judging by the number of endodontic treatments present, been obliged to visit the dentist on numerous occasions in the past. The problem of oral hygiene has not been resolved and, the caries process, which is very aggressive, has not been halted. Restorative and endodontic treatment do not in themselves solve the problems of oral health. The reasons for the

Fig. 1 The limitations of traditional dental treatment

MINIMAL INTERVENTION DENTISTRY

1. From 'compulsive' restorative dentistry to rational therapeutic strategies
2. Caries risk assessment in adults
3. Paediatric dental care – prevention and management protocols using caries risk assessment for infants and young children
4. Detection and diagnosis of initial caries lesions
5. Atraumatic restorative treatment (ART) – a minimum intervention and minimally invasive approach for the management of dental caries
6. Caries inhibition by resin infiltration
7. Minimally invasive operative caries management - rationale and techniques

This paper is adapted from: Featherstone J D B, Doméjean S. Le concept d'intervention minimale en cariologie. De la dentisterie restauratrice 'compulsive' aux stratégies thérapeutiques raisonnées. *Réalités Cliniques* 2011; **22**: 207–212.

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Minimal intervention dentistry: part 3. Paediatric dental care – prevention and management protocols using caries risk assessment for infants and young children

IN BRIEF

- Examines the problem of early childhood caries and how it can be minimised.
- Informs caries is a transmissible, infectious disease, which can be passed from mother to child.
- Stresses the importance of risk assessment and preventive dentistry in paediatric healthcare.

PRACTICE

F. J. Ramos-Gomez,[1] Y. O. Crystal,[2] S. Domejean[3] and J. D. B. Featherstone[4]

VERIFIABLE CPD PAPER

Recent increases in caries prevalence in young children throughout the world highlight the need for a simple but effective infant oral care programme. This programme needs to include a medical disease prevention management model with an early establishment of a dental home and a treatment approach based on individual patient risk. This article presents an updated approach with practical forms and tools based on the principles of caries management by risk assessment, CAMBRA. This method will aid the general practitioner to develop and maintain a comprehensive protocol adequate for infant and young children oral care visits. Perinatal oral health is vitally important in preventing early childhood caries (ECC) in young children. Providing dental treatment to expectant mothers and their young children in a 'dual parallel track' is an effective innovative strategy and an efficient practice builder. It promotes prevention rather than intervention, and this may be the best way to achieve long-lasting oral health for young patients. General dental practice can adopt easy protocols that will promote early preventive visits and anticipatory guidance/counselling rather than waiting for the need for restorative treatment.

MINIMAL INTERVENTION DENTISTRY

1. From 'compulsive' restorative dentistry to rational therapeutic strategies
2. Caries risk assessment in adults
3. **Paediatric dental care – prevention and management protocols using caries risk assessment for infants and young children**
4. Detection and diagnosis of initial caries lesions
5. Atraumatic restorative treatment (ART) – a minimum intervention and minimally invasive approach for the management of dental caries
6. Caries inhibition by resin infiltration
7. Minimally invasive operative caries management – rationale and techniques

This paper is adapted from: Ramos-Gomez F J, Crystal Y O, Domejean S, Featherstone J D B. Odontologie pédiatrique. Prévention et prise en charge de la maladie carieuse basées sur l'évaluation du risque pour les jeunes enfants. *Réalités Cliniques* 2011; **22 (3):** 221–232.

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INTRODUCTION

Despite progress made in caries control worldwide by the protective effects of fluoride, increased dissemination of oral hygiene information and widespread healthy diet education, dental caries still remains the most common chronic childhood disease. Consequently, it is a major financial burden on society in many countries throughout the world. In recent years, reports show that caries in the primary dentition has been increasing in the USA, UK, Canada, Australia, the Netherlands and other countries.[1–8]

Early childhood caries (ECC) is more prevalent among young children from low socioeconomic, ethnic minority populations.[9] This uneven distribution occurs in many developed countries with 25% of children bearing 75% of the affected surfaces. Dental caries is a preventable and transmissible infectious disease; it is well documented that the presence of caries in the primary dentition is one of the best indicators for future caries in the permanent dentition.[10,11] Thus, the early and accurate identification of children at risk is of great importance for cost-effective caries control. Signs of ECC can be detected soon after the eruption of the first tooth. If risk indicators are identified early and oral health preventive practices are implemented at a young age, the disease can be controlled and its progression slowed.

In the USA, the American Dental Association (ADA), the American Academy of Paediatric Dentistry (AAPD), the American Academy of Paediatrics (AAP), the American Association of Public Health Dentistry (AAPHD) and the Academy of General Dentistry (AGD) all recommend that a child should see a dentist and establish a 'dental home' by one year of age or when the first tooth erupts.[12–16] A dental home is defined as the ongoing relationship between the dentist and the patient where accessible and coordinated oral healthcare can be delivered comprehensively while actively involving family participation.[17] Despite the widespread advocacy of a 'medical' and a 'dental home' by age one, infant oral health visits have not yet been

Minimal intervention dentistry: part 4. Detection and diagnosis of initial caries lesions

A. Guerrieri,[1] C. Gaucher,[2] E. Bonte[3] and J. J. Lasfargues[4]

VERIFIABLE CPD PAPER

IN BRIEF

- Discusses the methods recommended for clinical diagnosis of initial carious lesions.
- Stresses the importance of a systematic approach to caries diagnosis and treatment.
- Presents a clinical case to consolidate diagnostic methods.

PRACTICE

The detection of carious lesions is focused on the identification of early mineral changes to allow the demineralisation process to be managed by non-invasive interventions. The methods recommended for clinical diagnosis of initial carious lesions are discussed and illustrated. These include the early detection of lesions, evaluation of the extent of the lesion and its state of activity and the establishment of appropriate monitoring. The place of modern tools, including those based on fluorescence, is discussed. These can help inform patients. They are also potentially useful in regular control visits to monitor the progression or regression of early lesions. A rigorous and systematic approach to caries diagnosis is essential to establish a care plan for the disease and to identify preventive measures based on more precise diagnosis and to reduce reliance on restorative measures.

INTRODUCTION

The initial caries lesion can be defined as a primary lesion which has not reached the stage of an established lesion with cavitation. It is therefore amenable to being treated by non-invasive procedures including ultra-conservative or minimal intervention dentistry.

The detection of carious lesions at an early stage is necessary in order to implement preventive and interceptive treatment strategies. In daily practice, the diagnosis of initial lesions is not always simple; it is often subjective and based on the clinician's clinical sense. For this reason, the search is on for more specific and sensitive tools, using new technologies, to help the practitioner diagnose initial caries lesions as precisely as possible. The purpose of this paper is to review the recommended clinical methods for diagnosing initial caries lesions and to examine recent tools for early detection of these lesions.

BACKGROUND

The initial enamel lesion results from an imbalance between the processes of demineralisation and remineralisation. The first changes in enamel appear at those sites where there is plaque biofilm retention and stagnation. The demineralisation alters the enamel surface, which becomes micro-porous, and with an opaque and matt appearance, characteristic of a white spot lesion. Acid penetration along the sheath of the enamel prism leads to the dissolution of crystalline spaces adjacent to the lesion and progressing to the enamel-dentine junction (EDJ) and, in the absence of treatment, cavitation occurs.[1-3]

High evidence-level studies are in agreement that the ideal tool for detection of the initial lesion, the 'gold standard,' has not yet been identified. Such a tool should have both a high level of sensitivity (the ability to detect disease when it exists) and a high level of specificity (the ability to confirm the absence of disease). The conventional and validated tools for detecting early carious lesions include visual and tactile examination and radiography (bitewings). These methods have good specificity but only moderate sensitivity and are relatively 'operator-dependent'.[4-6] The combination of clinical examination and bitewing radiographs nevertheless allows diagnoses with improved sensitivity and specificity. Some new technologies are appearing and it is of interest to link them with standard clinical practices, with a view to improving caries detection and diagnosis.[3]

THE STANDARD CLINICAL APPROACH

Systematised caries diagnostic procedures consist of three stages: the detection of a lesion, evaluation of its severity (depth) and its level of activity.[7,8] Before an examination, the practitioner will have noted the general context of caries activity. The

MINIMAL INTERVENTION DENTISTRY

1. From 'compulsive' restorative dentistry to rational therapeutic strategies
2. Caries risk assessment in adults
3. Paediatric dental care – prevention and management protocols using caries risk assessment for infants and young children
4. **Detection and diagnosis of initial caries lesions**
5. Atraumatic restorative treatment (ART) – a minimum intervention and minimally invasive approach for the management of dental caries
6. Caries inhibition by resin infiltration
7. Minimally invasive operative caries management – rationale and techniques

This paper is adapted from: Guerrieri A, Gaucher C, Bonte E, Lasfargues J J. Détection et diagnostic des lésions carieuses initiales. *Réalités Cliniques* 2011; **22:** 233–244

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Into the Future: Keeping Healthy Teeth Caries Free: Pediatric CAMBRA Protocols

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Abstract

Early childhood caries (ECC) prevalence has increased significantly in children ages 2–5 years.[1] ECC disproportionately affects lower socioeconomic and minority groups, is a predictor for future decay, but is preventable and manageable[2]. Caries risk assessment systematically derives a patient's caries risk and is important during an infant oral health visit beginning at age one. Information obtained through a risk assessment can guide a disease management care path tailored to an individual's age and risk to effectively treat and manage one's caries disease process.[3]

A recent national health survey from 2007 found California and Texas, the two most-populated states in the U.S., to rank among the lowest in children's oral health.[6] In addition, Hispanic children are the most at risk for poor oral health, since 28.5 % of Hispanic children compared to 19.1 % of white children, have not seen a dentist by the age of 17. Increased awareness of the causes and consequences of ECC could help families, especially those who suffer from disparities in access to care, obtain dental care and institute preventive measures within their family practices.

Many parents and caretakers are unaware of the role they play in bacterial transmission to their child. Caregivers pass organisms and bacteria to infants orally through close contact (vertical transmission).[7] Furthermore, women from vulnerable underserved communities, and some of their providers, fail to recognize the value of good oral health and relevant importance of regular dental visits and care during pregnancy.[8]

It is critical that oral health providers, whether at academic centers, in private practice, or at safety net sites (such as health centers and hospital clinics) embrace risk assessment and disease management in addressing ECC. In its Life Course Model 2010 concept paper, "a conceptual framework that helps explain health and disease patterns particularly health disparities — across populations and over time," the U.S. Department of Health and Human Services Maternal and Child Health Bureau (MCHB) posits, "that interventions that reduce risks and increase protective factors can change the health trajectory of individuals and populations". It further suggested "the need to: refocus resources and strategies for a greater emphasis on early ("upstream") determinants of health; incorporate earlier detection of risks coupled with earlier intervention; and promote protective factors while reducing risk factors at the individual, family and community levels."[5,9]

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Contemporary operative caries management: consensus recommendations on minimally invasive caries removal

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In brief

Suggests that after preventive non-operative control of caries, selective caries removal in the minimally invasive operative management of non-cleansable, cavitated carious lesions should now be the norm.

Highlights that the justification of such minimally invasive operative interventions is to provide a cavity of adequate proportion to support mechanically the final restoration in more superficial lesions; maintaining pulp health becomes the priority in deeper lesions, with more carious tissue being retained selectively over the pulp.

Points out that carious dentine consistency/hardness are still the parameters that should be used clinically to distinguish that tissue requiring removal during minimally invasive operative management.

The International Caries Consensus Collaboration (ICCC) presented recommendations on terminology, on carious tissue removal and on managing cavitated carious lesions. It identified 'dental caries' as the name of the disease that dentists should manage, and the importance of controlling the activity of existing cavitated lesions to preserve hard tissues, maintain pulp sensibility and retain functional teeth in the long term. The ICCC recommended the level of hardness (soft, leathery, firm, and hard dentine) as the criterion for determining the clinical consequences of the disease and defined new strategies for carious tissue removal: 1) *Selective removal of carious tissue* – including *selective removal to soft dentine* and *selective removal to firm dentine*; 2) *stepwise removal* – including *stage 1, selective removal to soft dentine*, and *stage 2, selective removal to firm dentine* 6 to 12 *months later*; and 3) *non-selective removal to hard dentine* – formerly known as complete caries removal (a traditional approach no longer recommended). Adoption of these terms will facilitate improved understanding and communication among researchers, within dental educators and the wider clinical dentistry community. Controlling the disease in cavitated carious lesions should be attempted using methods which are aimed at biofilm removal or control first. Only when cavitated carious dentine lesions are either non-cleansable or can no longer be sealed, are restorative interventions indicated. Carious tissue is removed purely to create conditions for long-lasting restorations. Bacterially contaminated or demineralised tissues close to the pulp do not need to be removed. The evidence and, therefore these recommendations, supports minimally invasive carious lesion management, delaying entry to, and slowing down, the destructive restorative cycle by preserving tooth tissue, maintaining pulp sensibility and retaining the functional tooth-restoration complex long-term.

On behalf of the International Caries Consensus Collaboration.
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Introduction

The prevalence of dental caries has decreased in many countries over the last three decades. Despite this significant achievement dental caries, a preventable disease, still remains the most prevalent worldwide, affecting billions of people and generating significant global healthcare costs.[1,2] Therefore, how the oral healthcare profession manages dental caries has become the central theme in reducing its burden globally. Strategies to achieve this must be evidence based and/or informed. Recommendations are becoming supported by evidence synthesised from clinical studies.[3] However, this is complicated by the use of different terms describing more or less the same management strategies. Researchers and clinicians are not speaking the same professional language. Another complicating factor is the gap between research findings and their implementation into clinical practice. The reasons for this difference are complex but there are a number of likely contributing factors such as inconsistencies in clinical guidelines among professional groups, differences in dental

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Managing Carious Lesions: Consensus Recommendations on Carious Tissue Removal

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Abstract

The International Caries Consensus Collaboration undertook a consensus process and here presents clinical recommendations for carious tissue removal and managing cavitated carious lesions, including restoration, based on texture of demineralized dentine. Dentists should manage the disease dental caries and control activity of existing cavitated lesions to preserve hard tissues and retain teeth long-term. Entering the restorative cycle should be avoided as far as possible. Controlling the disease in cavitated carious lesions should be attempted using methods which are aimed at biofilm removal or control first. Only when cavitated carious lesions either are noncleansable or can no longer be sealed are restorative interventions indicated. When a restoration is indicated, the priorities are as follows: preserving healthy and remineralizable tissue, achieving a restorative seal, maintaining pulpal health, and maximizing restoration success. Carious tissue is removed purely to create conditions for long-lasting restorations. Bacterially contaminated or demineralized tissues close to the pulp do not need to be removed. In deeper lesions in teeth with sensible (vital) pulps, preserving pulpal health should be prioritized, while in shallow or moderately deep lesions, restoration longevity becomes more important. For teeth with shallow or moderately deep cavitated lesions, carious tissue removal is performed according to *selective removal to firm dentine*. In deep cavitated lesions in primary or permanent teeth, *selective removal to soft dentine* should be performed, although in permanent teeth, *stepwise removal* is an option. The evidence and, therefore, these recommendations support less invasive carious lesion management, delaying entry to, and slowing down, the restorative cycle by preserving tooth tissue and retaining teeth long-term.

