Universidad Europea

TRABAJO DE FIN DE GRADO

Grado en Odontología

IMPLANT SURGERY AFTER TRAUMATISM

Madrid, curso 2020/2021

Número identificativo

152

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1. RESUMEN

Se investigaron las causas más frecuentes, sus efectos y las evoluciones de traumas dentales que conllevan a la pérdida de dientes. Accidentes de coche, asaltos y caídas fueron registradas como las más comunes causas de infortunios, por eso las revisiones rutinarias serían necesarias para establecer el mejor plan de tratamiento. La siguiente investigación se enfocó en casos en los cuales las cirugías con posicionamientos de implantes con o sin otros antecedentes de intervenciones fueron necesarios; con el objetivo común de obtener el mejor resultado funcional y estético para el paciente. Edad, enfermedades sistémicas y medicaciones fueron evaluadas para verificar si estos tipos de tratamientos serían aconsejados y si podrían garantizar una tasa de éxito a largo plazo. Los diferentes materiales para implantes e injertos fueron evaluados y comparados. Los artículos que fueron analizados pertenecen a bases electrónicas de datos como Medline, Pubmed, Cochrane a través de la búsqueda de palabras como trauma, implantes, traumas maxilofaciales, osteointegración, edad, evaluacion radiologica, implantes dentales, colisiones faciales y otras. Las publicaciones anteriores a los años 2000 que no fueron relevantes no se incluyeron. Se puso el foco en estudios hechos en humanos y publicaciones en inglés. Los accidentes traumáticos dentales necesitan aún de un protocolo de diagnóstico general para obtener datos globales para una evaluación más precisa. Generalmente, los tratamientos que incluyen implantes demostraron una buena tasa de éxito cuando todos los parámetros están cumplidos. Serán necesarios más estudios para determinar los mejores materiales y las técnicas más adecuadas para posicionar injertos, protocolos oficiales de cirugías, edad mínima e interacciones con los medicamentos en casos de fracasos de implantes y de una incompleta osteointegración.

2. ABSTRACT

The most frequent causes, effects and evolution of traumatic dental injury (TDI) which include or lead to teeth loss had been investigated. Car accidents, assaults, falls and sports could enhance the chances of crashes and the follow up checkups are often required to establish the best treatment plan. This research focused on cases where surgical implant placement with or without previous intervention had been required to restore and optimize a patient's aesthetic and function. Age, systemic diseases and medication had been investigated to see when these types of treatments are not suggested or did not guarantee a long term and predictable success. Implants and graft's materials had been discussed. The analysis of articles found in electronic databases as Medline, PubMed, Cochrane selected by key words such as trauma, implants, skeleton-facial trauma, traumatism types, osseointegration, age, radiological assessment, dental implant, oro-facial collision, and others leaded to the review. Gray literature, studies and articles published before 2000 which were not relevant for the research were excluded, and mainly human focused studies and English published research had been proposed. TDIs global frequency still needs an official protocol to obtain precise studies, data collection and evaluations. Implant placement had been broadly approved as a treatment option when all the requirements were previously evaluated. Further studies are necessary to determine the best and more suitable graft materials, universal surgeries protocols, minimum age and drug relation in cases of unsuccessful osseointegration or implant placement failure.

3. INTRODUCTION

3.1 TRAUMA FREQUENCY

The frequency of traumatic episodes world wide is incredibly high.

First steps, first falls, more or less abrupt collisions with siblings, objects, growing up, exposure to sportive activities or traffic increase the chances of suffering injuries.

Moreover, collisions might lead to oral-facial traumas, which higher incidence in permanent dentition results in boys related to their increased indulgence with sports and adventures. (1)

The causes can be really different, therefore traffic accidents in some countries are so far the leading cause of facial injuries, resulting in complex facial fractures followed by high-speed impacts, including bodily injuries, especially orthopedics ones. (2)

Besides, violence is considered a source of accidents and it results to be recurrent among people of lower socioeconomic status. (3) In developed countries the assaults and falls have been registered as the leading cause of facial trauma. (2) In some studies work accidents resulted in a high number of damaged teeth. (2)

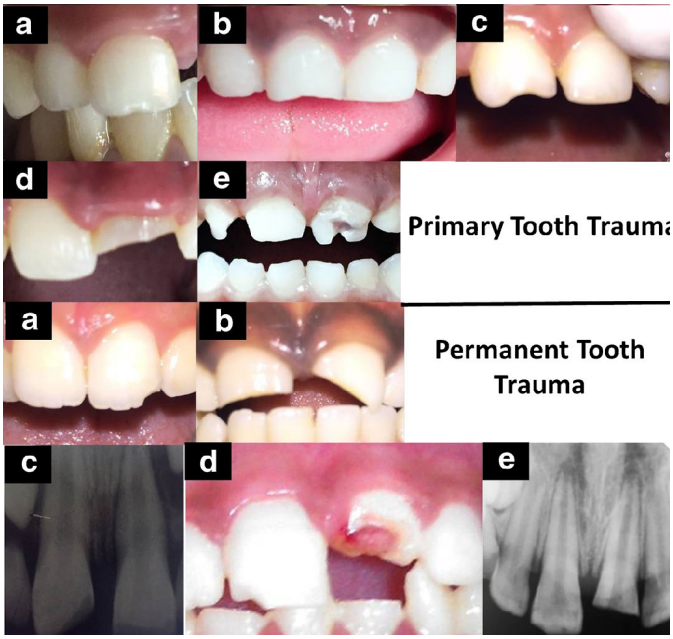

Figure 1 – 1. Primary and permanent teeth fractures: (a) enamel infraction, (b) enamel fractures, (c) enamel-dentin fracture, (d) complicated crown fracture, (e) complicated crown-root fracture.

2. Avulsion of upper central incisors. (1)

Subjects more prone or exposed to any kind of trauma due to systemic diseases which do not permit them to take enough precautions or to protect themselves as fast and effectively as possible, or people that are more vulnerable to violence have higher chances to suffer different types of traumas.

Furthermore, due to the contemporary demographic changes and the increasing aging of the population, the fall rate is continuously increasing, and so the falls' consequences.
The risk factors linked to those episodes are many, such as intrinsic ones like muscle weakness, lower strength and unstable balance, further and additional impairments, chronic illness, aging, drugs; or extrinsic ones such as polimedication, low income, environmental hazards and the lack of safety equipment. (3)
Patients with special needs did not result in a higher possibility of suffering traumatic dental injury (TDI); on the other hand, people with attention-deficit/hyperactivity disorders (ADHD) and cerebral palsy resulted to be more exposed to risks. (4)

Back in the days and nowadays in some parts of the world, warfare facial injuries and traumas need a personalized treatment plan, physical and functional impairments are a challenge. (5)

The majority of the studies report a large amount of cases related to the accidents that include the face, often affecting the maxillary anterior teeth and those are frequently linked to substantial alveolar bone loss.

Dental traumas, especially the ones altering the anterior sectors can be truly challenging to treat aesthetically and functionally.

The mandible's more affected sites by fractures are the condylar neck, the body of the angle and the symphysis. Those fractures are related to the intensity and direction of the force location, point, time of the injury, biomechanical properties of the mandible and the surrounding tissues. (6)

Traumas secondary to previous ones can be undoubtedly hard to manage.

3.2 TREATMENT PLAN

Dentists and specialists should collaborate by multidisciplinary team works to get the best diagnosis, treatment plan and prognosis.

Numerous factors have to be taken into account, such as the degree of tissue loss, patient compliance with maintenance, existing dental conditions, aesthetic possible outcomes and patient preferences. (7) Furthermore, the cost of the entire treatment, duration, complexity and possible risks should be all considered and agreed before starting the treatment.