Keywords: dental caries, stepwise excavation, selective excavation, incomplete excavation, caries sealing, minimally invasive dentistry

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The Role of Fluoride in the Prevention of Tooth Decay

Howard Pollick, BDS, MPH

KEYWORDS

• Dental caries • Dental decay • Oral health • Fluorides • Primary prevention
• Secondary prevention • Children

KEY POINTS

- Fluoride is the key to prevention of tooth decay.
- There are multiple fluoride modalities.
- Effectiveness and safety of fluoride depend on dose and concentration.
- Individual level fluoride use occurs at home and with professional application.
- Community level prevention occurs through fluoridation of water or salt.

INTRODUCTION

Dental Caries (Tooth Decay) in Children

Early childhood caries (ECC) is defined as the presence of one or more decayed (non-cavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth in a child younger than 6 years.[1] For children older than 6 years, there is no special category or definition of dental caries (see separate section/chapter on Dental Caries).

Fluoride is the Key to Prevention of Tooth Decay

Fluoride works to reduce the prevalence and severity of dental caries that requires restorative dental care, in preeruptive, posteruptive, systemic, and topical situations.

There are multiple mechanisms by which fluoride works:[2]

- Through reducing demineralization of enamel in the presence of acids produced by cariogenic bacteria in dental plaque breaking down fermentable carbohydrates,
- Through remineralization of early enamel caries, and
- Through inhibition of bacterial activity in dental plaque.

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Fluoride varnishes for preventing dental caries in children and adolescents (Review)

Marinho VCC, Higgins JPT, Logan S, Sheiham A

This is a reprint of a Cochrane review, prepared and maintained by The Cochrane Collaboration and published in *The Cochrane Library* 2009, Issue 1

http://www.thecochranelibrary.com

Combining casein phosphopeptide-amorphous calcium phosphate with fluoride: synergistic remineralization potential of artificially demineralized enamel or not?

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Abstract. Recaldent is a product of casein phosphopeptide-amorphous calcium phosphate (CPP—ACP). The remineralizing potential of CPP—ACP per se, or when combined with 0.22% Fl gel on artificially demineralized enamel using laser florescence, is investigated. Mesial surfaces of 15 sound human molars are tested using a He–Cd laser beam at 441.5 nm with 18-mW power as an excitation source on a suitable setup based on a Spex 750-M monochromator provided with a photomultiplier tube (PMT) for detection of collected autofluorescence from sound enamel. Mesial surfaces are subjected to demineralization for ten days. The spectra from demineralized enamel are measured. Teeth are divided into three groups according to the remineralizing regimen: group 1 Recaldent per se, group 2 Recaldent combined with fluoride gel and ACP, and group 3 artificial saliva as a positive control. After following these protocols for three weeks, the spectra from the remineralized enamel are measured. The spectra of enamel autofluorescence are recorded and normalized to peak intensity at about 540 nm to compare spectra from sound, demineralized, and remineralized enamel surfaces. A slight red shift occurred in spectra from demineralized enamel, while a blue shift may occur in remineralized enamel. Group 2 shows the highest remineralizing potential. Combining fluoride and ACP with CPP-ACP can give a synergistic effect on enamel remineralization. [DOI: 10.1117/1.3210780]

Keywords: casein phosphopeptide-amorphous calcium phosphate; fluoride; artificial demineralization; remineralization.

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1 Introduction

Caries is a chronic, slowly progressing disease, with symptoms not detected at the onset of the disease but generally much later. Its initiation is associated with demineralization (calcium and phosphate loss) of subsurface tooth enamel, resulting in the formation of a subsurface lesion. It is, therefore, very important to detect caries in its early stage, when the lesion can be reversed clinically by using, for instance, different fluoride supplements.[1,2] Visual inspections, examination with a probe, and radiography have been methods used to detect caries. However, these methods have different diagnostic possibilities, depending on how they are used and who uses them.

Optical methods have always played a main role in the study of biological phenomena. The optical properties of tissues are important and informative, and the spectroscopic aspects are preeminent for lesion localization and determination. Mineral loss could be registered by several optical methods, as scattering off teeth[3,4] or quantitative laser-induced fluorescence (QLF).[5–7] A recent method for caries detection and quantification is laser-induced fluorescence. The fluorescence spectroscopy-based devices for detecting teeth condition are promising diagnostic tools with high reproducibility of results.[8–12] It may be an alternative to the probe or x-ray examination. Promising results have been demonstrated using fluorescence spectroscopy with excitation wavelengths in the violet and blue spectral region. Alfano and Yao[13] were among the first who used fluorescence to differentiate between sound and carious tooth structure using excitation wavelengths between 400 and 700 nm. Additional work by Sundström et al.[14] revealed differences between sound and carious tooth structure using excitation wavelengths of 337 to 633 nm. This led to the establishment of a quantitative relationship between gross scattering of fluorescent light and mineral loss,[15] from which the QLF technique was developed.[8]

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RESEARCH REPORTS
Clinical

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J Dent Res 91(9):847-852, 2012

Effect of CPP-ACP Paste on Dental Caries in Primary Teeth: A Randomized Trial

ABSTRACT

This clinical trial tested the effect of daily application of 10% w/v calcium phosphopeptide-amorphous calcium phosphate (CPP-ACP) paste for 1 yr when added to regular toothbrushing with fluoridated toothpaste to prevent dental caries in pre-school children. High-caries-risk children aged 2½ to 3½ yrs in a suburban area of central Thailand were assigned to receive either CPP-ACP (n = 150) or a placebo control (n = 146) in addition to fluoridated toothpaste. The International Caries Detection and Assessment System (ICDAS) was recorded at baseline, 6 mos, and 1 yr. At 1 yr, a significant increase in mean numbers of enamel and dentin caries lesions, as well as dmfs, was found in both groups ($p < 0.001$). No significant difference was observed between groups on these 3 outcome measures ($p = 0.23$, 0.84, and 0.91, respectively). The odds of enamel caries lesion transitions to a state of regression or stability, compared with progression from baseline, was also not different between groups [OR = 1.00, 95% CI (0.86, 1.17)]. This trial found that daily application of 10% w/v CPP-ACP paste on school days for 1 yr, when added to regular toothbrushing with a fluoride toothpaste, had no significant added effect in preventing caries in the primary dentition of these pre-school children (ClinicalTrials.gov number CT01 604109).

KEY WORDS: caries detection/diagnosis/prevention, child dentistry, clinical studies/trials, enamel, preventive dentistry, remineralization.

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INTRODUCTION

Early childhood caries (ECC) is a major public health problem worldwide, especially in Thailand, where water fluoridation is not available and milk fluoridation is limited. According to the 6th National Oral Health Survey in Thailand 2006, 3-year-old children in the central part of the country have the highest caries prevalence rates, 69.8%, with dmft 3.63 (Thai Ministry of Health, 2007). Effective efforts to prevent caries and non-invasive treatment of initial caries lesions in young children are needed. Fluoride is widely accepted as the most effective tool for caries prevention. Current best practice recommends twice-daily toothbrushing with fluoride toothpaste for dentate children (Zero *et al*., 2012). Higher levels of caries prevention were reported in school or pre-school setting studies with supervised toothbrushing compared with unsupervised brushing at home (Twetman *et al*., 2003).

There is evidence that casein phosphopeptide-amorphous calcium phosphate, CPP-ACP, can bolster the effects of fluoridated toothpaste alone to prevent caries. The localized CPP-ACP nanocomplexes in plaque and on tooth surfaces can buffer the free calcium and phosphate ion activities, maintain a state of supersaturation with respect to tooth enamel, prevent enamel demineralization, and promote remineralization (Cross *et al*., 2007). Several studies have shown a synergistic effect of CPP-ACP and fluoride in reducing caries (Cochrane *et al*., 2008; Reynolds *et al*., 2008). Almost all clinical trials have investigated the effectiveness of CPP-ACP-containing products in caries prevention and enhancing remineralization of initial caries lesions in the permanent dentition of young adolescents (Andersson *et al*., 2007; Morgan *et al*., 2008; Bailey *et al*., 2009; Rao *et al*., 2009; Beerens *et al*., 2010; Brochner *et al*., 2011; Robertson *et al*., 2011). The majority of these studies reported the surrogate outcomes of caries and did not present all available caries data for all tooth surfaces or participants.

The purpose of this study was to determine if adding the daily application of a CPP-ACP-containing paste for 1 yr is superior to regular fluoride toothbrushing in preventing caries in high-caries-risk pre-school children.

MATERIALS & METHODS

The study design was a one-year, double-blind, placebo-controlled clinical trial. The study protocol was approved by the University of Washington and Thammasat University Human Subjects Divisions. The study took place in two provinces in central Thailand, near Bangkok, where water fluoride concentration is less than 0.1 ppm. Ten public nursery schools, with no organized oral health care program, participated. Power calculations indicated that 101 children *per* group would yield a power of 80% to detect a 30% difference in

Effectiveness of MI Paste Plus and PreviDent fluoride varnish for treatment of white spot lesions: A randomized controlled trial

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Introduction: White spot lesions are a common sequela of orthodontic therapy. In this parallel-group randomized trial, we assessed the effectiveness of 2 agents commonly used to ameliorate white spot lesions compared with a normal home-care regimen. **Methods:** Patients aged 12 to 20 years were recruited from the offices of orthodontists and dentists who belonged to the Practice-based Research Collaborative in Evidence-based Dentistry network. The patients had their orthodontic appliances removed within the past 2 months and had at least 1 white spot lesion affecting their maxillary incisors. The subjects were randomized to 1 of 3 arms: (1) an 8-week regimen of MI Paste Plus (GC America, Alsip, Ill), (2) a single application of PreviDent fluoride varnish (Colgate Oral Pharmaceuticals, New York, NY), and (3) usual home care (control). Photographs were taken at enrollment and 8 weeks later. Two panels consisting of 5 dental professionals and 5 laypersons assessed the before-and-after pairs of photographs in a blinded fashion. Objective assessments and self-assessments were also performed. **Results:** One hundred fifteen subjects completed the study; 34 were assigned to the MI Paste Plus group, 40 to the fluoride varnish group, and 41 to the control group. The mean improvements assessed by the professional panel were 21%, 29%, and 27% in the MI Paste Plus, fluoride varnish, and control groups, respectively.The results from the lay panel were 29%, 31%, and 25%, respectively. Objective improvements in the surface affected were 16%, 25%, and 17%, respectively; self-assessments of improvement were 37% in all 3 groups. No assessments indicated significant differences between subjects in the active arms compared with the control arm. **Conclusions:** MI Paste Plus and PreviDent fluoride varnish do not appear to be more effective than normal home care for improving the appearance of white spot lesions over an 8-week period. (Am J Orthod Dentofacial Orthop 2013;143:31-41)

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White spot lesions (WSLs), clinically defined as opaque, white areas caused by the loss of minerals below the outermost enamel layer, can be an unfortunate sequela of orthodontic treatment.[1] Although prevention of these lesions is the goal of every orthodontist, the prevalence of WSLs after orthodontic treatment has been reported to be 5% to 97%.[2,3] Once formed, WSLs compromise esthetics and can be extremely difficult or even impossible to reverse.

Saliva can remineralize WSLs to some degree, but this process is slow and rarely results in complete resolution of the lesions.[4,5] The pattern of remineralization follows a time trend, with greater remineralization during the first few months and then continuing at a slower rate.[6-8] Fluoride has been shown to increase the initial rate of remineralization.[9] High doses of fluoride have been recommended during and after orthodontic treatment for arresting areas of decalcification and preventing WSLs from progressing to carious lesions. This should cause an

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Bioactive Glass Nanoparticles (NovaMin®) for Applications in Dentistry –

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***Abstract*:** *Calcium Sodium Phosphosilicate (NovaMin®) have been used in bone and tissue regeneration for over 15 years. It is effective as an adjunct to conventional surgery in treatment of intrabony defects. It has also been incorporated in dentifrices as a remineralising ingredient for treating dentinal hypersensitivity. Recent studies with NovaMin containing dentifrices and the particulates mixed with water alone have been shown to possess a strong anti-microbial action against periodontal pathogens that could be of significant benefit to the patient in periodontal maintenance therapy. The dentifrice containing Bioactive glass significantly improves gingival health as measured by a reduction in gingival bleeding and reduction in supragingival plaque. Thus, in the present review, an attempt is made to discuss the various benefits of NovaMin in periodontal therapy.*
Keywords: *NovaMin, dentinal hypersensitivity, anti-microbial, bioactive glass, periodontal therapy.*

I. Introduction

NovaMin® is the branded ingredient that is found in a number of professional use and over-the-counter dental products designed to give immediate and long-lasting relief from tooth sensitivity. NovaMin® and the other (Calcium Sodium Phosphosilicate) CSPS materials were originally developed as bone regenerative materials. In the early 1970's, CSPS materials are part of the broader class of bioactive ceramics which included calcium phosphate materials and calcium hydroxyapatite materials that have been developed for hard tissue repair and replacement, by Professor Larry Hench at the University of Florida, mainly due to their chemical similarity to bone mineral. [1] It is instructive to understand the science behind the unique properties and reactivity of the CSPS materials, and how the science that was developed for bone regenerative medicine translated directly to the area of oral health care. Fig 1 shows the bonding interface of CSPS, 45S5 bioactive glass taken from a 3-month implant in a rat tibia.

Recently, anti-microbial properties inherent in NovaMin® have been described. [2-4] One of these compositions has recently been formulated into a dentifrice and has demonstrated strong anti-microbial behaviour in vitro as well as in vivo. While the exact mechanisms of the anti-microbial activity have not yet been fully established, it is likely that the high rate of ionic release and local changes in oral pH seem to play a major role. [5, 6]

This article briefly reviews the various advantages of NovaMin® in the field of dentistry. Specifically, periodontics is the largest field to take advantages of this material. NovaMin® proved to be effective, in reducing dentinal hypersensitivity, as a bone and tissue regenerative material and as an antiplaque and antigingivitis agent. In preparing this review, all English language articles published between 1971 (the first report of bioactive glass) and 2015 were accessed electronically using automated searches. The PubMed database and Google search engine were searched with keywords, including: bioactive glass, clinical application of Novamin and bioactive glasses in dentistry. We reviewed the abstracts of over 150 articles and short-listed 55 articles and scientific proceedings on the basis of their relevance to the review topic. Articles reporting similar findings were excluded. The final articles were printed and studied in detail.

The impact of polyol–containing chewing gums on dental caries

A systematic review of original randomized controlled trials and observational studies

Amol Deshpande, MD, MBA; Alejandro R. Jadad, MD, DPhil, FRCP(C)

ABSTRACT

Background. The authors conducted a systematic review of original studies that was designed to assess the impact of polyol-containing chewing gum on dental caries compared with the effect with no chewing gum.

Review Methods. The authors searched MEDLINE, The Cochrane Library and Google Scholar up to May 2008 to identify peer-reviewed articles that compared polyol-containing chewing gum with no chewing gum. The authors extracted study characteristics, data on incremental dental caries and quality by consensus. Data on prevented fraction (PF) were pooled across studies.

Results. The results of 19 articles with data from 14 study populations showed that the use of xylitol, xylitol-sorbitol blend and sorbitol were associated with mean PF (95 percent confidence interval) of 58.66 percent (35.42-81.90), 52.82 percent (39.64-66.00) and 20.01 percent (12.74-27.27), respectively. For the sorbitol-mannitol blend, it was 10.71 percent (–20.50-41.93), which was not statistically significant. Sensitivity analyses confirmed the robustness of the findings.

Clinical Implications. Although research gaps exist, particularly on optimal dosing and relative polyol efficacy, research evidence supports using polyol-containing chewing gum as part of normal oral hygiene to prevent dental caries.

Key Words. Polyol; xylitol; sorbitol; mannitol; dental caries; chewing gum; systematic review; evidence-based; meta-analysis.
JADA 2008;139(12):1602-1614.

Almost all adults and more than 90 percent of children have experienced caries at some point in their lives.[1] In the United States, dental caries is the most common chronic childhood disease.[2] Recent evidence suggests that specific populations in the United States and Australia could be experiencing an increase in dental caries.[3,4] Standard recommendations for caries prevention from many public health and dental care authorities have been based on the use of fluoride at home and in dental offices, the application of sealants, reduction of sugar intake and regular dental checkups. Although specific preventive programs have been developed to target high-risk groups, a population approach to reduce the overall caries burden could be more beneficial from a public health perspective.[5]

Globally, many strategies have focused on the avoidance, or at least the reduction, of sugar intake to prevent dental caries. Despite these efforts, world consumption of sugar continues to increase, with global demand in 2007 and 2008 increasing to 157 million tons—3.5 million tons more than in 2006 and 2007.[6] Most of this growth is driven by lower prices, as well as rising

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Are We Ready for Definitive Clinical Guidelines on Xylitol/Polyol Use?

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ABSTRACT

In the past decades, numerous studies have looked at the anticaries effects of polyols, particularly xylitol, and a great many studies have focused on xylitol's antimicrobial properties. Researched vehicles have mostly included chewing gums, followed by lozenges/candies, toothpastes, and others (*e.g.*, syrup). Good evidence supports the claims that xylitol is non-cariogenic and has a dose-/frequency-dependent antimicrobial effect on dental plaque/mutans streptococci, and that polyol use is very safe. However, interpretation of caries data has been controversial, due in part to variability in study designs, formulations/dosages tested, and outcomes reported (*e.g.*, many caries studies have a "no gum" control, limiting the interpretation of the polyol's benefit; few studies have compared different polyols side-by-side, or in adults). Even when the level/strength of high-quality anticaries evidence is still limited, most recent systematic reviews have consistently concluded that the habitual use of sucrose-free xylitol or polyol-combination chewing gum/lozenges is an effective adjunct in coronal caries prevention. Consequently, many health organizations worldwide are supporting this recommendation for at-risk populations. However, most experts agree that well-designed, placebo-controlled randomized clinical trials (RCTs) (focusing on efficacy, feasibility, adherence, dosage, vehicle, synergism with other preventive strategies, and cost) are still needed in target populations worldwide to reach definitive caries-preventive/therapeutic recommendations.

Despite the remarkable decline in caries prevalence in many parts of the world, dental caries is still a very common disease affecting people at all different ages, particularly children. The disease is not equally distributed, and is particularly prevalent in minority (racial and ethnic) and low socio-economic groups (Dye *et al.,* 2007). Targeting health-care delivery to caries risk groups has become paramount in the current environment of increasing healthcare costs and resource constraints. Although the strongest level of evidence currently available to prevent and manage dental caries is for fluoride and dental sealants (Zero *et al*., 2009; Rethman *et al*., 2011), numerous non-fluoride strategies are available to help prevent dental caries, including the use of polyols. In the past decades, numerous studies have investigated the caries-preventive effects and antimicrobial properties of polyols, particularly xylitol. The objective of this paper is to provide an analysis of reviews of the evidence for the role of polyols, particularly xylitol, in caries prevention within the past decade to help answer the question: "Are we ready for definite guidelines for polyol/xylitol use?" If "definite" means having distinct limits, free of all ambiguity, then we contend that the answer to the question depends on to whom "we" refers (*e.g.*, clinician *vs*. researcher). Clinicians will likely be ready for definite guidelines the moment a product is available on the market, to enable them to decide whether, and how, to add to their caries management armamentarium. The researcher will develop guidelines only after a careful analysis of the body of evidence and, as long as questions remain, is unlikely to consider them "definite".

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EXAMPLES OF GUIDELINES AND POSITIONS REGARDING XYLITOL OR POLYOL USE IN CARIES PREVENTION

Dental and other health organizations have started to develop guidelines or take positions on the use of polyols in dental caries prevention. Examples of these guidelines, recommendations, or positions are provided in Table 1. Clinical recommendations and guidelines are typically based on the systematic analysis of the quality (*e.g.*, systematic review, randomized clinical trial, controlled clinical trial, non-randomized trial), quantity, and consistency of the research available on a topic (Agency for Healthcare Research and Quality, 2002). Existing clinical recommendations or guidelines generally emphasize effectiveness, providing information that can be applicable to the average patient. However, numerous processes are used to develop recommendations, according to the need of the specific organization (Newman *et al.,* 2007), and thus conclusions may vary depending on how evidence is assessed, the purpose of the recommendation, and

Key Words

xylitol, polyol, clinical studies, guidelines, caries, clinical outcomes.

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Resin infiltration of proximal caries lesions differing in ICDAS codes

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Paris S, Bitter K, Naumann M, Dörfer CE, Meyer-Lueckel H. Resin infiltration of proximal caries lesions differing in ICDAS codes.
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Resin infiltration of non-cavitated proximal caries lesions has been shown to inhibit further demineralization. However, the effect of resin infiltration in cavitated lesions is unknown. Therefore, the aim of this in vitro study was to evaluate infiltration patterns of proximal caries lesions differing in International Caries Detection and Assessment System (ICDAS) codes. Extracted human molars and premolars showing proximal caries lesions with and without cavitations (ICDAS codes 2–5) were etched with 15% hydrochloric acid gel and resin infiltrated according to the manufacturer's instructions. Three sections from each lesion were prepared and analyzed using a dual-fluorescence staining technique and confocal microscopy. The dimensions of the demineralized and cavitated lesions areas, as well as the resin-infiltrated parts within these lesions, were measured. The demineralized parts were infiltrated from 73% to 100% (median values) but the cavities were filled only negligibly (0–5%). Teeth that had an ICDAS code of 5 showed a significantly lower percentage infiltration/filling of lesions compared to teeth with ICDAS codes of 2 and 3. It was concluded that under in vitro conditions the tested infiltrant penetrates most parts of the demineralized enamel but is not capable of filling up cavities and therefore the efficacy of caries infiltration, particularly in lesions with larger cavitations, might be impaired.

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Key words: caries; cavitation; infiltration; International Caries Detection and Assessment System; micro-invasive treatment

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Superficial and medium-sized proximal caries lesions are frequently observed in adolescents and young adults (1). As a result of the impaired access to such lesions, they are difficult to detect and to treat. Often the destruction of large amounts of sound enamel and dentin is necessary to 'treat' the diseased hard tissues. As a result, it is desirable to postpone the first operative intervention for as long as possible and to arrest lesion progression by non-operative measures only. However, once a cavitation is present, non-operative measures are often ineffective because patients are unable to clean the cavity of dental plaque, the driving force of the caries process, by flossing (2). Therefore, the presence of a cavity is often regarded as a threshold to implement an operative intervention to treat the proximal lesion (3). As radiographs give no direct information about possible cavitations, several studies have aimed to correlate the radiographic lesion depth with the probability of a surface breakdown (4–6). Early lesions extending up to the outer half of enamel (E1) are rarely cavitated, whereas lesions extending into the middle (D2) or inner third (D3) of dentin are probably cavitated. Uncertainty often exists for radiolucencies into inner enamel (E2) or the outer third of dentin (D1): 8–11% and 22–44% of such caries lesions, respectively, were cavitated, as assessed clinically (4–6). In particular for these stages the decision between non-operative and restorative measures is difficult because of the risk of either under-treatment or over-treatment.

Caries infiltration is a microinvasive treatment option for these intermediate stages of caries lesions in which the porosities of enamel lesions are occluded by infiltration with low-viscosity light-curing resins. After the pioneering work of Davila *et al.* (7) and Robinson *et al.* (8), several studies investigated the infiltration of artificial caries lesions (9–14). In order to enable the infiltration of natural lesions, the technique was modified (15) and special resins (so-called infiltrants), optimized for rapid penetration of the lesion body, were developed (16, 17). The caries-infiltration technique comprises erosion of the pseudo intact and relatively impermeable surface layer with hydrochloric acid gel (15), desiccation of the lesion with ethanol, and subsequent application of an infiltrant. In contrast to caries sealing, for caries infiltration any excessive resin on the lesion surface is removed before the material is light cured. Consequently, the caries-inhibiting effect is primarily achieved by occlusion of the pores within the lesion body, which results in the slowing down of diffusion processes (18). Clinical trials have shown that for non-cavitated proximal caries lesions being extended radiographically at maximum to the outer third of dentin, caries infiltration,

Minimal intervention dentistry: part 6. Caries inhibition by resin infiltration

J. J. Lasfargues,*[1,2] E. Bonte,[1,2] A. Guerrieri[1,2] and L. Fezzani[1,2]

IN BRIEF

- Suggests the inhibition of caries progression by resin infiltration should now be considered an alternative to invasive restorations.
- Describes the principle and protocol of resin infiltration of carious lesions.

PRACTICE

Resin infiltration has made possible an innovative way of treating initial carious lesions that fits perfectly with the concept of minimal intervention dentistry. Infiltration of carious lesions represents a new approach to the treatment of non-cavitated lesions of proximal and smooth surfaces of deciduous and permanent teeth. The major advantage of this method is that it is a non-invasive treatment, preserving tooth structure and that it can be achieved in a single visit. While this therapy can rightly be categorised as minimum intervention dentistry, clinical experience is limited and further controlled clinical trials are required to assess its long-term results. The inhibition of caries progression by resin infiltration should now be considered an alternative to invasive restorations, but involves early detection of lesions and does not allow for appropriate monitoring of the caries risk.

INTRODUCTION

In recent decades, the management of carious lesions has shifted the paradigm of drilling and filling into the paradigm of prevention, control and minimally invasive restoration.[1] In this context a new technique to stop the progression of initial caries without the use of drilling has been proposed: the inhibition of caries by resin infiltration, that is, stopping the active carious process at its site without any invasive procedure.[2]

Remineralisation of enamel demineralised by acids from the cariogenic biofilm can be achieved principally through the application of topical fluorides and remineralising agents[3,4] by the use of fissure sealants or by repair of the lesion using bioactive materials.[5] In all cases the goal is to stop lesion progression. Remineralisation by topical application of fluoride requires multiple treatment sessions and strict long-term follow-up, which implies strong cooperation from the patient and is often difficult to obtain. In addition, monitoring systems for assessing the status of the lesions over time are still being studied and are difficult to apply in every-day clinical practice.[6] Sealing techniques using resin or glass-ionomer cements are primarily intended for initial carious lesions in the pits and fissures on occlusal surfaces of erupting posterior teeth. They have been proven to prevent tooth decay[7] but their effectiveness in the sealing of carious lesions in site 1 (occlusal surfaces) to prevent the need for a restoration of stages 0 and 1 (SiSta classification)[8] remains controversial. Thus, hitherto there has been a lack of effective procedures for stopping initial lesions in one session. This applies particularly to proximal carious lesions and the buccal and lingual smooth surfaces.

Resin infiltration of carious lesions represents an approach to the treatment of non-cavitated lesions on proximal and smooth surfaces of primary and permanent teeth. The principal feature of this technique is that it is non-invasive, preserves tooth structure and can be completed in a single visit. The concept was first developed in Germany, at the Charité University Hospital in Berlin, from *in vitro* studies on the penetration of resin into caries[9-11] and marketed under the brand name of Icon® (DMG America Company, Englewood, NJ).

PRINCIPLE OF RESIN INFILTRATION OF CARIOUS LESIONS

The principle of resin infiltration is to perfuse porous enamel with resin by capillary action, thereby stopping the process of demineralisation and stabilising the carious lesion. The principle can be compared with the saturation of a sugar cube or sponge with a liquid (Fig. 1). The infiltration takes place within the enamel, in contrast to pit and fissure sealants, which forms a superficial mechanical barrier on the outer surface of the initial lesion, depriving the bacteria that colonise the surface of the lesion of

MINIMAL INTERVENTION DENTISTRY

1. From 'compulsive' restorative dentistry to rational therapeutic strategies
2. Caries risk assessment in adults
3. Paediatric dental care – prevention and management protocols using caries risk assessment for infants and young children
4. Detection and diagnosis of initial caries lesions
5. Atraumatic restorative treatment (ART) – a minimum intervention and minimally invasive approach for the management of dental caries
6. **Caries inhibition by resin infiltration**
7. Minimally invasive operative caries management – rationale and techniques

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Evidence-Based Dentistry Update on Silver Diamine Fluoride

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Keywords

Silver diamine fluoride; Dental caries; Caries arrest; Caries management; Pediatric dentistry

INTRODUCTION

The global burden of oral disease and the negative social and economic effect associated with it, are a growing problem worldwide.[1]

The widespread use of water fluoridation and fluoride-containing oral products produced significant decreases in the prevalence and severity of dental caries over the last 70 years.[2,3] However, the benefits of these prevention interventions have not materialized in all segments of society in most countries. Free sugars and processed carbohydrates as a component of diet have increased in many countries, both developed and developing alike. As Thompson and colleagues[4] have shown, lower income groups are particularly vulnerable to high dietary sugar intake. The result has been a disparity in caries experience across socioeconomic groups. In the United States and other high-income countries, untreated dental decay in children is strongly patterned by income and ethnicity, mainly owing to cost and limited availability and/ or access to services.[5] In lower income groups, much of the caries goes untreated, resulting in severe disease levels that leads to pain, expense, and a decreased quality of life for the affected children and their families.[6]

Even when dental services are accessible, traditional restorative treatment can be difficult to deliver to young children with severe disease and those with special management considerations.[7] To address this difficulty, advanced forms of behavior management like sedation and/or general anesthesia are often used, which increase the cost and the risk for the patient and the dentist.[8] Elderly patients often face similar challenges, because increasing rates of untreated decay can severely affect their quality of life, and the difficulties of receiving dental care are accentuated by limitations with mobility and other comorbidities.[9]

When it comes to prevention, epidemiologic studies indicate that when the bacterial challenge is high or the salivary components are lacking, natural remineralization or that

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The use of silver diamine fluoride (SDF) in dental practice

Nassar Seifo,[1] Mark Robertson,[1] Jeanette MacLean,[2] Katharine Blain,[3] Sarah Grosse,[3] Roderick Milne,[1] Clement Seeballuck[1] and Nicola Innes*[1]

Key points

- Explains why, how and when clinicians should use SDF.
- SDF is currently not licenced for caries arrest. This article explains what this means for clinicians and how they should approach this issue
- Explains the side-effects and potential adverse events associated with SDF use and how to manage these

Abstract

Silver diamine fluoride (SDF) is a clear, odourless liquid indicated for desensitisation of non-carious tooth lesions and molar incisor hypomineralisation. It is also useful for arresting carious lesions in adults and children who are high caries-risk and/or have difficult-to-control, progressing carious lesions, those who are unable to tolerate invasive treatment, elderly populations, and those who are medically compromised or have additional care and support needs. SDF may be used to manage lesions that are too extensive to restore but not associated with pain and/or infection. This can be important particularly where extractions might be contra-indicated for medical or behavioural reasons. This paper summarises the global evidence for the effectiveness and safety of SDF, describes what it is, its mechanisms of action and presents recommendations on how to use it. There are details on indications/contra-indications and risks/benefits to be considered in the use of SDF also discussion of how to approach SDF's side effect of black staining of carious tooth tissue. We give an example of an information sheet (Appendix S1, see online supplementary information) that may be used when discussing SDF with patients, particularly for primary teeth in children, but adaptable for the permanent dentition and for adults.