Succeeding a trauma with bone and soft tissue loss or resorption, it can be challenging to provide and guarantee a successful and long term therapy plan.

In any case the objectives should aim to restore the functions of chewing, phonation and the correct eating and swallowing of the patient.

Additionally, aesthetic and comfort should be taken into account.

In recent times, implant placement has a tremendous popularity as a treatment option to rehabilitate structures and missing teeth. (8) The spaces to fill up might require a full mouth rehabilitation in cases of edentulous patients, or partial or single implant placement.

A dental implant is an alloplastic bioinert material that is introduced into a natural or artificial socket to restore functions.

Figure 2- 1. Screw threaded implant in trabecular bone (9); 2. Full mouth rehabilitation; 3. Partial rehabilitation. (10)

The age, an accurate medical history and clinical examination of the patient should always be performed before the beginning of the treatment.

The adverse effects of placing dental implants in healthy growing children has not been proved due to the insufficient evidence, but is neither considered the first treatment option. (8)

3.3 IMPLANTS CONTRAINDICATIONS

Implant placement is contraindicated in cases of patients presenting psychotic conditions, addictions, heavy drinkers and or smokers, patients on chronic treatments with intravenous bisphosphonates and irradiation therapy.

Interactions and an accurate evaluation should be assessed for patients with hypertension, diabetes, on anticoagulant therapy, children, local or systemic infection, chronic or neoplastic illnesses or severe bone atrophy.

Additionally, the oral hygiene and the tobacco consumption can have a remarkable influence on the treatment success and follow up. Patients should be informed previously.

3.4 IMPLANT PLACEMENT REQUIREMENTS

A prior precise actualized periodontal assessment is required focusing on the teeth, bone loss, mobility and periodontal pocket depth. In addition, plaque and bleeding index should be recorded and a detailed occlusal and prosthodontic examination and a pre-operative radiological report should be performed. (11)

The soft tissues health, tone, state, the amount of keratinized tissue, occlusal anomalies, bone dimension and amount, implant's type should all be included in the evaluation preceding the beginning of the treatment.

The diagnostic radiological examination will follow the protocols and principles of the radiation protection, taking into account the efficacy, lowest radiation exposure and costs for the patient. (12)

An orthopantomography and peri apical x-rays will be helpful, as well as a computed tomography (CT) scan is required to evaluate the quantity, quality, width and height of bone that the patient presents as shown in the picture below. Those are crucial factors for the planning.

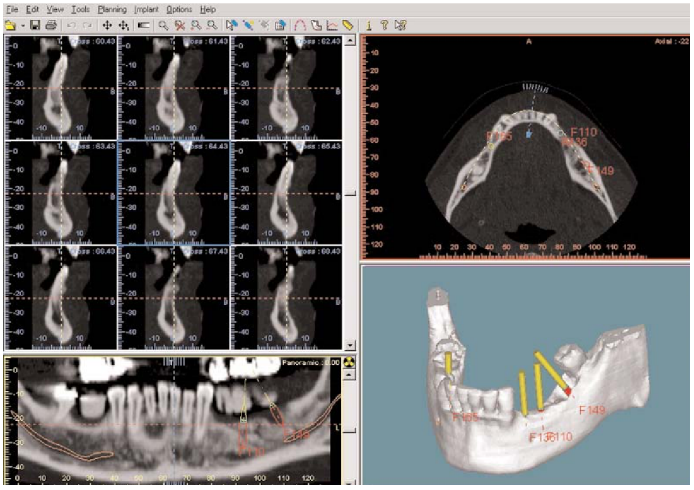

Figure 3- CT imaging used to evaluate bone density, quality, contour and volume. (10)

A traumatic episode affects the bone quality, dimension and the surrounding structures, which will influence the surgeries that will follow as the implant type, size, shape, number and placement as the drills and steps.

Misch in 1988 described the different bone densities: type 1 as the hardest one with dense cortical, type 2 characterised by a thick dense cortical crest and coarse trabecular, type 3 with a mayor porosity compared to the previous, with a thin cortical on crest and larger fine trabecular, type 4 which is the softest of the classification with a fine trabecular and nearly no cortical. The first type is prevalent in the mandibular symphysis and nasal spine, the second is mainly present in the lower anterior region, the third one is present in the posterior lower maxilla and anterior upper one, while the fourth is found in the posterior upper jaw.

Habitually the surgeon determines the bone quality subjectively, by the initial drill of the sequence . (13)

During the surgery, all the anatomical structures such as muscles, nerves, blood vessels should be respected. In cases of interferences, different treatments should be considered such as the sinus lift, a guided bone regeneration, alveolar preservation, implementation of block grafts, partial or complete removable prosthesis.

Titanium-based alloy implants are chosen, due to their suitable biochemical properties. Titanium does not dilate neither melt, it has an homogeneous oxidized layer, it is neutral and electrically inert, it is not toxic, neither cariogenic and only few cases of allergies have been reported. As shown in the picture below, titanium based alloys materials are often implied in surgeries. The implant itself, meshes and other structures are titanium based thanks to the great qualities that this material has proved to offer over the years of studies.

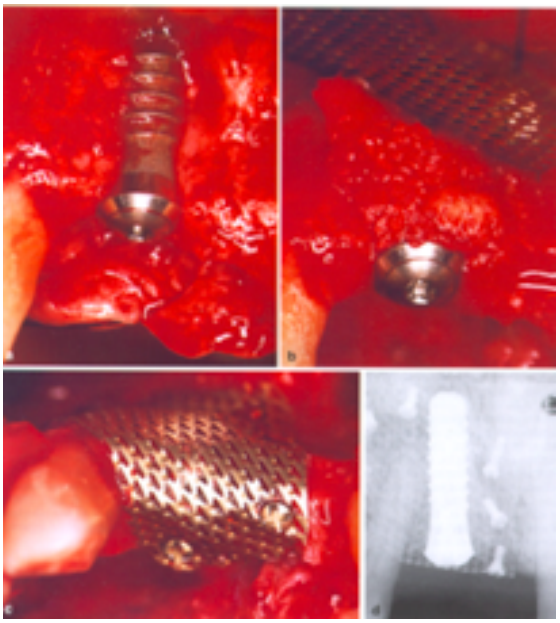

Figure 4- Titanium implant supported by autogenous bone and micro titanium mesh. (14)

Endosteal implant's macro and micro design can vary and the choice will be assessed depending on the case. Conical, straight or parallel walls' shaped rather than cylindrical implants can be chosen, with mechanisms of internal or external connection.

Those implants can then support a single crown, a bridge, or longer span dentures.

The surfaces of each can vary, as the treatment that they might require prior the surgery such as smooth, machined, acid etched or coated. Each brand personalizes their systems, trying to get to the most successful designs.

3.5 IMPLANT PLACEMENT PROTOCOLS

Implant placement can follow different protocols, depending on the previously mentioned factors. In the classical method which is defined as delayed load, the implant will be placed and bone maturation will be assess after three to six month time; for the early load technique soft and hard tissues will be ready to be loaded within two to four months; and for immediate load performed in optimal situations, the loading will take place within forty-eight hours. This last option is not usually taken in consideration when the surrounding structures are not ready, as in cases of traumatic episodes.

Depending on the implant's stability, one or two steps surgery will be provided. If we assess a good stability of the implant, a healing abutment can be placed already instead of the healing cap. On the contrary, if the firmness and or the primary stability of the implant is not established a healing screw on the implant will be placed firstly. When a correct healing and a great osseointegration will take place, the procedure can then go on.