Introduction

Dental caries and silver diamine fluoride (SDF) – a brief introduction

In 1900, GV Black observed that 'Caries of the teeth is the most prevalent disease to which man is liable. There is no other disease which afflicts so large a proportion of the human family.'[1] Over one hundred years later, it may seem that not much has changed, with untreated dental caries in permanent teeth being the most prevalent condition of humankind, affecting 2.5 billion people worldwide.[2] Cariology research has improved understanding of the pathological process involved in the initiation and progression of the disease, and of the efficacy and effectiveness of strategies to manage caries and its consequences. This includes supporting the use of cariostatic agents to stop the progress of the disease as part of treatment, rather than limiting the focus of treatment to restorative options alone.[3] Minimal intervention dentistry (MID)[4] as a concept within oral healthcare was once considered a peripheral and unconventional topic but has now moved to centre-stage of oral health care. MID embodies a patient-centred approach to care, is evidence-based and supports development of novel treatment options. One of these is silver diamine fluoride (SDF) as a cariostatic agent. SDF was first recorded as being used in Japan in 1969 but has recently had a renaissance.[5]

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What is silver diamine fluoride (SDF)?

SDF is a colourless, odourless solution of silver, fluoride and ammonium ions, the ammonia acting as a stabilising agent for the solution. It looks just like water, although one product, Advantage Arrest (Elevate Oral Care, Florida), not available in the UK, is tinted blue. SDF (38%) contains a high concentration of fluoride ions; 44,800 ppm. When placed on carious tooth tissue, a series of chemical reactions take place that promote tooth desensitisation by dentinal tubule blockage and carious lesion arrest by dentinal tubule blockage, bacterial death, remineralisation of demineralised tooth and inhibition of dentinal collagen degradation (Fig. 1). These chemical reactions have the side effect of staining carious lesions (enamel and dentinal) permanently black (Fig. 2) but sound enamel does not stain.[6] It is therefore also useful as a caries detection agent.

Japan was the first country to approve SDF for use as a therapeutic agent in the 1960s. From 1969 onwards, it has been used to arrest carious lesions in children's primary teeth[7,8] and to prevent and arrest root caries in elderly people.[9] SDF has also been shown to reduce dentine hypersensitivity.[10]

SDF was cleared by the Food and Drug Administration (FDA) in the United States in 2014 to treat dentine hypersensitivity entering the US market as Advantage Arrest

REVIEW

Clinical Trials of Silver Diamine Fluoride in Arresting Caries among Children: A Systematic Review

S.S. Gao[1], I.S. Zhao[1], N. Hiraishi[2], D. Duangthip[1], M.L. Mei[1], E.C.M. Lo[1], and C.H. Chu[1]

Abstract: *This review aims to investigate the clinical effectiveness of silver diamine fluoride (SDF) in arresting dental caries among children. A systematic search of publications was conducted with the key words "silver diamine fluoride," "silver diammine fluoride," "silver fluoride," "diamine silver fluoride," or "diammine silver fluoride" as well as their translation in Chinese, Japanese, Portuguese, and Spanish in 7 databases: PubMed (English), Embase (English), Scopus (English), China National Knowledge Infrastructure (Chinese), Ichushi-web (Japanese), Biblioteca Virtual em Saude (Portuguese), and Biblioteca Virtual en Salud Espana (Spanish). Duplicated publications were deleted. The title and abstract were screened and irrelevant publications were excluded. The full text of the remaining publications was retrieved. Prospective clinical studies of SDF that reported a caries-arresting effect among children were included. Meta-analysis was performed for quantitative analysis. A total of 1,123 publications were found, including 19 publications of clinical trials. Sixteen clinical trials studied the caries-arresting effect on primary teeth, and 3 clinical trials were on permanent teeth. Fourteen studies used 38% SDF, 3 used 30% SDF, and 2 used 10% SDF. Meta-analysis was performed on extracted data from 8 studies using 38% SDF to arrest caries in primary teeth. The overall percentage of active caries that became arrested was 81% (95% confidence interval, 68% to 89%; P < 0.001). Apart from staining the arrested lesion black, no significant complication of SDF use among children was reported. SDF was commonly used at 38%. It was effective in arresting dentine caries in primary teeth among children.*

Knowledge Transfer Statement: *This systematic review found that 38% silver diamine fluoride (SDF) can effectively arrest caries among children. SDF treatment is noninvasive and easily operated. It can be a promising strategy to manage dental caries in young children or those who have special needs.*

Keywords: meta-analysis, pediatric dentistry, tooth remineralization, dental caries, fluorides, silver compounds

Introduction

Although people's dental knowledge has generally improved and dental treatment techniques have advanced in the past few decades, early childhood caries (ECC) still remains a global health problem. ECC is the presence of 1 or more decayed, missing due to caries, or filled tooth surfaces (dmfs) in any primary tooth in a child at 71 mo of age or younger (American Academy of Pediatric Dentistry 2008). While dietary sugars and poor oral hygiene are important factors causing

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Evidence-based clinical practice guideline for the use of pit-and-fissure sealants

A report of the American Dental Association and the American Academy of Pediatric Dentistry

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ABSTRACT

Background. This article presents evidence-based clinical recommendations for the use of pit-and-fissure sealants on the occlusal surfaces of primary and permanent molars in children and adolescents. A guideline panel convened by the American Dental Association (ADA) Council on Scientific Affairs and the American Academy of Pediatric Dentistry conducted a systematic review and formulated recommendations to address clinical questions in relation to the efficacy, retention, and potential side effects of sealants to prevent dental caries; their efficacy compared with fluoride varnishes; and a head-to-head comparison of the different types of sealant material used to prevent caries on pits and fissures of occlusal surfaces.

Types of Studies Reviewed. This is an update of the ADA 2008 recommendations on the use of pit-and-fissure sealants on the occlusal surfaces of primary and permanent molars. The authors conducted a systematic search in MEDLINE, Embase, Cochrane Central Register of Controlled Trials, and other sources to identify randomized controlled trials reporting on the effect of sealants (available on the US market) when applied to the occlusal surfaces of primary and permanent molars. The authors used the Grading of Recommendations Assessment, Development, and Evaluation approach to assess the quality of the evidence and to move from the evidence to the decisions.

Results. The guideline panel formulated 3 main recommendations. They concluded that sealants are effective in preventing and arresting pit-and-fissure occlusal carious lesions of primary and permanent molars in children and adolescents compared with the nonuse of sealants or use of fluoride varnishes. They also concluded that sealants could minimize the progression of noncavitated occlusal carious lesions (also referred to as initial lesions) that receive a sealant. Finally, based on the available limited evidence, the panel was unable to provide specific recommendations on the relative merits of 1 type of sealant material over the others.

Conclusions and Practical Implications. These recommendations are designed to inform practitioners during the clinical decision-making process in relation to the prevention of occlusal carious lesions in children and adolescents. Clinicians are encouraged to discuss the information in this guideline with patients or the parents of patients. The authors recommend that clinicians reorient their efforts toward increasing the use of sealants on the occlusal surfaces of primary and permanent molars in children and adolescents.

Key Words. Pit-and-fissure sealants; clinical recommendations; guideline; occlusal caries; caries prevention; caries arresting.

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Pit-and-fissure sealants have been used for nearly 5 decades to prevent and control carious lesions on primary and permanent teeth. Sealants are still underused despite their documented efficacy and the availability of clinical practice guidelines.[1,2] New sealant materials and techniques continue

Supplemental material is available online.

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BMC Research Notes

CORRESPONDENCE Open Access

Caries-preventive effect of glass ionomer and resin-based fissure sealants on permanent teeth: An update of systematic review evidence

Steffen Mickenautsch*, Veerasamy Yengopal

Abstract

Background: This article constitutes a partial update of the original systematic review evidence by Yengopal et al. from 15 January 2008 (published in the Journal of Oral Science in 2009) with primary focus on research quality in regard to bias risk in trials. Its aim is to update the existing systematic review evidence from the English literature as to whether caries occurrence on pits and fissures of teeth sealed with either GIC or resin is the same.

Methods: In addition to the 12 trials included during the original systematic review, 5 new trials were identified during the database search (up to 26 August 2010) and 2 further trials were included from a hand search and reference check. Of these, 3 trials were excluded and 16 were accepted for data extraction and quality assessment. The quality of accepted trials was assessed, using updated quality criteria, and the risk of bias was investigated in more depth than previously reported. In addition, the focus of quantitative synthesis was shifted to single datasets that were extracted from the accepted trials.

Results: Twenty-six dichotomous and 4 continuous datasets were extracted. Meta-analysis and cumulative meta-analysis were used in combining clinically homogenous datasets. The overall outcome of the computed datasets suggest no difference between the caries-preventive effects of GIC- and resin-based fissure sealants.

Conclusions: This overall outcome is in agreement with the conclusions of the original systematic review. Although the findings of the trials identified in this update may be considered to be less affected by attrition- and publication bias, their risk of selection- and detection-/performance bias is high. Thus, verification of the currently available results requires further high quality randomised control trials.

Introduction

Pits and fissures of posterior teeth are considered to be highly susceptible to the adhesion of micro-organisms and consequently, to caries. Therefore, a significant amount of tooth decay occurs at these sites. Fissure sealants are used to prevent occlusal caries, 71% percent of occlusal decay being preventable after a once-off fissure sealant application [1]. Evidence regarding the efficacy and cost-effectiveness of sealants in reducing occlusal caries in molars has been highlighted [1-5]. The most commonly used sealant material is resin composite [6-8]. Its caries-preventive effect relies on the sealing of pits and fissures through micro-retention, created through tags after enamel acid etching. However, these are easily destroyed by saliva contamination, which reduces micro-retention and, consequently, the caries-preventive effect [9]. Under the generally wet conditions in the oral cavity, Glass Ionomer Cement (GIC) offers an alternative. Owing to its hydrophilic properties, GIC is not as moisture-sensitive as hydrophobic resin [10].

In a previous systematic review Yengopal et al. [11] conducted a meta-analysis in order to quantitatively appraise, for the first time, the evidence regarding the caries-preventive effect of GIC in comparison to that of resin-based fissure sealants. This systematic review with meta-analysis found no evidence that either material was superior to the other in the prevention of dental caries. Therefore, both appeared to be equally suitable for clinical application as fissure sealant materials. These

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Dental fillings for the treatment of caries in the primary dentition (Review)

Yengopal V, Harnekar SY, Patel N, Siegfried N

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This is a reprint of a Cochrane review, prepared and maintained by The Cochrane Collaboration and published in *The Cochrane Library* 2009, Issue 3

http://www.thecochranelibrary.com

EAPD guidelines for the use of pit and fissure sealants

R. WELBURY*, M. RAADAL**, N.A. LYGIDAKIS

Definition
"A fissure sealant is a material that is placed in the pits and fissures of teeth in order to prevent or arrest the development of dental caries".

Introduction

Tooth surfaces with pits and fissures are particularly vulnerable to caries development [Manton and Messer, 1995]. Ripa [1973] observed that although the occlusal surfaces represented only 12.5% of the total surfaces of the permanent dentition, they accounted for almost 50% of the caries in school children. This can be explained by the morphological complexity of these surfaces, which favours plaque accumulation to the extent that the enamel does not receive the same level of caries protection from fluoride (F) as does smooth surface enamel [Ripa, 1973; Bohannan, 1983; Ripa, 1990]. The plaque accumulation and caries susceptibility are greatest during the eruption of the molars [Carvalho et al., 1989], and caries susceptible individuals are therefore vulnerable to early initiation and fast progression of caries in these sites. Brown et al. [1996] and Kaste et al. [1996] showed that in fluoridated communities over 90% of dental caries is exclusively pit and fissure caries.

Types of pit and fissure sealants

Resins. Resin based fissure sealants (FS) are bonded to the underlying enamel by the use of the acid etch technique. Their caries preventive property is based on the establishment of a tight seal, which prevents leakage of nutrients to the microflora in the deeper parts of the fissure. The resin sealants may be either pure resin, composites or compomers, and their polymerisation may be initiated chemically or by light.

Several studies reported the effectiveness of second generation chemical initiated FSs. Wendt and Koch [1988] reported, under optimal dental office conditions, 80% complete retention after 8 years and combined partial and 94% complete retention after 10 years. Romcke et al. [1990], in a Canadian study after 10 years reported 41% complete retention and 8% partial retention. Eighty-five per cent of the sealed teeth were caries free after 8-10 years. Simonsen [1987] reported 57% complete retention 10 years after a single FS application and 28% after 15 years [Simonsen, 1991]. After 15 years 74% of surfaces that had been sealed were caries free. Chestnutt et al. [1994] reported on more than 7,000 FSs after 4 years where 57% of the sealed tooth surfaces remained fully sealed, with 18% scored as deficient or failed and 24% completely missing. Of the surfaces originally scored as deficient at baseline 23% were scored as carious compared with 21% of surfaces not sealed. Only 14.4% of the sound/sealed surfaces at baseline became carious. Wendt et al. [2001a] reported 95% complete or partial retention without caries in second permanent molars after 15 years and 87% complete or partial retention without caries in first permanent molars after 20 years. In a different study the same authors [Wendt et al., 2001b] reported that 74% of first permanent molars that had been sealed were caries free after 15 years.

Ripa [1993] reviewed numerous studies that have been carried out comparing the retention rates between third and first and/or second generation FS. The results indicated that the performance levels for chemical initiated FS and visible light photoinitiated FS were similar within an observation period of up to 5 years. However, in three comparison studies of longer

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Minimally invasive direct restorations: a practical guide

L. Mackenzie*[1] and A. Banerjee[2]

In brief

Understand the concepts of minimally invasive dentistry.	Understand the materials, equipment and clinical techniques available for MI direct restorative procedures.	Enhance patient care by optimising all clinical stages of MI direct restorations.

The primary objectives of minimum intervention dentistry (MID) are to prevent or arrest active disease using non-operative management techniques. However, patients commonly present with cavitated caries lesions or failed restorations that are in need of operative intervention. Although much of clinical practice is devoted to preventing and managing the effects of caries and subsequent failure of the tooth-restoration complex, the clinical survival of restorations is often poor and becomes significantly worse as they increase in size and complexity. Minimally invasive (MI) restorative techniques present a range of well-documented advantages over more tissue-destructive traditional restorations by minimising unnecessary tooth tissue loss, insult to the dentine-pulp complex and reducing the risk of iatrogenic damage to adjacent hard and soft tissues. They also maximise the strength of the residual tooth structure by use of optimal adhesive restorative materials designed to restore function and aesthetics with durable, long-lasting restorations that are easy for the patient to maintain. In contemporary oral healthcare practice, if patients are to give valid consent for operative interventions, minimally invasive options must be offered, and may be expected to be the first choice of fully informed patients. This paper describes concepts of MID and provides an update of the latest materials, equipment and clinical techniques that are available for the minimally invasive restoration of anterior and posterior teeth with direct restorations.

Introduction

The concept of minimum intervention dentistry (MID) embraces all aspects of clinical practice and its primary focus is the prevention and control of oral disease.[1,2] In clinical situations where prevention has failed and treatment of uncontrollable disease is indicated, procedures should be chosen which respect the patient's natural tissues.[3] This is referred to as minimally invasive dentistry. It may be applied to the management of all oral diseases including the minimally invasive (MI) management of caries and has been termed 'ultraconservative dentistry', 'microdentistry' as well as the protocol-specific atraumatic restorative treatment (ART).[3-6]

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Dental restorations are only indicated when lesions have advanced to obvious cavitation and where remineralisation techniques have reached their limits.[1] Contemporary management of these lesions should use the least invasive solutions and preserve the maximum amount of sound tissue.[1] All clinical stages of restorative procedures should be optimised, with prevention of disease recurrence as the ultimate goal.[3] In addition to the minimally invasive management of primary caries, MI principles are equally applicable to the management of the restored dentition and should conform to the following well-established objectives:[7]

- Restore significant loss of dental tissue
- Eliminate plaque retention/stagnation
- Restore physiological masticatory function
- Minimise the risk of recurrent disease
- Restore aesthetics where appropriate.

MI procedures have evolved significantly over the last three decades, particularly with innovative developments in adhesive dentistry and the use of resin composite restorative materials.[8,9] This continual ongoing progress has promoted a more biologically-focused approach to patient care delivery and resulted in significant advances in the fundamental principles of contemporary restorative dentistry[1,3,9] (Box 1).

Challenges in restorative dentistry

There is no such thing as permanent restoration of teeth.[3] Unequivocal evidence exists to show that dental restorations fail clinically and that the most commonly reported modes of failure are caries associated with restorations and sealants (CARS – formerly termed secondary/recurrent caries) and tooth-restoration complex

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In vitro Evaluation of Five Alternative Methods of Carious Dentine Excavation

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Key Words
Air-abrasion · Bur · Carisolv™ · Confocal microscopy · Dentine caries · Excavation · Fluorescence · Sono-abrasion

Abstract
This in vitro, split-tooth study aimed to evaluate the efficiency (time taken) and effectiveness (quantity of dentine removed) of four techniques of carious dentine excavation (bur, air-abrasion, sono-abrasion and Carisolv™ gel) compared to conventional hand excavation. Eighty freshly extracted human molars were assigned to four experimental groups (n = 20), sectioned longitudinally through occlusal lesions and pre-excavation colour photomicrographs obtained. Using the natural autofluorescence of carious dentine (detected using confocal laser scanning microscopy) as an objective and reproducible guide, carious dentine removal was assessed in each half of the split tooth sample, comparing hand excavation to the test method. The time taken to reach a cavity floor that was hard to a dental probe was noted and final colour photomicrographs were taken. From the results, it was concluded that bur excavation was quickest but overprepared cavities relative to the autofluorescent signature, whereas Carisolv excavation was slowest but removed adequate quantities of tissue. Sono-abrasion tended to underprepare whereas air-abrasion was more comparable to hand excavation in both the time and amounts of dentine removed. Conventional hand excavation appeared to offer the best combination of efficiency and effectiveness for carious dentine excavation within the parameters used in this study.

When operative treatment is indicated in deep dentinal lesions, quantities of softened carious tissue are removed with the ultimate aims of eliminating the highly infected biomass of tissue to prevent further lesion progression and leaving a cavity which can be suitably restored for strength and function [Elderton, 1984; Kidd et al., 1993; Frencken et al., 1994; Bjørndal et al., 1997; Mertz-Fairhurst et al., 1998; Weerheijm et al., 1999]. Currently, the physical criterion used most commonly by dental practitioners to guide clinical excavation of this infected, demineralised dentine is the hardness/texture of the tissue, although some dentists may take into account its colour and may use caries detector dyes [van de Rijke, 1991; Kidd et al., 1993, 1996]. All of these criteria suffer from the subjectivity inherent between dentists in clinical practice, which is likely to result in variations in the quality and quantity of dentine removed during operative intervention. These variations may have clinical implications including differences in the size of the cavities produced, the pulpal health beneath prepared cavities and the strength of the remaining tooth structure. It seems sensible, therefore, to develop an objective marker for excavatable carious dentine. This objectivity is also needed in the research laboratory as well as the clinic. These are interest-

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Minimal intervention dentistry: part 5. Atraumatic restorative treatment (ART) – a minimum intervention and minimally invasive approach for the management of dental caries

IN BRIEF

- Describes the clinical aspects of the atraumatic restorative treatment (ART) approach.
- Stresses the importance of following the treatment protocol to ensure reliable results and reviews the evidence base supporting its use.
- Suggests ART should be considered as a therapeutic option especially in children, anxious patients and those with special needs.

PRACTICE

C. J. Holmgren,[1] D. Roux[2] and S. Doméjean[3]

VERIFIABLE CPD PAPER

While originally developed in response to a need to provide effective restorative and preventive treatment in underserved communities where running water and electricity might not always be available, over the past two decades, the atraumatic restorative treatment (ART) approach has become a worldwide phenomenon; used not only in some of the poorest developing countries but also in some of the most wealthy. The ART approach involves the removal of infected dentine with hand-instruments followed by the placement of a restoration where the adjacent pits and fissures are sealed simultaneously using high viscosity glass-ionomer inserted under finger pressure. Reliable results can only be obtained if the treatment protocol, as described in this article, is closely followed. ART should be considered as a therapeutic option especially in children, anxious patients and those with special needs.

MINIMAL INTERVENTION DENTISTRY

1. From 'compulsive' restorative dentistry to rational therapeutic strategies
2. Caries risk assessment in adults
3. Paediatric dental care – prevention and management protocols using caries risk assessment for infants and young children
4. Detection and diagnosis of initial caries lesions
5. **Atraumatic restorative treatment (ART) – a minimum intervention and minimally invasive approach for the management of dental caries**
6. Caries inhibition by resin infiltration
7. Minimally invasive operative caries management – rationale and techniques

This paper is adapted from: Holmgren CJ, Roux D, Doméjean S. Traitement restaurateur atraumatique (ART). Une approche a minima de la prise en charge des lésions carieuses. *Réalités Cliniques* 2011; **22**: 245–256.

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INTRODUCTION

Atraumatic restorative treatment (ART) was developed in the 1980s but embodies all the principles of an alternative philosophy of dental care that was ultimately to become known as minimal (or minimum) intervention dentistry.[1,2] Minimal intervention management of caries attaches importance to the diagnosis and evaluation of caries risk and includes prevention, stabilisation and healing (remineralisation) of early lesions and minimally invasive restorative treatment for cavitated dentine lesions with selective excavation of destroyed tissue combined with maximal preservation of healthy tissues. While developed originally in response to a need to provide effective restorative and preventive treatment in underserved communities, over the past two decades the ART approach has become a worldwide phenomenon. ART can be considered to be a cornerstone of minimal intervention caries management in combining prevention and minimal invasion.

The objectives of this paper are to:

1. Describe the philosophy of the ART approach within the overall concept of minimal intervention and minimal invasion for the management of dental caries
2. Describe the clinical aspects of ART
3. Review the evidence base for supporting the use of ART
4. Describe the indications for ART.

WHAT ARE ART SEALANTS AND RESTORATIONS?

Over the past 20 years some confusion has arisen as to what constitutes the atraumatic restorative treatment (ART) approach since a number of authors use the term to describe procedures that are not considered to be ART. To avoid confusion a recent definition by Frencken and van Amerongen should be adopted as follows: 'ART is a minimally invasive approach to both prevent dental caries and to stop its further progression. It consists of two components: sealing caries prone pits and fissures and restoring cavitated dentin lesions with sealant-restorations. The placement of an ART sealant involves the application of a high-viscosity glass-ionomer that is pushed into the pits and fissures under finger pressure. An ART restoration involves the removal of soft, completely demineralised carious tooth tissue with hand instruments. This is followed by restoration of the cavity with an adhesive dental material that simultaneously seals any remaining pits and fissures that remain at risk'.[3]

Atraumatic restorative treatment and minimal intervention dentistry

J. E. Frencken[1]

In brief

To update the reader about the level of quality of ART sealants and ART restorations which is no different from that of comparable traditional treatments.

To inform the reader about the importance of Minimal Intervention Dentistry for managing the burden of dental caries in society. One should not forget that dental caries, in essence, is a preventable disease.

To inform the reader that atraumatic care procedures should be given preference over rotary-driven procedures as in doing so the chance for reducing anxiety and discomfort is reduced, access to care increased and oral health improved, particularly in children.

Too many people worldwide suffer from the consequences of untreated dentine carious lesions. This finding reflects the inability of the currently used traditional mode of treatments to manage such lesions. A change is needed. Dental training institutions should depart from the traditional 'drill and fill' treatments and embrace the holistic oral healthcare approach that is minimal intervention dentistry (MID) and includes within it minimally invasive operative skills. Dental caries is, after all, a preventable disease. The atraumatic restorative treatment (ART) concept is an example of MID. ART consists of a preventive (ART sealant) and a restorative (ART restoration) component. ART sealants using high-viscosity glass-ionomer (HVGIC) have a very high dentine carious lesion preventive effect. The survival rate of these sealants is not significantly different from that of sealants produced with resin. The survival rate of ART/HVGIC restorations matches those of amalgam and resin composite in single- and multiple-surface cavities in primary teeth and in single-surface cavities in permanent teeth. The principles of carious tissue removal within a cavity recommended by the International Caries Consensus Collaboration are in line with those of treating a cavity using ART. Owing to its good performance and the low levels of discomfort/pain and dental anxiety associated with it, ART and/or other evidence-based atraumatic care procedures should be the first treatment for a primary dentine carious lesion. Only if the use of ART is not indicated should other more invasive and less-atraumatic care procedures be used in both primary and permanent dentitions.

Minimal intervention dentistry

MID is a philosophy or concept that attempts to ensure that teeth are kept functional for life. Its development was facilitated by the many studies conducted on a range of dental caries-related topics carried out from 1940 onwards that include fluoride, sugar, dental biofilm, adhesive dental materials and the repeat restoration cycle.[1] By early 1990, research had shown that managing dental carious lesions could be better achieved by moving away from the traditional surgical approach in favour of a 'biological' or 'medical' approach The new approach in the management of the carious lesion was named minimal intervention dentistry or MID.[2] This approach encompasses the following important strategies that aim to keep teeth free from carious lesions: (i) early caries detection and assessment of caries risk with validated instruments; (ii) remineralisation of demineralised enamel and dentine; (iii) optimal caries preventive measures; (iv) tailor-made recalls; (v) minimally invasive operative interventions; and (vi) repair rather than replacement of restorations.[1] It is evident from these strategies that MID does not exclusively equate to cutting smaller cavities than before, as many dentists had initially thought.[3,4] The first three MID strategies should be employed throughout a person's life, and only when oral health maintenance has failed and a frank cavity has developed should a minimally invasive operative intervention be undertaken.

This publication presents the recommended contemporary cariologic principles for managing dental caries, enamel carious lesions and dentine carious lesions. This is followed by a discussion of the atraumatic restorative treatment (ART) approach and the results of its use in oral healthcare. The publication concludes with a comparison of the principles that guide the application of the preventive and restorative components of the ART approach and the principles underlying contemporary cariology.

Managing dental caries

'Dental caries' is the name of a disease and a carious lesion is the consequence of the caries process over time. A carious lesion appears in various forms, from a small demineralised area in enamel to a large cavity in dentine with or without pulpal involvement. The two major aetiological factors that govern the development and progression of a carious lesion are the supply of fermentable carbohydrates, particularly free sugars, and the inability to remove the cariogenic

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Atraumatic Restorative Treatment: Restorative Component

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Abstract

Atraumatic restorative treatment (ART) is a method of managing dental caries based on 2 pillars: sealants for preventing carious lesions in pits and fissures, and restorations for cavitated dentine carious lesions. ART uses only hand instruments for opening/enlarging the cavity and for removing carious tissue. The amount of carious tissue that should be removed depends mainly on the cavity depth. In cavities of shallow and medium depth, carious tissue is removed up to firm dentine. In deep/very deep cavities, in which there is no sign of pulp exposure, pulp inflammation and/or history of spontaneous pain, some soft dentine can be left in the pulpal floor/wall with the aim of avoiding pulp exposure. The ART restorative method is indicated for treating single-surface cavities in primary and permanent teeth, and in multiple-surface cavities in primary teeth. Insufficient information is available to conclude on its use for treating multiple-surface cavities in permanent teeth.

The aim of this chapter is to present how the atraumatic restorative treatment (ART) method came into existence, how carious tissue removal is performed using it, and its indications, contraindications, and limitations for restoring tooth cavities. Finally, survival results of ART restorations are provided.

ART was developed in the mid-1980s in response to the unavailability of restorative care for populations with limited resources, where the presence of cavitated lesions frequently led to tooth extractions [1]. On the basis of the principles of the minimum intervention dentistry (MID) concept, the ART method has evolved into a caries management concept for global use. The main goal of ART is to prevent carious lesion development through fissure sealing and to stop its progression through restoring cavitated lesions. The restorative care is performed using hand instruments only and the cavity is filled with an ad-

ARTICLE 1

RATIONALE AND TREATMENT APPROACH IN MINIMALLY INVASIVE DENTISTRY

JOEL M. WHITE, D.D.S., M.S.; W. STEPHAN EAKLE, D.D.S.

ABSTRACT

Background. Current methods of detecting caries, especially fissure caries, are inaccurate, causing some caries to go undetected until it has reached more advanced stages. Minimally invasive dentistry is a philosophy in which the goal of intervention to conserve healthy tooth structure. The authors review the rationale and role of air abrasion in successful practice in the 21st century that includes the philosophy of minimal intervention.

Clinical Implications. This objective encompasses a range of clinical procedures that includes assessment of caries risk to reinforce patient self-help, early detection of the disease before lesion cavitation to fortify the oral environment, restoration of fissure caries with maximum retention of sound tooth structure and sealant placement in unaffected areas. This conservative approach minimizes the restoration/re-restoration cycle, thus benefiting the patient over a lifetime.