3.6 OSSEOINTEGRATION

The process defined as the establishment of a direct contact between bone and implant without an interposition of soft tissues is defined as osseointegration. (13)

Figure 5- In the (A) scheme the initiation of distance osteogenesis can be observed and in (B) the contact one. Those insets will report differences in the bone formations. Where distance is present, the active osteoblasts are trapped between the bone they are producing and the implant, leading to their death. In the contact graph, the novo bone is formed on the implant surface.(9)

This concept is crucially relevant in an implant placement success and it was discovered by Branemark in the 1950. He revealed the titanium incorporation within the bone, performing an experiment by placing titanium chambers in the rabbit's bone. Later Zarb and Albrektsson et al defined osseointegration as a process through a rigid fixation of alloplastic material achieved without presenting symptomatology, and it is maintained in the bone and it can ensure functional loading. The accomplishment of this process will guarantee primary stability which refers to the initial mechanical stability of the implant at the time that is placed, thanks to the friction of bone-surface. Multiple factors can interfere with the process, mainly the design of the implant, the surgical approach and the bone quality. When the micromotion is superior to 50-100 µm, osseointegration can fail and fibrous tissue formation can replace the planned bone. Iatrogenic traumas on the surrounding structures and bone during the surgical procedure should be avoided.

The secondary stability is based on bone regeneration and remodeling between the implant and the surfaces around it. The processes that will take place in the endosseous structures around the implant is defined as osteoconduction where differentiating osteogenic cells will move toward the implant, and the presence of the blood clot fibrin will be crucial. Subsequently, de novo bone will be created, followed by the remodulation of it. To achieve

the wonder secondary stability, lamellar bone developing from the woven one will guarantee a stronger bone to implant interface.

Ongoing studies are still verifying the elasticity modulus of implants in bone as the mechanical compatibility and biocompatibility of different materials. (13)

The histopathology of any alloplastic biomaterial in bone can lead to a healing process occurring through bone apposition, as shown in the figure 6, rather than by the encapsulation of connective tissues. The goal of the osseointegration is the mechanical stability of the implant during the healing phase.

A relevant attachment apparatus that tightly bound enamel or cementum of the tooth as a great mechanical barrier is the junctional epithelium (JE). The JE modifies during the tooth loss and implant placement processes, depending on the host's inflammatory response. The reaction needs to be different compared to the one happening in response to a pathogenic microorganism where a pathologic inflammatory process rich in exudation of inflammatory mediators will destroy the structures such as fibers and bone, leading to an increase of osteoclastic activity. On the contrary, after the positioning of an implant, the epithelial attachment turns into scar tissue, free of vascular structures. This scar tissue that lacks vascular structures will not be able to create effective defense response in case of infections.

Figure 6 -Electron scan of a mini implant presenting bone apposition on the surface of a rat femur. (9)

3.7 POST IMPLANT PLACEMENT PHYSIOLOGY

The physiological stages posterior to the implant location consist in slight hemorrhaging, where forming a blood clot is crucial for the healing of the surrounding bone and implant surface relation. Nutrients will then be provided by an ingrowth of capillaries, promoting the proliferation of preosteoblast which are essential in bone growth. In this phase, the body recognizes the implant as a foreigner, starting to react immunologically. But as the bone will be forming around the implant surface, the immunological cells will start to decrease. In the meanwhile, an acute inflammation and wound healing will also occur. Physiologically new woven bone will be created in two weeks, and it can be remodeled into lamellar bone within two months. This is a delicate and crucial period of time to guarantee the success and implant stability. The implant's segments not covered by bone, will be wrapped by adipose tissue.

Going back to the placement and bed preparation for placement of the implant, many vessels are ruptured, releasing blood in situ, as fibrin will accumulate too. In the following first two week time the hematoma will regenerate, forming new blood vessels and tissues, followed by bone. In this phase, the creation of superfluous connective tissue can compromise the success of the surgery and treatment. After a month and a half , callus bone is remodeled as the Haversian system, leading to the creation of a more lamellar one. Generally, the remodeling process will last two years. The resorption process that starts

within the extraction appointment will reach the highest activity in the first twelve week time, slowing down in the following twenty-four weeks afterwards.

The process happens in each person and in each site of the body differently.

The resorption rate of the mandible is three to four times higher compared to the maxilla. Those processes will be accelerated in case of systemic diseases and or aging processes which will induce a physiologic reduction in the bone densities, osteoblasts and other hormonal-regulated body mechanisms. (13)

3.8 GRAFTS

In some patients bone grafting is required and it can lead to tissue regeneration and new bone formation. (13)

From the placement of a graft, the integration process goes on over the time, including other physiological activities such as resorption, replacement and remodeling. The first phase is focused on the freshly implanted osteoblasts that will proliferate to form an osteoid matrix, where the quantity of cells will influence the amount of new matrix. The blood supply of the graft will be crucial as it will nourish and it helps the working osteoblasts forming osteoid. In the window time after the insertion, osteoid matrix will be generated by the fibroblasts helped by other cells transforming into osteoblasts. (13)

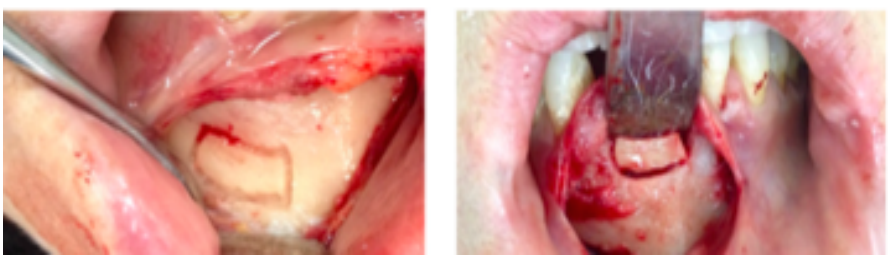

Figure 7- Autogenous bone grafting from the donor site, the symphysis in the picture on the left is shown. On the right, the

graft wedging in the recipient site is shown. (15)

So when all the requirements are assessed, the procedure and the treatment will be planned meticulously, taking into account the need of one or more surgeries and the use of grafts or other pre implantation steps.

The surgery that can follow might include an incision and a mucoperiosteal flap or a flapless surgery, followed by the marking the implant's side, length, diameter and placement, as the example shown in the figure 7. Speed, refrigeration, and drills sequence to follow are determined by each brand's protocol that should be punctiliously followed. Depending on the surgery, sutures and healing abutment placement rather than immediate load or other steps will follow.

4. OBJECTIVES

The first objective of this bibliographic review is to determine the most frequent causes of oro-facial traumas, the evolution and surgical treatment possibilities to restore aesthetic and function by dental implants for the long run.

The secondary objectives aim to determine the cases where dental implants should be included in the treatment plan having a high predictability of a long term success, including age-success/failure relation in younger and older patients.

Tertiary objectives focus on suitable types of graft types and implants materials.

5. METHODOLOGY

Searches were performed in electronic databases such as Medline, PubMed, Cochrane and the Biblioteca Crai using the following keywords: trauma, implants, skeleton-facial trauma, traumatism types, osseointegration, age, radiological assessment, dental implant, oro-facial collision, and others.

The terms listed and the one related to those brought to the research of the articles cited in the paper.

Moreover, a hand search of the reference lists of the electronic search helped to implement more studies and information. Furthermore, oral pathology and surgery books have been consulted. Firstly reading the articles' titles, abstracts and full articles helped then to select the most relevant, centered and topic related.

5.1 Eligibility criteria

The research focuses firstly on the publications of the last twenty years, and a further selection has followed, taking into account the one presented in the last ten years.

Articles which have been published in the late nineteenth century by authors and researchers which are relevant in the field of osseointegration and basic implantology have been included.

Generally gray literature and the studies and articles published before 2000 which were not relevant for the research were excluded.

Case reports, cohort retrospective studies, systematic computer assisted database and literature reviews have been included.

As much as articles and researches taking into account large age spectrums were included.

Only English written articles have been included and mainly human focused ones.

Furthermore studies that were taking into account systemic diseases related to the traumas and to the post trauma period were comprehended.

6. RESULTS

An exact statistical relevance cannot be assessed so far in relation to the implants following a traumatic episode based on this bibliographic review since traumatic dental injury (TDI) global frequency have not been reported accurately. TDI diagnosis does not have a standardization protocol. The lack complicates the precise reports to make cumulative and accurate study and data estimation of the cases and the subsequent follow up. (16)

Data reports collected by different studies showed a frequency higher than the 80% world wide of injuries in the oral region, taking into account the differences in diagnosis of the episodes. (16)(17)(18)(19)(20)(21).

In the cases where the teeth affected by the trauma could not be saved or treated, the implant placement has been accepted widely as a successful functional and aesthetical treatment option for the long term rehabilitation, when all the requirements were previously assessed and met. (7)(22)(23)

The majority of the procedures aim to the osseointegration of the implants and grafts, for a stable and successful outcome.(13)(24)(25)(26)

To guarantee the long term success, maintenance checkups, periodontitis control and peri-implantitis prevention, great oral hygiene and control over tobacco and alcohol consumption have been confirmed to be all relevant. (4)(7)(23)(27)(28)

Most of the authors reported the end of the growth as a requirement for the implant placement, even if there is not yet any protocol which prohibits it in really young patients. (8)(29)(30)(31)(32)

All the reviewed papers agree about the need of a meticulous evaluation in cases of people affected by systemic diseases with possible drugs interactions. Patients with not controlled periodontitis, not managed psychosis, bad oral hygiene, heavy smokers and alcohol consumers, with ongoing chronic treatments with bisphosphonates intravenously, undergoing to irradiation therapy, some cases of anticoagulant therapy, not stabilized hypertension, diabetes, presenting a local or systemic infection, the ones suffering from severe bone atrophy and with chronic or neoplastic disease can present absolute or relative risks and contraindications for the implant placement. (23)(15)(33)(34)(35)

Titanium alloys and autograft often mixed with bovine xenografts resulted as the materials mostly implied in the surgeries with high success results. (33)(34)(36)(37)(38)(39)(40)

7. DISCUSSION

7.1 TRAUMATIC DENTAL INJURIES

Traumatic dental injury (TDI) is considered as fractured, displaced or teeth lost followed by negative functional and esthetic effects. Additionally, TDI interferes with a patient's life, speech and appearance quality, as the example shown in the figure 8 below. (41)

Figure 8- Eight years old boy, ten days after a trauma that caused luxation and fracture of the central incisors splinted posteriorly. (42)

Dentoalveolar trauma can be associated with the loss of hard (teeth and bone) and soft (tissues and mucosa) tissues. (7)

Andreasen can be considered as a reference, thanks to his multiple publications reports where a high frequency of oral trauma have been described exhibiting two peak incidence in children: between boys at one to three and ten to twelve, in girls at one to three and generally at eight to ten years. (1) (42)

Glendor's review agrees with Andreasen, adding more data. In his study, he reports that one of three adults had at least one TDI, meanwhile young subjects which suffered one in permanent dentition are one out of four. (16)(20)

The most common injury to permanent dentition is the anterior upper teeth's enamel fracture, followed by enamel and dentine fractures, as the graph below can show in the figure 9. (1)(41)

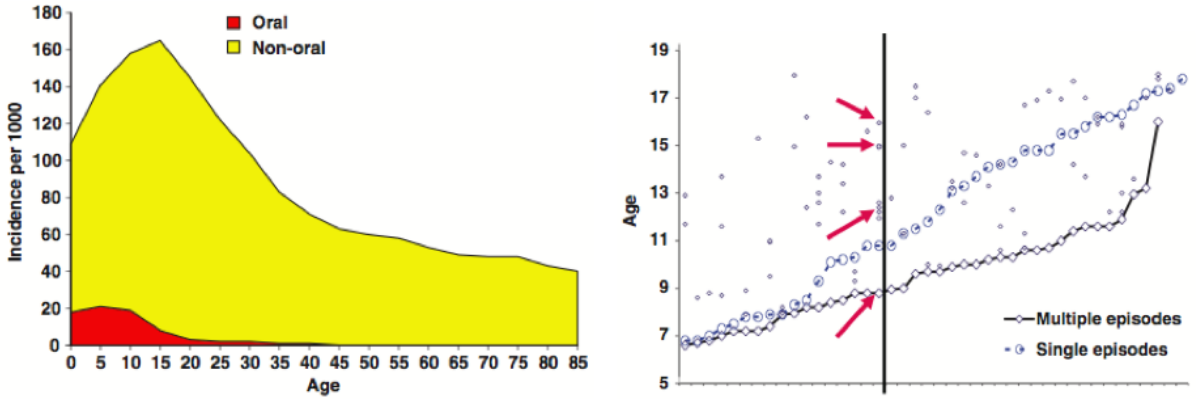

Figure 9- Incidence of oral and non oral injuries report on the left display. On the right, the graph represents dental injuries frequency in permanent dentition in children of six years old with a 12 years follow up. (20)

Since the maxillary incisors usually protrude and may have inadequate lip coverage, they can be more prone to those TDI, especially in case of Angle class II division 1 malocclusion. (41) In those patients the prevention of it can be carried out by preventive and interceptive orthodontic treatments.

Systemic condition such as even allergic rhinitis, which is one of the major cause of airway obstruction in children, affecting child's growth pattern (adenoid and long face syndrome and mouth breathing) is linked to a higher prevalence of TDI. (41)

Studies showed changes in cranio-facial dimensions during adulthood, also including eruptive movement of teeth and dento-alveolar changes. (8)(31)

A TDI can lead to ridge atrophies, which can compromise the future treatment success, functional and aesthetic outcome. The site needs to be managed and assessed periodically

for years, until the growth and the recovery will be completed. (42) Not all the authors agree about a certain age to start the definitive treatment, since researchers clinched the concept of individual variation in growth patterns, where dental and skeletal maturity cannot be determined at a fixed chronological age for dental implant placement.

Rekhalakshmi's study and other articles sustain insufficient evidence to affirm that implants are contraindicated as a treatment in growing children. (8)(31)

On the other hand, most of the authors suggest to respect every single patient's situation and growth pattern, to achieve the best result in the long run. (26)(29)(42)

7.2 MECHANICAL COMPONENT OF A TRAUMA

The mechanical components of a TDI are many, and the Australian Dental Journal discussed and analyzed the trauma physical components and how those affect the obstacle. The impact's components that influence the effect on a body depend on its velocity, mass, direction, shapes, resilience of the force receiver, the point where the energy is applied, the dispersion and attenuation depending on the materials. Additionally, the energy of the collision is strictly related to the mass and mainly to the velocity. In episodes of high velocity and lower mass, the injury will have a major effect on the affected point and usually is less severe compared to the one where there is an impact with lower velocity and a higher mass. In those impacts, there will be a greater damage to the surrounding and supporting structures. Besides, the body's resilience will be crucial for the distribution of the energy in the contiguous anatomical structures. When oro-facial traumas take place, teeth are

protected by the outer anatomical tissues such as the lips, cheeks, muscles. Object's shape makes a remarkable difference too.

In addition the skeletal mechanical properties in young children differ from the older subjects. In adults there is higher mineralization and so, less resiliency.

Fractures generally happen in the weakest point of the body and pre existing defects or anomalies can influence the effect of the impact.