Minimally invasive dentistry adopts a philosophy that integrates prevention, remineralization and minimal intervention for the placement and replacement of restorations.[1] Minimally invasive dentistry reaches the treatment objective using the least invasive surgical approach, with the removal of the minimal amount of healthy tissues. A carious dental lesion is the result of bacterial infection. Restoration of the tooth does not cure the disease. Acids produced by bacteria as metabolized sugars and cooked starches continue to demineralize tooth structure. Initial lesions occur beneath the enamel surface and can be repaired largely by ingress of salivary calcium, phosphate and fluoride ions. A balance between demineralization and remineralization inhibits progression of the lesion. Measurements of cariogenic bacterial levels with simple in-office saliva tests, determination of salivary flow rates and buffering capacity and analysis of dietary intake are needed. Patients who have active caries or who are at high risk of caries should be put on a regimen that attacks each part of the caries process: antibacterials (for example, chlorhexidine), buffering agents such as baking soda products, sugarless gum for increased salivary flow, office and home fluoride applications, diet counseling to explain the role of sugars and cooked starch in the caries development process, and use of sealants. When it has been determined that a lesion needs to be restored, removal of decay with maximal conservation of healthy tooth structure should be the main consideration. Since our "permanent" restorations are seldom that, we need to minimize the restoration's size and the restoration cycle that often leads to tooth fracture, endodontic treatment and crown, and occasionally root fracture and extraction of the tooth.

This article discusses the philosophy and treatment involved in performing minimally invasive dentistry.

EARLY CARIES DETECTION

Fluoride has contributed to a dramatic reduction in the caries rate among children. Smooth surfaces have received the greatest reduction in caries incidence; however, almost 90 percent of the caries occurs in pits and fissures.[2] Pits and fissures do not respond to remineralization as effectively as smooth surfaces, and caries progression in dentin is more rapid than in enamel. Pitts and Lond[3] discussed the changing character of fissure caries, with its tendency to cavitate at a much later stage than seen in years past so that detection with the explorer occurs much later in the development of the lesion. Weerheijm and colleagues[4] discussed the "hidden occlusal

Minimal intervention dentistry II: part 4. Minimal intervention techniques of preparation and adhesive restorations. The contribution of the sono-abrasive techniques

IN BRIEF

- Outlines the sono-abrasion technique for selective preparation of enamel and dentine.
- Describes the therapeutic principles and choice of instrumentation.
- Illustrates appropriate clinical situations for sono-abrasion in the preservation and optimisation of tissue bonding for both initial lesions and advanced lesions.

PRACTICE

F. Decup[1,2] and J-J Lasfargues*[1,3]

The concept of minimal intervention in oral medicine is based on advances in biological sciences applied to the dental organ. Many cultural barriers, economic as well as technical, have thwarted the application of micro-invasive conservative techniques by the general practitioner. Emerging technologies do not remove all obstacles but promote the integration of less invasive techniques in daily practice. Sono-abrasion is a technique for the selective preparation of enamel and dentine offering excellent efficacy, quality and safety. The authors describe the therapeutic principles, the choice of instrumentation and its mode of action and discuss its interest in adhesive restorative dentistry. The illustrated clinical situations focus on the preservation and optimisation of tissue bonding for both initial lesions and advanced lesions.

MINIMAL INTERVENTION DENTISTRY II

1. Contribution of the operating microscope to dentistry
2. Management of caries and periodontal risks in general dental practice
3. Management of non-cavitated (initial) occlusal caries lesions – non-invasive approaches through remineralisation and therapeutic sealants
4. **Minimal intervention techniques of preparation and adhesive restorations. The contribution of the sono-abrasive techniques**
5. Ultra-conservative approach to the treatment of erosive and abrasive lesions
6. Microscope and microsurgical techniques in periodontics
7. Minimal intervention in cariology: the role of glass-ionomer cements in the preservation of tooth structures against caries
8. Biotherapies for the dental pulp

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INTRODUCTION

For the past 20 years traditional operative dentistry has evolved towards a more conservative concept, the main objective of which is the increased preservation of dental tissue.[1,2,3]

New operative techniques for caries excavation and cavity preparation have developed, offering less patient discomfort and less tissue removal.[4,5] These techniques can be classified as mechanical and non-mechanical. The first involves manual and rotary excavation, sono-abrasion and ultrasonic abrasion. The second involves chemo-mechanical and enzymatic air abrasive methods and lasers.

The generic term of sono-abrasion covers the oscillatory diamond abrasive techniques that have been developed in the 1990s specifically for the preparation of small proximal cavities.[6–8] In the last decade, sono-abrasion has benefited from technological developments, the instrumentation is diverse and indications for it use have expanded.

The purpose of the present article is to review the contribution of sono-abrasive operative methods to the preparation of dental hard tissues and to discuss their benefits in operative dentistry.

SONO-ABRASIVE INSTRUMENTATION

A sound is a wave produced by the mechanical vibration of a carrier fluid or solid, and propagated through the elasticity of the surrounding medium.

Depending on the frequency of the wave, the sounds are classified into different categories: those that we use in dentistry are sound and ultrasound.

- Infrasound = 1–20 Hz
- Sound = 20–20,000 Hz
- Ultrasound = 20–1,000 KHz
- Megasound = 1–100 MHz
- Hypersound = >100 MHz

Oscillating systems

Sonic handpieces in current use create sound with a frequency about 8,000 Hz to 15,000 Hz, with three power levels depending on the treatment being undertaken and deliver an oscillating amplitude <200 µm. The vibrations are generated by the compressed air from the dental unit, which is transmitted by a tube to the handpiece. No additional generator is required. The pressurised air drives a rotor, which causes a circular oscillation to be transmitted to the tip. The tip moves with a tri-dimensional elliptical motion.

Handpieces of the most recent generation were chosen, producing limited noise (<70 dB) with spray cooling, integrated LED light and a multiflex connection (eg: SONICflex Lux 2003L®, KAVO; SF1LM®, Komet; ZA-55LM®, WH).

Ultrasonic handpieces operate at high frequency, about 20,000 Hz to 40,000 Hz (by comparison, the frequencies used by

Minimal intervention dentistry: part 7. Minimally invasive operative caries management: rationale and techniques

A. Banerjee[1]

VERIFIABLE CPD PAPER

IN BRIEF

- Describes minimally invasive operative caries management techniques.
- Highlights the degree to which dental caries should be excavated.
- Suggests removal of grossly softened caries-infected dentine is recommended in most situations along with the placement of a sealed restoration.

PRACTICE

When patients present with cavities causing pain, poor aesthetics and/or functional problems restorations will need to be placed. Minimally invasive caries excavation strategies can be deployed depending on the patient's caries risk, lesion-pulp proximity and vitality, the extent of remaining supra-gingival tooth structure and clinical factors (for example, moisture control, access). Excavation instruments, including burs/handpieces, hand excavators, chemo-mechanical agents and/or air-abrasives limiting caries removal selectively to the more superficial caries-infected dentine and partial removal of caries-affected dentine when required, help create smaller cavities with healthy enamel/dentine margins. Using adhesive restorative materials the operator can, if handling with care, optimise the histological substrate coupled with the applied chemistry of the material so helping to form a durable peripheral seal and bond to aid retention of the restoration as well as arresting the carious process within the remaining tooth structure. Achieving a smooth tooth-restoration interface clinically to aid the cooperative, motivated patient in biofilm removal is an essential pre-requisite to prevent further secondary caries.

INTRODUCTION

The term MI dentistry or 'MID' has been used for many years with several meanings in the dental literature. Minimum(al) intervention dentistry is the holistic patient care philosophy that encompasses the complete patient-dentist team-care approach to managing dental disease by identification and diagnosis (including caries risk assessment), prevention and control, restoration and recall, so educating and empowering the patient to take responsibility for their personal oral health.[1,2] Minimally Invasive Dentistry describes contemporary ultraconservative operative management of cavitated lesions requiring surgical intervention. It does not mean unduly early operative intervention of incipient lesions, which in most cases is unnecessary as more effective and appropriate non-invasive preventive approaches exist. It is the latter definition that will be discussed further in this paper.

MINIMAL INTERVENTION DENTISTRY

1. From 'compulsive' restorative dentistry to rational therapeutic strategies
2. Caries risk assessment in adults
3. Paediatric dental care – prevention and management protocols using caries risk assessment for infants and young children
4. Detection and diagnosis of initial caries lesions
5. Atraumatic restorative treatment (ART) – a minimum intervention and minimally invasive approach for the management of dental caries
6. Caries inhibition by resin infiltration
7. **Minimally invasive operative caries management – rationale and techniques**

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'Golden triangle' of MID

A thorough understanding and appreciation of the interplay between three critical factors is required to achieve success clinically when using a minimally invasive operative caries management strategy (MI OCMS):

1. The histology of the dental substrate being treated
2. The chemistry/handling of the adhesive materials used to restore the cavity
3. Consideration of the practical operative techniques available to excavate caries minimally.

Appreciation of these factors will enable the dental practitioner to embrace the contemporary oral physician's biological approach to operative caries management as opposed to the surgeon's mechanistic efforts of preparing cavities of a pre-determined shape, governed primarily by the properties of the chosen restorative material as opposed to the actual histopathology of the disease process and retention of tooth substance.[3,4]

LESION HISTOLOGY

Enamel caries

Long-term, repeated episodes of bacterial acid demineralisation instigated at a susceptible tooth surface by the residing plaque biofilm results in the growth of subsurface structural porosities, eventually enlarging, if not controlled at the earliest stages by remineralisation/oral hygiene procedures, coalescing and ultimately causing cavitation. Carious enamel

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Original

Preparation time and sealing effect of cavities prepared by an ultrasonic device and a high-speed diamond rotary cutting system

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Abstract: The purpose of this study was to compare a high-speed handpiece to an ultrasonic device regarding the time taken for cavity preparation in bovine incisor teeth (n = 12), and to evaluate microleakage after the restorations. Two cylindrical cavities each were prepared on the labial surfaces of 12 teeth. One of them was made with a diamond tip in group 1 (G_1 = 12) coupled with a high-speed handpiece, and the other with a chemical vapor deposition (CVD) tip in group 2 (G_2 = 12) coupled with an ultra-sound device (n = 24). The time taken for each preparation was measured with a stopwatch. The cavities were treated with adhesive (Scotchbond Multipurpose, 3M), restored with composite (Filtek Z250, 3M), finished and polished, and then the prepared teeth were immersed in a 50% silver nitrate solution. The samples were cut in the mesio-distal direction and evaluated for microleakage. Data were analyzed using the Wilcoxon test ($P < 0.01$). The results revealed that the time taken to prepare cavities was 7.9 times shorter in G_1. There was no microleakage in 100% of the samples indicated by the absence of dye penetration in G_1, and 46% in G_2. It was concluded that the performance of the high-speed handpiece was better than that of the oscillatory system, in terms of both the time taken for preparation and the microleakage. (J. Oral Sci. 49, 207-211, 2007)

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Keywords: instruments; cavity preparation; leakage; ultrasound.

Introduction

Rotary instruments have been used in dentistry for over two hundred and fifty years and advances in technology have enabled efficient cavity preparation (1). The first dental drills, made of steel, were superseded by tungsten carbide. However, diamond drills were the first to be featured in the dental market (2). The technology which can be applied to improve conventional diamond drills is somewhat limited due to the heterogeneous shape of diamond granules, and their short-term durability (3,4). Added to that, they remove a good part of the sound portion of the tooth structure (5).

Current cavity preparation procedures demand a more cautious approach than the traditional procedures, with conservative removal of the carious tissue and use of adhesive restorations. This approach to the treatment is known as Minimally Invasive Dentistry (6).

As a solution to the above-mentioned problems, chemical vapor deposition (CVD) diamond tips were launched. A CVD diamond tip coupled with an ultrasound piece makes cavity preparations minimally invasive (7,8). The efficiency of this instrument can be attributed to an improved capacity of removing tooth structure within a minimum period of time and with minimum effort. Once this has been established, it will be easier to compare it with the efficiency of other instruments and standardize the time taken for the procedure.

Therefore, the aims of this in vitro study were to compare the time taken by a rotary cutting instrument (high-speed

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Influence of Diamond Sono-Abrasion, Air-Abrasion and Er:YAG Laser Irradiation on Bonding of Different Adhesive Systems to Dentin

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ABSTRACT

Objectives: Different surface treatments may affect bonding performance of adhesive systems to dentin. This study evaluated the influence of different methods of surface treatment on adhesion of bonding agents to dentin.

Methods: Dentin surfaces abraded with #600-grit SiC paper were used as control. Three methods of surface treatment (sono-abrasion, air-abrasion and Er:YAG laser irradiation) were used under specific parameters. Four adhesive systems (Tyrian, Clearfil SE Bond, Unifil Bond and Single Bond) were applied to treated surfaces, according to the manufacturers' instructions. Composite blocks were built on bonded surfaces, then restored teeth were vertically and serially sectioned to obtain bonded slices for interfacial micromorphologic analysis or to produce beam specimens for μ-TBS bond test. Data were analyzed with two-way ANOVA and Tukey test at a significance level of 5%.

Results: The results indicated that the preparation of dentin with sono-abrasion or laser did not affect the bond strength, while the preparation of dentin with SiC paper and air-abrasion influenced the bond strength for some systems. A clear difference of the preparation of dentin surfaces and formation of hybrid layer and resin tags were noted.

Conclusion: Bonding effectiveness of both the etch-and-rinse and the self-etch adhesives can be influenced by different methods of dentin preparation. (Eur J Dent 2007;1:158-166)

Key words: Dentin; Bond strength; Adhesive systems; Er:YAG laser; Sono-abrasion; Air-abrasion.

INTRODUCTION

In conventional restorative dental treatment, rotary instruments are routinely used to remove caries lesions and to prepare the cavities.[1,2] However, it is common for patients to be fearful and anxious about receiving dental care, particularly with conventional treatment.[3,4] Alternative methods of caries removal and cavity preparation have

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Chemochemical caries removal: a review of the techniques and latest developments

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Chemomechanical caries removal involves the chemical softening of carious dentine followed by its removal by gentle excavation. The reagent involved is generated by mixing amino acids with sodium hypochlorite; N-monochloroamino acids are formed which selectively degrade demineralised collagen in carious dentine. The procedure requires 5–15 minutes but avoids the painful removal of sound dentine thereby reducing the need for local anaesthesia. It is well suited to the treatment of deciduous teeth, dental phobics and medically compromised patients. The dentine surface formed is highly irregular and well suited to bonding with composite resin or glass ionomer. When complete caries removal is achieved, the dentine remaining is sound and properly mineralised. The system was originally marketed in the USA in the 1980's as Caridex. Large volumes of solution and a special applicator system were required. A new system, Carisolv, has recently been launched on to the market. This comes as a gel, requires volumes of 0.2–1.0 ml and is accompanied by specially designed instruments.

In brief

- Chemochemical caries removal involves the selective removal of carious dentine. The reagent is prepared by mixing solutions of amino acids and sodium hydrochlorite.
- Reagents for the procedure were originally marketed as a solution known as Caridex. More recently, a similar system in the form of a gel has been marketed as Carisolv.
- Being a gel, Carisolv has the advantage of requiring volumes of less than 1 ml. No applicator system other than specially designed instruments is required.
- Because only carious dentine is removed, the painful removal of sound dentine is avoided and the need for local anaesthesia is minimised.
- The procedure is suitable for soft carious lesions access to which may still require conventional mechanical procedures.