Biological factors have shown to directly influence the recovery ability of the tissues post a traumatic episode. (43)

7.3 HISTOPATHOLOGY OF A TRAUMA

The histopathology of a place exposed to a trauma includes many processes. When a traumatic episode affects the oro-facial structures, the body will respond by starting different defensive processes such as hemostasis, inflammatory cascades, proliferation, and remodeling of the affected structures. The tissue responses will vary in relation to the stimulus activated by the inflammatory mediators, depending on the presence of an infection. In occasions of continuous stimulus and infection, the tissue reaction will be worse and more aggressive, leading to poorer tissue healing and repair.

The peri radicular structures including the periodontal ligament, cementum, proper alveolar bone, dentogingival junction, all structures rich in mix of mineralized and non-tissues originating from the dental follicle will be subjected to changes after a TDI. The neutrophils, lymphocytes, macrophages and osteoclast activation as a physiological response to the episode can trigger aggressive tissue repair systems, leading to resorptions. The rate and

amount of cellular response and ingrowths, as much as the bacterial invasion will determine the gravity of the process. The healing has been shown that is strictly related to the regenerative potential and the tissues' cells reaction speed to counter attack the event. In circumstances of significant alveolar crest loss, major periodontal ligament damage, fibrous connective tissue might colonize and replace the structures, which will not lead to the optimal healing.

If the alveolar hard tissue is greatly vascularized, it is easily reachable by the inflammatory compounds. When the inflammatory response is activated, it will turn on the cytokines mechanisms that will activate the osteoclastic activity, to take off the damaged hard tissues. Osteoclast have been proven to be the major responsible of the bone resorption process since they can digest the mineral matrix present in the bone. The osteoclasts will start to act only after the osteoid surface layer and non-mineralized collagen have been destroyed. Moreover, the osteoclast leads the healing of the tissues around the tooth after a TDI. In the meanwhile, it has a key role in the damage defiance against an infection in the body. Osteoclastic activity will be responsible for crestal, lateral and apical resorption too. On the other hand, the osteoblast removes the non-mineralized collagen component.

Bacteria will always have an enormous power and influence over the processes.

The amount of alveolar crest loss subsequent to a trauma will rarely get back to its original shape. This is due to the different capacity of the connective tissue which will replace the original structures, without having the equal osteogenic potential.

Focusing on the gingival health and shape post a TDI, in some incidences the probability of extensive laceration including the periosteum and the surrounding bone with a subsequent loss of attachment and recession is probable. The mayor responsible for this process are the

bacteria. Plaque accumulation and poor oral hygiene are closely related to a worse prognosis, since those will cause inflammation and so, the proliferation and apical migration of the junctional epithelium, creating a periodontal pocket. Due to this, the underneath tissues which should be protected by the gingiva, will be exposed.

In cases of bone-sequestrum formation, the chances of permanent loss of structure are elevated. (43)

7.4 POST TRAUMA IMPLANT PLACEMENT

In TDI many different situations can follow, and the teeth can be affected and react in many ways. Regular clinical and radiological follow ups after the accident are required to establish the best prognosis. Not all the collisions can be easily cured and in some circumstances the treatment plan will lead at some point to an implant replacement to guarantee the best aesthetic and function for the masticatory system of the patient.

Researchers showed that when a TDI happens and teeth are involved, the pulp is often affected and it can react over time in different ways.

Where the crown is involved and the pulp is affected, the response can include locally an inflammation, followed by granulation tissue proliferation or necrosis with or without an abscess.

If the collision causes a luxation with root fracture, the pulp and the periodontium will react to try to save the tooth. Optimal conditions such as blood supply and bacteria free environment would be helpful. In clashes including concussion or subluxation, the pulp is unusually affected.

Fibroblasts are the preponderant unit in the pulp, and as the inflammation takes place activating cytokines, those will stimulate the fibroblast activating the repairing mechanism. This can trigger many reactions in the host.

Often lateral luxation or extrusion cause calcification of the pulp canal. On the other hand, when there is a drastic dislodgement, pulp necrosis will follow, since the neurovascular system around it has been compromised. It might result in a blood clot formation with bacteria accumulation in situ, kept on by an ischemic reaction prone to infections. A granulation tissue proliferation takes over, generating a chronic inflammation. Situations of permanent root development affected by an ongoing pulp necrosis will compromise the extension process and will not help the healing process in cases of fractures. External or internal resorption might follow. The processes that take place in a tooth after a trauma can vary, mainly consisting in pulp healing, calcification or necrosis. Monitoring the traumatic area is essential since teeth loss is possible. Avulsion injuries are proven to be the one with the worst prognosis due to a notable damage to the periodontal fibers and detrimental consequences of the time passed out of the socket, frequently with an inadequate storage medium. The replanted ones can present later ankylosis and external resorption and likewise in severe injuries where the loss of attachment and marginal bone are drastically affected, regular follow up are recommended. Repeated trauma over those susceptible structures should be taken into account in malocclusions or bruxist patients. In any case, the first attempt should always include the most conservative treatment option. (43)

In incidents where a conservative management is not possible, for example in TDI with avulsions and follow ups of other severe injuries, implants are included in the treatment plan to restore the missing teeth.

7.5 TEMPORARY SOLUTIONS PRE IMPLANT PLACEMENT

When the patient's situation does not permit the implantation or the requirements for it are not yet all fulfilled, temporary solutions that can optimize the future treatment have to be applied. Temporary bridges, space maintainers and provisional restorations can help to keep the space and lead to gum and soft tissue healing and shaping for a better prognosis.

The goals of provisional restoration include keeping the position of the adjacent teeth, preventing migrations, rotations or extrusions, preservation of the periodontal health, reshaping the soft tissue and papillae, ensuring the proper phonation, mastication and aesthetic.

Depending on the number of missing teeth, there can be placed single tooth provisional rather than fixed partial dentures with pontics. Those can be direct if prepared chair side or indirect if prepared by the laboratory. Materials such as self-curing acrylic resin, self-curing composite resin, polycarbonate, cellulose acetate or aluminum, prefabricated crown can be used.

7.6 AGE RELATED GUIDELINES FOR IMPLANT PLACEMENT: YOUNG PATIENTS

There are no official rigid guidelines related to a fixed chronological age for an implant placement.

For a successful prognosis, the skeletal maturation should be taken into account and it can be accessed by the help of hand wrist radiographs or cephalometric analysis. (8)

Studies showed that if an implant is placed in a young growing child or teenager, the alveolar ridge continues the development, while the implant itself will behave as an ankylosed tooth. So the immediate surrounding of the implant will not take part in the physiological process which can lead to complications such as aesthetic ones, especially in the anterior sector and functional one too. On the other hand, authors suggest that when the germ of permanent teeth is not present, the follow up treatment should focus on the early implant placement to help the competition of the skeletal growth. Meanwhile, cases of early implantation in boys younger than 17 years old and girls younger than 15 in the maxillary anterior sector, the risk of implant located too low in the jaw is present, leading to unsatisfactory results. Moreover, long term deep location of implants can lead to non aesthetic outcomes and early peri-implant infection, as shown in the table of figure 10, including other outcomes. Additionally, the surgeon has to be careful during the operation while suturing the area which might interfere with the transverse growth; so implantation should be performed far away from the axis. When the patient is still in a period of active growth, treatment alternatives such as single crowns or removable or fixed partial denture able to self-adjust three dimensions that do not interfere with the growth should be selected. (44)

In the literature there are many proves about the growth of a child that can lead to changes in the dentition and jaw, except for the area around the implant leading then to the

infra-occlusion of the implant-supported prosthesis, creating complications for the patient. (8)

PICO	Population	Intervention	Comparison	Outcome
Characteristics considered	Children/adolescents below the age of 19 years	Dental implant	Between boys and girls, Between maxilla and mandible, Between anterior and posterior region	Difference in vertical growth of adjacent teeth and alveolus
MeSH terms	Adolescent, Child	Dental implant	Males, Females, Maxilla, Mandible, Dental arch	Growth, Development
Alternative terms	Teenagers, Teens, Youth, Early adulthood, Puberty	Dental implantation, Artificial tooth, Implant support dental prosthesis	Upper arch, Lower arch, Anterior area, Posterior region	Infraocclusion, Occlusal relationship, Underocclusion, Maxillary growth, Mandibular growth

Figure 10- Resume of a systematic review by Rekhalakshmi Kamatha and colleagues where the effects of early implant placement are reported. (8)

Not many articles followed the same objective criteria for measuring the success rates and evaluations such as the one proposed for adults by Albrekttson and Buser. (8)

7.7 IMPLANTS AND SYSTEMIC CONDITIONS

Moreover, life's expectancy is increasing in the world and so, also polymedicated patients which are affected by multiple systemic diseases that can be complicated to manage.

Likewise, in women a non-controlled osteoporosis is considered as a risk factor for the success of an implant placement. This illness causes a negative bone turnover leading to bone reduction and bone quality changes. Bone mineral density (BMD) should be calculated previously to have a precise estimation. A low BMD can increase the chances of fractures and traumas. Furthermore, studies take into account the possible relationship between osteoporosis and periodontal disease. There are many disagreements related to osteoporosis relationships with an increased risk of implant failures and periodontitis, so further studies would help to clarify the contraindications. (35)

Besides, aging is related to systemic diseases complications which can convey to muscles and bone weaknesses, loss of balance and an increased risk of falls and traumas.

All those aspects should be taken into consideration in the moment of planning treatments and the follow ups.

7.8 PERIODONTITIS: A RISK FACTOR

The periodontitis as a risk factor for the failure of implant placement have been investigated. Doctor AlJehani in a review article highlighted the periodontitis and how it can seriously affect the success of surgeries implying bone grafting, implant placing and the long term success. This is the reason why a meticulous periodontal study of the patient should be performed afore the establishment of the treatment plan since it is a risk factor for the failure of an implant.

There are many risk factors that are linked to periodontitis which can affect and influence the choice of implant placement, such as plaque accumulation and poor oral hygiene, leading to periodontal pockets. Additionally, tobacco can compromise the gingival health in many ways, thus the patients should be warned, so they should decrease the consumption to enhance the implant long term success. As well, poor controlled diabetes has been proven to lead to a poor prognosis. Forbye periodontitis can enhance risks and effects of cardiovascular disorders. Also stress and hormonal imbalances can increase the severity of periodontally compromised soft tissues. Many drugs, including antihypertensives, narcotics used as analgesics, sedatives, antihistamines, antimetabolites, sugar-rich liquid or chewable drug

composition, anticonvulsants, calcium antagonists, cyclosporine can induce to xerostomia, gingival hyperplasia, periodontal disorder. Obesity and a diet deprived of calcium and vitamin C can also increase the chances of suffering from oral infections. In various conditions, where the host has poor response to bacterial or viral aggression, an augmented risk of implant failure will be perceived too. (28)

7.9 SURGERY PROCEDURE RISKS

Dentistry such as medicine in general is known as not error free science. Since there is still a notable human presence in the treatments of the patients by doctors which are human beings, a failure risk during or due to the procedure should also be included in the evaluations. Even if each practitioner will always try his/her best to not provoke harm to the patients, iatrogenic incidents and errors can happen. Those can be related to the practitioners, to the environment, or the situation itself which can be challenging and in those cases the doctor will evaluate the situation, if it is worth to accept risks, always aiming to the best for the patient.

Dentists can cause undesired and unwanted iatrogenic traumas in different occasions such as during an extraction in the surrounding structures and teeth, throughout a post removal in endodontic treated teeth, in the course of conservative treatments, performing and endodontic treatment or through orthodontic treatments.

Traumatic episodes or incidents are challenging , thus error free surgeries and procedures might be unavoidable.

This is the reason why a detailed examination and evaluation should be previously performed, to increase the success chances and diminish the procedures failure risks. (45)

7.10 RETAINED TOOTH OR ROOT POST TRAUMA

Periodic follow up can be crucial for a successful outcome of a treatment after a trauma. Steiner and his team have shown that retained teeth and roots preserve the associate alveolar ridge, which can be relevant for a future implant placement, achieving higher esthetic and functional outcomes. His studies revealed that retained root segments appear to be able to maintain well the height and width of the alveolar ridge, preventing the resorption's side effects of those challenging cases.

So, keeping the fragment in situ might help the ridge to fully develop vertically. (42)

This treatment option may be included in long term treatment plans for growing children.

7.11 DENTAL IMPLANT PLACEMENT REQUIREMENTS

To guarantee a long term successful implant placement, all the requirements should be assessed previously.

Taking a step back, the National Health and Nutrition Examination Survey of the US published in 2015 found 52% of adults aged 20-64 had lost one or more permanent teeth.

In partially and fully edentulous patients, the endosseous dental implants are a long term great treatment option.

Implants gained a lot of success in the last years, but they shouldn't be considered always the only and first treatment option for everyone, and it should always be clear to the

patients that implants don’t last forever, and patient’s collaboration is crucial for the best prognosis in the long term.

Bijukumar and his colleagues assess the major factors associated with the failure of the implants which can be either biological or mechanical such as peri-implantitis, degradation of the material and or the bone surrounding it, the implant design, the bone density and patient condition’s play a relevant role. (39)

For the success and full functioning of an implant, osseointegration is one of the keys. (24) (25) Additionally, the factors that dictate bone formation around the implant includes the materials, the design, biomechanical factors, surface charge, chemistry and topography. (39)

The patient's health condition, the bone and periodontal quality play a key role in the implant success. (39)

Traumas follow up can help and those will permit the election of the most suitable treatment for each patient.

In cases where teeth have been exposed to traumas and they present complications such as root internal or external resorption or instability due to the past traumas implying crown/root fractures without a complex or compromised surrounding, the extraction of the tooth can be followed by an early definitive treatment.

Authors sustain the success of immediate implant placement and restoration to reduce the appointments, improve the patient’s comforts and more importantly limit the bone and soft

tissues resorption, an example is presented in the figure 11. This treatment plan option is sensible to a correct and precise planning and execution. The protocol might include before, during and after implant placement procedures such as connective tissues grafts. To guarantee the success of the procedure, the protocol should be applied meticulously. The steps to follow include the provisional restoration of the tooth that will be replaced, an atraumatic extraction will be strictly necessary, a surgical guide will be helpful, followed by an initial stability above 35 Ncm torque, followed by a great three dimensional bone packing, a customized abutment delivery, a provisional reline and connective tissue grafts which can be taken for example from the tuberosity (TCTGs) before, during and after the procedure, depending on the case. (13) (38)

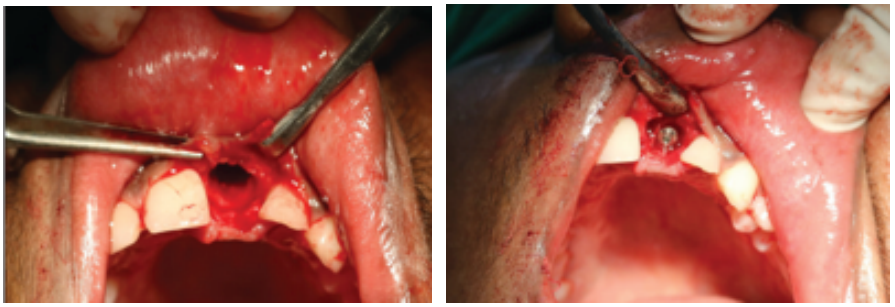

Figure 11- On the left the extraction of a left central incisor and on the right, the immediate implant replacement. (38)

Cone-Beam computed tomography (CBCT) before and after the procedure is helpful to decide the best treatment options and it permits the evaluation of the follow up period.