The earliest attempts to remove caries involved the use of a hand drill which was soon surpassed in 1871 by James Morrison's treadle instrument developed from the mechanisms of Isaac Singer's sewing machine. Modern high speed drills are the latest development of this more than a century old technique.[1] Over the years, other procedures have also been used for caries removal (CMCR). These include air abrasion with aluminium oxide, chemomechanical caries removal, atraumatic restorative therapy (ART)[2] and most recently, lasers.[3] With the recent launch onto the market of a new product for CMCR, there is renewed interest in this procedure which selectively removes carious dentine but avoids the painful and unnecessary removal of sound dentine. Restoration of cavities prepared by this technique requires materials such as composite resins or glass ionomers which bond to the dentine surface rather than materials such as amalgams which involve cutting a cavity designed to mechanically retain the restoration.

Dentine consists of mineral (70%wt.), water (10%wt,) and an organic matrix (20%wt.). Of this organic matrix, 18% is collagen and 2% non-collagenous compounds including chondroitin sulphate, other proteoglycans and phosphophoryns.[4–5] Collagen is an unusual protein which contains large amounts of proline and one third of the amino acid content is glycine. The polypeptide chains are coiled into triple helices which are known as tropocollagen units; these tropocollagen units then orientate side by side to form a fibril. Co-valent bonds between the polypeptide chains and between the tropocollagen units form cross links and give the collagen fibrils stability (Fig. 1), in dentine the fibrils are in the form of a dense meshwork which becomes mineralised.[6]

When caries occurs, acids produced by plaque bacteria by anaerobic fermentation of carbohydrate initially cause solubilisation of the mineral in enamel. As the process progresses, dentinal tubules provide access for penetrating acids and subsequent invasion by bacteria which results in a decrease in pH and causes further acid attack and demineralisation. When the organic matrix has been demineralised, the collagen and other matrix components are then susceptible to enzymatic degradation, mainly by bacterial proteases and other hydrolases.[7] With respect to collagen degradation, two zones can usually be distinguished within a lesion. There is an inner layer which is partially demineralised and can be remineralised and in which the collagen fibrils are still intact, and there is an outer layer where the collagen fibrils are partially degraded and cannot be remineralised.[8] A CMCR reagent must be able to cause further degradation of this partially degraded collagen, by cleavage of the polypeptide chains in the triple helix and/or hydrolysing the cross linkages as explained in Figure 1.

The principal on which CMCR is based arises from studies by Goldman and Kronman working in New Jersey, U.S. in the 1970's. They were studying the effect of

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Chemical Versus Conventional Caries Removal Techniques in Primary Teeth: A Microhardness Study

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The aim of this in vitro study was to assess the remaining dentinal surface after carious tooth tissue removal with a low speed conventional bur and two chemomechanical methods, (PapacárieTM and Carisolv®), using the microhardness test. It was concluded that the hardness of the remaining dentin after carious tissue removal was lower than that obtained on healthy dentin, without significance between the different means of carious tissue removal (p<0.05).

Key words: *carisolv, papacarie, primary teeth, tooth microhardness, caries*

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INTRODUCTION

Although there has been a substantial reduction of the prevalence of caries in industrialized countries, this disease continues to be widespread in the world. Once it has become installed, it is of fundamental importance to use conservative procedures that simultaneously prevent lesion progress and minimize healthy tooth structure wear. Ideally, the methods used to remove carious tissue should be capable of distinguishing the internal carious tissue layer from the more superficial and highly infected tissue, in which collagen fibers can no longer be remineralized.[1,2,3] In addition, these methods must be comfortable for the patient, easy to use, noiseless, painless and must not cause vibration.

The following are among the main disadvantages of the traditional method using a rotary instrument: the possibility of overextending the cavity, healthy tissue removal, pressure and heat on the pulp, vibration, noise, pain stimulus and the need of local anesthetic, a procedure that causes aversion in many patients, specially children. New methods of carious tissue removal have been developed as an alternative to traditional treatment, among which one may mention laser, air abrasion, ultrasound, and chemomechanical removal.

The objective of chemomechanical substances is to remove the most external portion (infected layer), leaving the affected demineralized dentin that is capable of being remineralized and repaired.[5] Chemomechanical methods are said to remove only the infected dentin where collagen is degraded, maintaining the demineralized portion.

Innumerable studies have been conducted to assess the efficacy and clinical safety of Carisolv®, many of which have pointed out that the majority of patients felt no discomfort during treatment,[5,6,7] it was hardly ever necessary to use local anesthesia [8,9] and carious tissue removal was efficient.[10,11] As a disadvantage, this method was less efficient in comparison with the traditional method for carious tissue removal, making it necessary to spend more clinical time.[4,7,11,12,13] In addition, the high selling price to the consumer was an obstacle to the regular use of the method in clinical routine.

With the intention of presenting a chemomechanical caries removal product that cost less than Carisolv®, in 2003 Papacárie®, a material composed of papain, chloramin and toluidine blue, was launched. Papain is an endoprotein, with bacteriostatic, bactericide and anti-inflammatory activity.[5] Chloramin, a compound that contains chlorine and ammonia, presents bactericide and disinfectant properties, is used to irrigate root canals and to chemically soften carious dentin, so that the degraded portion of the carious dentin collagen is chlorinated by the solution used for chemical and mechanical caries removal.[9]

Thus, the purpose of this study was to compare the Knoop microhardness of sound dentin before and after carious tissue removal using the two chemical-mechanical methods, and the conventional method.

MATERIAL AND METHODS

This research protocol received previous consent from the Research Ethics Committee, School of Dentistry, University of São Paulo (protocol number 167/04).

Thirty extracted central primary incisors, with active carious cavities on one proximal surface, were divided into three experimental groups as follows, in accordance with the carious tissue removal method: conventional mechanical treatment – slow speed rotary instrument – and two chemomechanical methods - PapacárieTM and Carisolv®.

Carious tissue removal using the conventional technique was performed with a spherical steel bur (Wilcos do Brasil, Petrópolis-Brazil) with the largest diameter compatible with the cavity size, at

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SEM Analysis of Residual Dentin Surface in Primary Teeth Using Different Chemomechanical Caries Removal Agents

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Background: *The purpose of this in vitro study was to analyze the residual dentinal surfaces following caries removal using two chemomechanical methods (Papacarie Duo and Carie Care), by scanning electron microscopy (SEM).* ***Study design:*** *Twenty extracted primary molars with active occlusal carious lesions were randomly assigned two groups depending on the CMCR agent used for the caries excavation – Group 1 – with Papacarie Duo and Group – 2 with Carie Care. After the caries excavation, the specimens were subjected to SEM analysis.* ***Results:*** *Though both the agents showed the minimal smear layer with the patent dentinal tubules, Carie care showed patent dentinal tubules with a clearly exposed peritubular and intertubular collagen network.* ***Conclusion:*** *Carie Care treated surface exhibited better surface morphology of residual dentin.*

Key words: *SEM, residual dentin, chemomechanical caries removal, Carie care, primary teeth*

INTRODUCTION

Dentin substrate is a vital hydrated composite material with structural components and properties that may be altered by physiological processes, age and diseases. Significant variations in its architecture may occur according to the depth and response to previous injuries such as carious lesions and cavity preparations[1, 2]. With the advent of the adhesive restorative materials, the concept of caries excavation with preservation of healthy dentin has gained popularity. In order to accomplish this principle, the procedures available include: air abrasion with aluminum oxide, CMCR, atraumatic restorative therapy (ART) and most recently, lasers[3]. The CMCR method stands out among the other minimal invasive options as it address the advantages like cost effectiveness, patient's compliance, avoid the use of local anesthesia, preserve the healthy dentin intact and facilitate ultimate tissue preservation[4]. The CMCR system involves selective dissolution of outermost portion (infected layer), by the application of a natural or synthetic agent, followed by atraumatic mechanical removal leaving behind the affected demineralized dentin that can be remineralized and repaired[5].

Considering the advantages of CMCR, a gel based on papain containing chloramine and toluidine blue named Papacarie Duo™ was developed in Brazil in 2003. A number of studies can be found in the literature evaluating the clinical efficacy and surface topography of residual dentin and remnant tooth structure with this material after caries removal[2, 5-8]. The data corroborated, indicated Papacarie Duo™ to be a clinically efficient material in terms of the dentin surface morphology and non-interference with the resin composite bonding[2, 9, 10].

An alternative to Papacarie Duo™, named Carie Care™ was launched in India in 2011 with an intent to be more cost effective, which is composed of papain, clove oil, and chloramine[9]. This gel is based on papaya extract, an endoprotein rich in basic amino acids in combination with essential therapeutic oils. The active ingredient has proteolytic action that would soften the pre degraded collagen of the lesion without pain or any undesirable effects on adjacent healthy tissues with added antiseptic and anti-inflammatory properties of the essential therapeutic oils[11, 12].

Due to the difference in composition, the two materials will yield a different pattern of dentin substrate. Therefore giving the relevance to the subject, the emergence of new CMCR material and the scarcity of the studies in this regard on primary teeth, the present study aimed at evaluating remaining dentinal substrate after caries removal in primary teeth using two different CMCR agents–Carie Care™ and Papacarie Duo ™ using SEM.

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ORIGINAL RESEARCH
Restorative Dentistry

Chemomechanical *versus* drilling methods for caries removal: an *in vitro* study

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Declaration of Interests: The authors certify that they have no commercial or associative interest that represents a conflict of interest in connection with the manuscript.

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Abstract: The purpose of this study was to compare the performance of chemomechanical caries removal (CMCR) with that of conventional drilling for efficacy of caries removal, time spent, morphological changes and microhardness of surface dentin, and microleakage of subsequent restorations. Forty-six carious deciduous molars were randomly divided into two groups: one each for caries removal by (1) CMCR and by (2) drilling. The completeness of caries removal was evaluated by visual and tactile criteria and a caries detector device. Twenty teeth in each group were restored with glass ionomer (GI) and subjected to thermocycling before undergoing microleakage and microhardness tests. In each group, three restored teeth were used for polarized light microscopic analysis, and three unrestored teeth for scanning electron microscopy (SEM). There was no significant difference in the completeness of caries removal between groups. However, time spent for caries removal by CMCR was significantly longer than that required for drilling. Restorations in the CMCR group had significantly more microleakage than those in the drilling group. Dentin hardness of the cavity floor after CMCR was also significantly lower. Microscopic analyses showed roughened and irregular dentin surfaces in the CMCR group, unlike the smooth surfaces observed in the drilling group. In conclusion, CMCR was as efficacious as drilling in term of completeness of caries removal, but required longer excavation times and resulted in lower microhardness of residual dentin as well as more microleakage after restorations with GI. Further laboratory and clinical evaluations on the efficiency and performance of CMCR for the durability of subsequent restorations are required.

Keywords: Dental Caries; Papain; Dentin.

Introduction

Dental caries continues to affect a significant portion of the world population. Various methods have been used for dental caries management. The conventional method for caries removal is drilling with dental burs.[1] However, drilling may cause adverse biological reactions to dental pulp tissues and non-selectively remove both infected and sound dental tissues. Importantly, drilling can cause anxiety, fear, and pain in patients and frequently requires a local anesthetic injection.[1,2] Fear and anxiety in children are known barriers to acceptance of dental treatment. Compliance by some children in dental care can be poor, even with good behavior management. To overcome

The use of Erbium:YAG laser for caries removal in paediatric patients following Minimally Invasive Dentistry concepts

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Abstract. *The Er:YAG laser has proven to be effective and efficient in dental hard tissue ablation. The Minimally Invasive Dentistry (MID) approach in caries removal is to stop the disease process and to restore lost tooth structure and function, maximizing the health potential of the tooth. One of the most important concepts of the MID is to preserve as much as possible the dental tissue and this approach is even more important in primary dentition where the dimensions of the crown are smaller and the dimension of the pulp chamber is bigger in relationship to the crown. After treating 30 children's teeth (primary molars and first permanent molars) with the Er:YAG laser, we come to conclusion that laser treatment possesses the requirements of Minimal Invasive Dentistry: the possibility to ablate small area of infected layer guarantees maximum conservation of the tooth structure; using the antibacterial property of the Er:YAG laser we can decontaminate the affected layer that retains its remineralising potential; the lack of smear layer after vaporization with laser assures a better retention of the composite resin to the dentine; preparing the enamel surface with laser before etching gives a better marginal seal of the composite restoration.*

Keywords: *Minimally Invasive Dentistry, Er:YAG laser, Caries ablation.*

Introduction

In the 21st century caries is still one of the most frequent mouth disease in childhood Roman population due to the lack of information, health education and health promotion [Panetta et al., 2004]. A previous study by the National Institute for Food and Nutrition Research (INRAN), demonstrated a consistent percentage of the variability exists in DMFT related to the frequency of carbohydrates intake and dental caries [Arcella et al., 2002].

The carious dental lesion is the result of bacterial infection where the acids produced by bacteria, as they metabolize sugar and cooked starches, de-mineralise the tooth's structure [Kleinberg, 1979; van Houte, 1980].

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In the past, carious treatment approach was mainly a surgical removal of the infected and affected tissue followed by reconstruction with a dental restorative material (mostly amalgam). This approach was necessary because of the limitation of other available materials and the lack of proved alternative therapies [Laurens, 1950]. It is important to remember that, at that time, diagnosis of carious lesions was carried out at more advanced disease stages compared to the incipient lesions detected today, and instrumentation was limited to slow rotary and hand instruments [Skeie et al., 2004].

The preparation of the cavity was performed with excessive tooth structure reduction even for relatively small lesions, removing not only the caries but also healthy dental tissue in order to follow the concepts of extension for prevention, resistance and retention [Jahn and Zuhrt, 1990; Osborne and Summit, 1998].

Modern dentistry has moved to a minimally invasive approach, in which caries is managed as an infectious disease and the focus is on maximum conservation of

Caries removal by Er,Cr:YSGG laser and Air-rotor handpiece comparison in primary teeth treatment: an *in vivo* study

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Aim: The aim of this study was to evaluate and compare caries removal by Er,Cr:YSGG Laser and conventional method using Air-rotor handpiece in primary teeth.

Materials and Methods: 25 children with at least two class I carious lesions on primary teeth with Diagnodent readings not differing more than ± 10 for both teeth were included in the study. All 50 teeth in the study received treatment by the same operator. Time taken for caries removal was recorded using a timer. Pain assessment was done using Wong Baker Modified Faces Pain Rating Scale and Visual Analog Scale before and after the procedure. After caries removal, caries detection dye was applied to the prepared cavity to check the efficacy of the procedure. In addition, after completion of treatment, each child was asked to indicate which method of caries removal, Er,Cr:YSGG Laser or Air-rotor handpiece, was more comfortable.

Results: The difference between the mean values for post-procedural Wong Baker Faces Pain Rating Scale scores and Visual Analog Scale scores in Group A and Group B were compared, which showed that children experienced less pain during the caries removal procedure with Er,Cr:YSGG Laser than with Air-rotor handpiece. Time taken for caries removal procedure was more in Group A than in Group B. It was seen that in both the groups caries detection dye was completely removed and both the procedures were equally efficacious for caries removal. Children indicated caries removal procedure with Laser to be more comfortable.

Conclusion: Within the parameters and limitations of the present study, it is suggested that Er,Cr:YSGG Laser seems to be an acceptable tool for caries removal in primary teeth. Children found caries removal with Er,Cr:YSGG Laser to be more comfortable even though time taken was more than the conventional method using Air-rotor handpiece.