Digital impressions techniques can be helpful in the process too, as so digitally planned surgical stent. (46).

Authors sustaining the success of immediate implant placement evaluates also the need or not of the grafts and the possible materials that should be used to get a successful outcome. (38)

7.12 ATRAUMATIC EXTRACTION

In cases of teeth that suffered previous past traumas and need a replacement by an implant, the protocol's step aiming an atraumatic extraction is fundamental, whenever possible. The goal consists in conserving as much the coronal bone, limiting bone resorption and achieving a high and predictable result. To do so, no instrument should be placed between the crestal bone and the root. In case of multi radicular teeth, the procedure will consist in cutting vertically the root in the middle by a diamond bur to create and internal trough that will lead to the extraction of the first half firstly and the second more easily , or opening apically an opening to place there the instruments or by using special instruments to retain the root in uni radicular teeth. A post can be then be screwed into the root, pulling it out by a lever arm. (46)

7.13 GRAFTS and MEMBRANES

A treatment plan posterior to a TDI affecting the place where the implant should be placed, needs to take into account the possible application of grafts types, according to each case. There are many different types of grafts and membranes.

Researches sustain and suggest the application of grafts in cases where the jumping distance is bigger than two millimeters. The jumping distance is defined as the residual space

between the implant and the socket walls. In occasions of smaller gaps, the graft placement is not strictly necessary neither it reports a higher or different success rate evaluating the peri implant hard and soft tissues follow ups.

Grafts and barrier material purpose to regenerate and maintain the hard and soft tissues in situ. Autogenous, demineralized or not free dried bone allograft, hydroxyapatites, polytetrafluoroethylene and connective tissue membranes can be applied. (38)

The autogenous bone graft or self-graft is often mentioned by researchers as the gold standard thanks to the absence of immunological reactions, with the limitation of the morbidity that limits the use of it. (11)(13)(38)(39)(40) Autogenous grafts are osteoconductive, osteoinductive, osteogenic, biocompatible, cost-effective, and readily available.

Different donor sites, membranous or endochondral, regional or distant can be selected. Those insertions can vary in the embryology, histological and mechanical properties of each. The block is a solid piece of cortical within a core of cancellous bone. (13) The donor site election varies depending on expected donor site morbidity, also on the bone resorption rate. Single and localized defects will not require a large amount of grafting, by contrast in sizable facial trauma where a notable bone loss is present, more grafting material will be required. Moreover, risks related to intraoral grafts harvesting should be considerate such as relevant morbidity, the resorption and the oral exposures. This is the reason why the donor site and the procedure should be meticulously programmed. The failure and complication of the intra and post-operative phases should also be taken into account. (11)

Systematic literature reviews confirmed evidence of bone gain and high success rates in cases of lateral atrophic ridges regenerated by intraoral bone grafts. (11)(47)

In the table (Figure 11) are presented the results of a study focused on autologous grafting from the zygomatic crest, mandible's ramus or symphysis, anterior sinus walls and the iliac crest. (11)

Allogeneic grafts are extracted from the same species' groups. In studies performed on humans they are harvested from cadavers with different genetic heritage. It is considered to be biocompatible and it will not report the complications of the autologous donor's site graft. Studies confirm that the morbidity and the risk of immune reactions are minimized by processes such as freeze-drying or freezing with or without demineralization process. They are available in licensed tissue banks. (11)(13)

Xenografts materials derive from animals such as cows or horses, after being refined removing completely the organic component. Those can be utilized for small defects such as a tooth's socket scaling. The risk of the recipient site rejection would be diminished by treating previously the grafts, minimizing the immune reaction. (11)(13)

The application of anorganic bovine bone is gaining popularity in cases of vertical and horizontal augmentation, sinus lifting and post extraction cavity filling. (34)

In cases of immediate implant placement, authors suggest the application of xenograft which can be used pre implant placement to fill the gaps, meanwhile the TCTG should be placed fully and circumferentially to get a physiological effect of the soft tissue phenotype. Parameters of the intracrevicular marginal location, soft tissue support and health, interproximal contacts and papilla, aesthetic and functional should be all considered. (46)

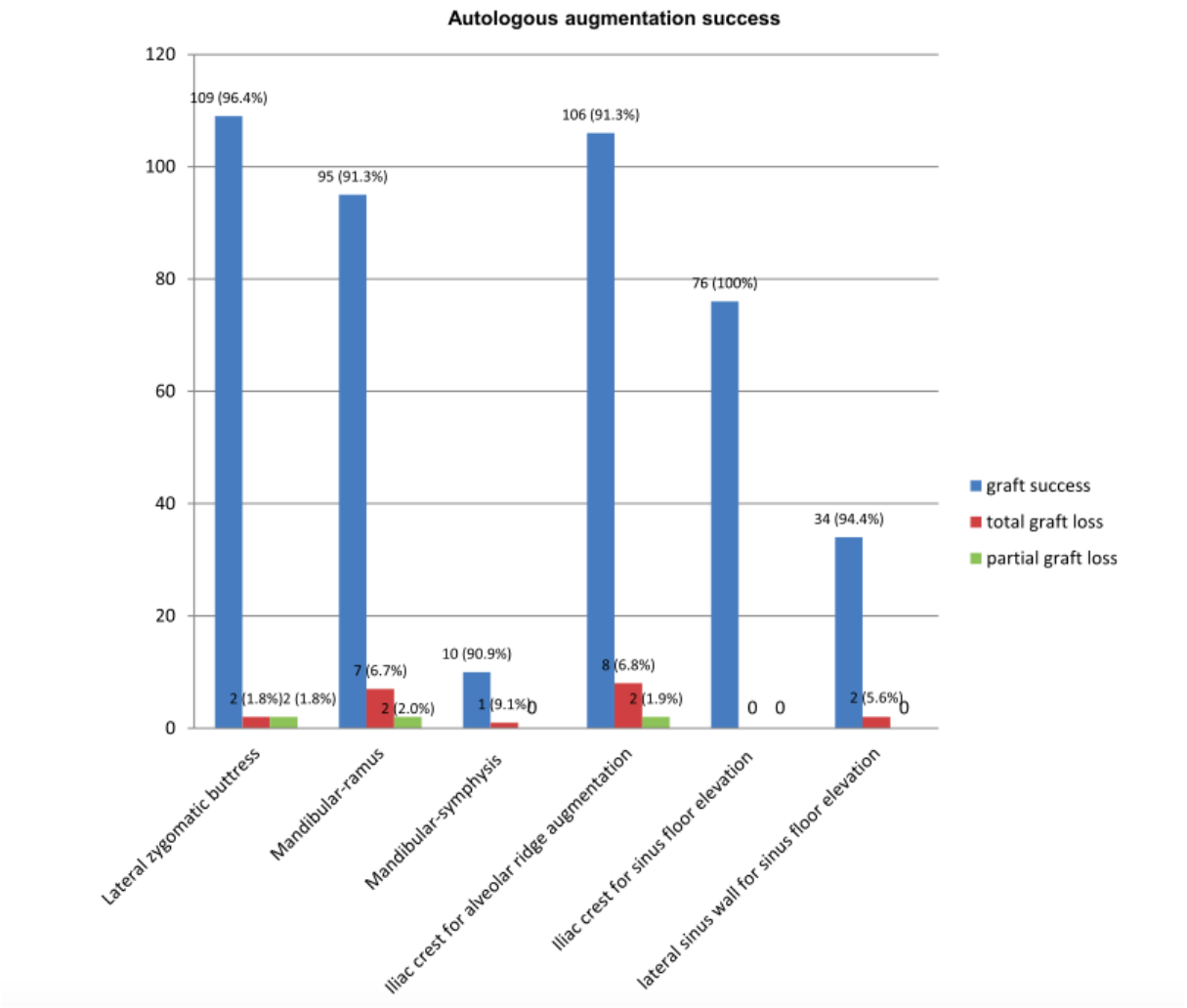

Figure 11 – Surgical outcome after autologous augmentation procedures from different donor sites (11)

Alloplastic grafts are synthetic materials composed by phosphates and bioactive glasses that help to give a physical mesh for bone grafting procedures. Those can be combined with other compounds.