Key words: Er,Cr:YSGG Laser · Air-rotor handpiece · Pain assessment

Introduction

Air-rotor handpieces and burs are among the most frequently used mechanical devices for caries removal as it is cost-effective, less time consuming and easy to use. However, their use has several disadvantages such as high-pitched noise and bone-conducted vibrations that often make patients feel uncomfortable. The noise and vibrations of a conventional handpiece may be terrifying to children and lead to increase in dental anxiety. [1] This may also lead to unwanted head and body movements due to anxiety. To overcome these advantages various techniques are available such as air-abrasion, air-polishing, ultrasonication, sono-abrasion, chemo-mechanical methods and Lasers. [2]

Erbium Laser have been introduced for various hard and soft tissue applications including caries removal. The Er,Cr:YSGG Laser has an emission wavelength of 2780 nm, and is strongly absorbed by water and hydroxyapatite. This energy when absorbed by water is used to cause rapid vaporization and to create microexplosions in hard tissue. Ideally, the remaining dental tissue beneath should not be affected by the ablation, thereby allowing precise control and minimal damage to the surrounding tissue. [3] The Erbium Laser's shallow depth of tissue penetration, high affinity with water and lack of thermal dam-

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Paediatric laser dentistry. Part 1: General introduction

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ABSTRACT

Knowledge of the physical characteristics of different laser lights and optical and thermal properties of oral tissues is very important to understand the interaction of dental lasers with biological tissues. Choosing the correct dental laser is crucial to match specific wavelengths with target chromophores of different tissues; this affinity makes laser irradiation selective and therefore minimally invasive. Various types of lasers are used in dentistry, offering a viable alternative to low and high-speed handpieces and surgical blades, and also minimising fear and discomfort of the patient. Lasers can provide innovative and minimally invasive therapies in different branches of dentistry including preventive and restorative dentistry, traumatic injury treatments and surgical procedures. Laser has also biostimulating and anti-inflammatory effects, as well as analgesic effect.

Keywords *Children; Laser tissue interaction; Paediatric laser dentistry.*

Introduction

The American Academy of Pediatric Dentistry (AAPD) recognises the use of laser as beneficial in restorative dentistry and soft tissues treatments for infants and children, including patients whith special health care needs [AAPD, 2013].

The term laser is an acronym that stands for Light Amplification by Stimulated Emission of Radiation. Laser technology was introduced in dentistry in the mid 1970's, and its classification in dentistry is based on the active medium used to supply electrons for the emission of laser photons. Laser photons are delivered as waves, which are typically collimated, coherent and monochromatic, i.e. of a single wavelength [Convissar, 2000; Coluzzi, 2005-2007; Moritz, 2006; Fasbinder, 2008; Olivi and Olivi, 2015]. Another classification considers the clinical use as follows: for soft tissues exclusively, for soft and hard tissues, for low level applications, for photopolymerisation, for tooth whitening and for caries detection (Table 1).

The choice of a laser depends on the optical affinity and absorption coefficient in different target chromophores for different wavelengths. Lasers in the visible and near-infrared electromagnetic spectrum are specifically absorbed by haemoglobin and melanin, and are used to treat soft tissues pathologies. The erbium family lasers (mid-infrared spectrum) are absorbed by water in the gingiva and mucosa, and within the hydroxyapatite and are therefore used on both hard and soft tissuess [Kotlow, 2004; Olivi, 2009; Caprioglio, 2010-2017; Boy, 2011]. CO_2 lasers (far-infrared spectrum) are absorbed by water in the mucosa and gingiva and are mainly used for surgery (incision and vaporisation of tissues); in addition, CO_2 wavelenghts are absorbed by hydroxyhapatite, and some studies reported also their ability to increase the acid-resistance of tooth enamel for preventive dentistry [Featherstone et al., 1997; Rechmann et al., 2013].

Soft tissue lasers	Argon 514 nm
	KTP 532 nm
	Diode 445, 803, 810, 940, 970-980, 1064 nm
	Nd:YAG 1064 nm
	Nd:YAP 1340 nm
	CO_2 10600 nm
Hard and soft tissue lasers	Er,Cr:YSGG 2780 nm
	Er:YAG 2940 nm
	CO_2 9300 nm
Low-Level lasers	Helium neon: 635 nm
	Diode 635-660 nm; 810 to 1064 nm
Photopolymerisation lasers	Argon: 488 nm
Tooth-whitening lasers	KTP 532 nm
	Diode 803, 810, 940, 970-980, 2940 nm
Caries detection lasers	Diode 405 and 655 nm

TABLE 1 Laser classification.
Legend KTP-potassium titanyl phosphate; Nd:YAG-neodymium-doped yttrium aluminum garnet; Nd:YAP- neodymium-doped yttrium aluminum per ovskite; CO_2-carbon dioxide; Er,Cr:YSGG-erbium chromium –doped yttrium scandium gallium garnet; Er:YAG-erbium-doped yttrium aluminum garnet.

REVIEW ARTICLE

Role of Ozone Therapy in Minimal Intervention Dentistry and Endodontics - A Review

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ABSTRACT

Ozone has been successfully used in medical field since many years owing to its oxidizing property making it an excellent antimicrobial agent. Moreover its potent anti-inflammatory property along with favorable cellular and humoral immune response made ozone an effective therapeutic agent. Also its ability to arrest and reverse carious lesions in a predictable way opened up a new chapter in minimal intervention dentistry. Furthermore its efficacy in curbing resistant poly microbial root canal flora appears very promising. This article is based on information through valid textbooks, peer reviews, journals and medline/pubmed search.

Key Words: Ozone, Endodontics, Minimal Intervention Dentistry.

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Introduction

Ozone is a natural allotrope of oxygen found in upper layer of atmosphere protecting living organisms on earth from U.V. Radiation. It is an unstable gas quickly giving up nascent oxygen which is a strong oxidant rendering multiple beneficial effects like an effective antimicrobial agent, disruption of tumor metabolism, metabolic & immune modulation, sterilization of medical & dental equipment, purification of drinking water to name a few[1].Ozone can arrest white spot lesions and reverse early caries process thus leading to a promising future in minimal intervention dentistry.

History

Ozone was first observed by a German chemist Christian Friedrich Schonbein in 1840 when he detected an "Odorful Gas" on passing electrical discharge through water (Ozen = Odor). He is considered as father of Ozone therapy.

1857 – Joachim Hensler, a German physicist and Hans wolf German Physician developed first Ozone generator for medical use[2].

1870 – Lender first used Ozone in Medical field for purifying blood in test tubes.

1881 – Used as therapeutic agent in treatment of diphtheria.

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Antimicrobial Effect of a Novel Ozone-Generating Device on Micro-Organisms Associated with Primary Root Carious Lesions in vitro

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Key Words
Micro-organisms · Ozone · Root caries

Abstract
The aims of this present study were (1) to assess the antimicrobial effect of ozone from a novel ozone-generating device (Heolozone, USA) [0.052% (v/v) in air delivered at a rate of 13.33 ml·s^{-1}] on primary root carious lesions (PRCLs) and (2) to evaluate the efficacy of ozone specifically on *Streptococcus mutans* and *Streptococcus sobrinus*. In study 1, 40 soft PRCLs from freshly extracted teeth were randomly divided into two groups to test the antimicrobial effect on PRCLs from exposure to ozonated water for either 10 or 20 s. Half of a lesion was removed using a sterile excavator. Subsequently, the remaining lesion was exposed to the ozonised water for a period of either 10 or 20 s (corresponding to 0.069 or 0.138 ml of ozone, respectively). Using paired Student t tests, a significant ($p<0.001$) reduction (mean ± SE) was observed in the ozone-treated groups with either a 10-second ($\log_{10}$ 3.57±0.37) or 20-second ($\log_{10}$ 3.77±0.42) ozone application compared with the control groups ($\log_{10}$ 5.91±0.15 and $\log_{10}$ 6.18±0.21, respectively). In study 2, 40 sterile saliva-coated glass beads were randomly divided into two groups for each micro-organism. One glass bead was put into each bijou bottle with 3 ml of Todd-Hewitt broth. *S. mutans* and *S. sobrinus* were inoculated anaerobically overnight. Each glass bead was then washed with 2 ml of phosphate-buffered saline. Immediately, 10 s of ozone gas was applied to each glass bead in the test groups. There was a significant ($p<0.0001$) reduction (mean ± SE) in ozone-treated samples for *S. mutans* ($\log_{10}$ 1.01±0.27) and *S. sobrinus* ($\log_{10}$ 1.09±0.36) compared with the control samples ($\log_{10}$ 3.93±0.07 and $\log_{10}$ 4.61±0.13, respectively). This treatment regime is an effective, quick, conservative and simple method to kill micro-organisms in PRCLs. Ozone gas application for a period of 10 s was also capable of reducing the numbers of *S. mutans* and *S. sobrinus* on saliva-coated glass beads in vitro.

Root caries is an emerging challenge to the dental profession as the risk factors for developing root caries point to both intra-oral and environmental factors, making management complex and multidisciplinary [Shay, 1997]. The microbiology of primary root carious lesions (PRCLs) is well established [Beighton et al., 1993; Lynch and Beighton, 1994]. The primary initiating agent of root caries is generally accepted to be *Streptococcus mutans* [Sumney et al., 1973; Billings et al., 1985; Brown et al., 1986; van Houte et al., 1990], although animal models and clinical data suggest

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Review

Hall Technique for Carious Primary Molars: A Review of the Literature

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Abstract: The high frequency of caries in primary teeth and its inadequate treatment are major public health problems during childhood. Nowadays, the Hall technique is one of the methods used for biological sealing in carious lesions in primary molars. Thus, the bacteria will be sealed from oral environment and the caries will be inactive. The objective of this article was to provide an updated search on the Hall technique description, indication, contraindication, advantages, concerns, success and failure, cost-effectiveness, acceptability, and preference in pediatric dentistry, and to compare the Hall technique with traditional crown preparation and conventional treatment options for carious primary molars. A discussion of the recently published articles on the Hall technique reveals that the Hall technique is considered a promising restorative option with high acceptability and longevity; with low failure rate for managing carious primary molars compared to conventional treatment modalities used in primary care settings. Furthermore, the survival rate of stainless steel crowns (SSCs) is considered high, whether provided using Hall technique or traditional preparation by a pediatric dentist. Thus, the Hall technique can be an effective addition to the clinician's range of treatment options for carious primary molars. However, it should be chosen in restricted cases.

Keywords: Hall technique; use; primary molars; carious; pediatric dentistry

1. Introduction

Dental caries in primary teeth is considered as the most common oral disease of childhood and has been studied in different countries worldwide [1]. The prevalence rate of early childhood caries (ECC) is between 1% and 12% in most developed countries [2]. However, the prevalence is higher in less developed countries, reaching 70% [3].

Traditional methods of managing carious primary molars in children include restoration with amalgam, composite resin, compomer, glass ionomer, and stainless steel crowns (SSCs) using conventional tooth preparation [4] or extraction [5]. Recently, silver diamine fluoride (SDF) is being used as a non-invasive treatment option [6].

Most of the methods for managing carious primary molars are done in secondary care settings or by specialists in private clinics. Restorations carried out by general dental practitioners (GDPs) showed less promising results [7]. The high frequency of caries in primary teeth, and its inadequate treatment, is considered a major public health problem during childhood and could significantly affect children's lives. Fifteen percent of Scottish children have had at least one extracted tooth by the age of five years [8]. By the age of eight years old, this percentage is increased to 42% [9]. Furthermore, many children have to accept dental pain; with approximately half of children with carious primary teeth stated to have attended the general dental practitioners' clinics with dental pain [10]. Despite the fact that preformed metal crowns (PMCs) are recommended as the optimum treatment for managing

Modern approaches to caries management of the primary dentition

N. P. T. Innes*[1] and D. J. P. Evans[1]

IN BRIEF

- Explores the differences between children and adults in the delivery of evidence-based techniques for preventing dental caries.
- Outlines the different approaches to managing dental caries in primary teeth to those used for the carious permanent dentition.
- Describes the Hall technique and its current implementation in the UK.

PRACTICE

When prevention of dental caries fails, and a child is exposed to the risk of pain and infection, the disease must be managed to reduce this risk. There is growing evidence supporting more 'biological' and fewer 'surgical' approaches to managing dental caries in primary teeth. These biological methods include partial and stepwise caries removal procedures, as well as techniques where no caries is removed. An overview of clinical trials comparing these biological methods to complete caries removal shows that they perform as well as traditional methods and have the advantage of reducing the incidence of iatrogenic pulpal exposures. The Hall Technique is one biological approach to managing caries in primary molars which involves sealing caries beneath preformed metal (stainless steel) crowns. The crown is cemented over the tooth without caries removal, tooth preparation or use of local anaesthesia. The clinical steps for the Hall Technique are straightforward but, as with all dental care provision, appropriate treatment planning for the procedure requires skill. The Hall Technique offers another method of managing early to moderately advanced, active carious lesions in primary molars, with good evidence of effectiveness and acceptability. This evidence aligns with the positive findings of other studies on biological strategies for managing caries in primary teeth.

INTRODUCTION

Dentistry for children is not the same as dentistry for adults. The effective prevention and management of dental caries in children presents the oral healthcare team with a different set of challenges (and opportunities), compared with providing care for adults. Although evidence-based techniques for preventing dental caries are available, and the delivery of these interventions might seem at first glance to be similar for children and adults, the reduced autonomy of children means there are important differences, and this paper explores these. Similarly, the limited lifespan of the primary dentition before it is naturally shed presents the opportunity for a different approach to managing dental caries from that used for the carious permanent dentition. A more 'biological', less 'surgical' approach can be used to slow or arrest caries progression in primary teeth such that the tooth exfoliates before causing the child pain or infection. This paper gives an overview of the evidence on biological approaches to caries management in the primary dentition, demonstrating that they perform as well as traditional methods with the advantage of reducing the incidence of iatrogenic pulpal exposures. One particular biological caries management method, the Hall Technique, is described, along with an overview of the current place of the technique in the UK.

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CARIES PREVENTION AND CHILDREN'S ORAL HEALTHCARE

With regard to their oral health, children are extremely vulnerable, being entirely dependent on their parents/carers, who must take full responsibility for the child's oral health until the child is old enough to accept this responsibility for themselves. This involves the parents/carers in more than simply bringing children for appointments with the oral healthcare team. It includes the wider aspects of oral healthcare, such as providing the fundamental home-based caries preventive programmes of best toothbrushing practice and a healthy diet, as well as being role models for children in establishing good habits and attitudes. Children also depend on the oral healthcare team to deliver the four principal evidence-based preventive interventions of toothbrushing (toothpaste) advice, dietary advice, fluoride varnish and fissure sealants, in line with national guidance,[1-3] as well as providing caries management when prevention has failed and, of course, all of this to a high standard. Children and their parent/carers are rarely sufficiently informed to ask for these interventions, neither are they in a position to make any assessment of the quality of the intervention provided; the oral healthcare team looking after the child must shoulder this responsibility.

The imperative for effective caries prevention for children is that adult dental disease begins in childhood.[4] This means that prevention not only ensures children avoid the consequences of unmanaged dental caries (pain and infection), but that in addition, they can progress to adulthood with a healthy dentition (see Fig. 1),