Titanium and its alloys are considered as gold standard for the implants. (39)

In the past other materials have been used such as gold, stainless steel, cobalt chromium and others alloys.

The titanium is still considered a popular alloplastic material that is often used in surgeries for the great properties that it showed. It is either used as pure or in alloys. Layers of titanium dioxide form spontaneously in air and water as it is a non-noble metal. This material has been used to create implants since it allows many compressive and shearing forces to be transferred to the surrounding bone and structures well. Theories sustain that thanks to the oxide layer or a thin film of surrounding tissue's ground substances rich in proteoglycans and glycosaminoglycans on the titanium implant will help to create a great surface interaction with the surrounding structures. The proteoglycans behave as fillers within the biological tissues, binding molecules for cations and water, meanwhile the glycosaminoglycans behave as adhesion molecules of the cell surface. The actual chemical bonding between bone and titanium is still investigated. (24)

Bone morphogenic proteins (BMP) are recently gaining popularity, those are a group of cytokines able to stimulate the patient's osteogenic pathways achieving new bone formation. Authors focus their application on groups belonging to the transforming growth factors (TFG) family of proteins such as the BMPs and BMP 2 and 7. Those are able to interact with the specific cell surface receptor leading to osteoblasts differentiation. Studies reported the success of the application of BMPs and BMP-2 in the continuity defects of both maxilla or mandible post traumatic or pathological conditions. Researchers focusing on the application of the recombinant human BMP (rhBMP-2) achieved adequate bone restoration in the defect

sites, as presented as an example in the figure 13. The implementation of absorbable collagen sponge (ACS) has been applied in some cases to create a collagen scaffold. The ACS helps during the healing stage by allowing the slow release of the BMP, preventing the releasing of those in the bloodstream which can cause systemic toxicity. The structure can be reinforced by a titanium mesh plate which can provide rigid support. It is proven that patients presenting allergies to bovine type I collagen are not candidates for the use of rhBMP-2. (13)(36)(48)

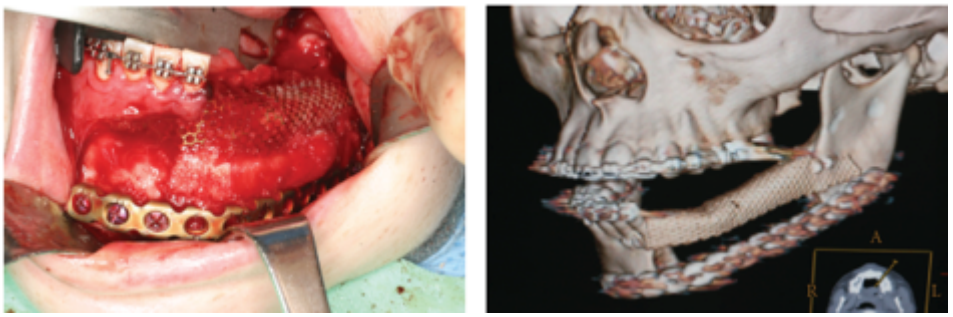

Figure 13- Reconstruction plate of the left body of the mandible with bioimplant, rhBMP-2/ACS, demineralised bone allograft and titanium mesh on the top on the left. On the right, the postoperative CT scan. (49)

To diminish the complication of the grafted sites, studies proved that the application of resorbable or non-resorbable membranes can help. (13)

Barrier membranes' role is to prevent the ingrowth of non-osteogenic cells coming from the surroundings and overlying mucosa. Moreover, they will lead to the ingrowth of angiogenic and osteogenic cells from the marrow space. The implication of membranes is indicated in cases of immediate or delayed extraction socket defects, bone dehiscence defects apically to the implant, lateral or vertical ridge augmentation or sinus floor elevation with or without

ridge augmentation. The use of different types of membranes such as absorbable or not, or such as occlusive or not is debated in many studies, and it will depend on many factors. The barrier should be adapted to the bone contours. (50) In cases of lateral and vertical ridge augmentation cases, a stiffer membrane will avoid the collapse, and in any case the underneath solid structure should be ensured previous to the placement. (51) Membranes can be reinforced by titanium-reinforced expanded polytetrafluoroethylene (e-PTFE) membranes or miniscrews or pins or even recent studies apply the use of self-reinforced polyglycolide membranes. (51)

Furthermore, studies report less bone resorption in cases of the application of titanium mesh over the onlay osseous grafting, leading to stabilization and graft protection. According to further studies, the titanium mesh's holes are appreciated since they allow the blood supply much more compared to other membrane's designs. (49) The mesh firmly stabilized by the titanium screws will guarantee and aim to a great primary closure which is a critical step to guarantee the success of the grafting procedure. (40)

All types of membrane can be subjected to infections and failure themselves. (13)
Other complications can happen such as soft tissue dehiscence with a subsequent membrane exposure, displacement of the membrane during the wound closure, the partial or total collapse of the membrane itself. Incision techniques, flap design and a specific study of each case will improve the predictability of the intervention and tissue healing. (50)

Grafting complications may occur as the loosening and resorption of the graft itself, infections or interaction with closeby anatomical structures.

7.14 BONE AUGMENTATION

Reconstruction and restoration of the place that suffered trauma to achieve high functional and aesthetic results for the patient is the aim of surgeons and dentists.

In cases of atrophic alveolar crests or alveolar defects, the treatment can be challenging.

The bone augmentation approach aims to a successful implant placement. The procedure should be performed simultaneously or separately for implant placement.

There are various techniques such as the split crest technique, onlay with autograft one, guided bone regeneration with or without the membrane, vertical ridge augmentation sinus floor elevation or grafting or Le Fort I osteotomy. Frequently the staged guided technique is applied including the transplantation of the autologous bone, reinforcing it by mechanical support. Authors suggest that this procedure should be applied in cases of a severe alveolar ridge atrophy and cases of residual maxillary bone less than 5 mm, measuring from the sinus floor up to the alveolar crest. (11) The minimum required volume of bone for complete circumferential coverage of the implants should be 4 mm horizontally and 7 mm vertically. Membrane's goal will be creation and maintenance of the space under it to lead to the development of new forming bone. An excess of soft tissue pressure in the area surrounding the graft and membrane should be avoided to avoid the membrane to collapse, leading to a treatment failure. (51)

Authors suggest in some cases the use of autogenous graft that can be collected from the recipient site's apical cortical bone or rather from the implant's placement osteotomy

procedure. The graft can be mixed with calcium sulfate powder and saline and placed over the defect, it will be held in place and covered up by a titanium mesh and screws as shown in the picture below in figure 14. The blood supply and irrigation has a crucial influence in those processes. To achieve so, periosteal releasing should be performed.

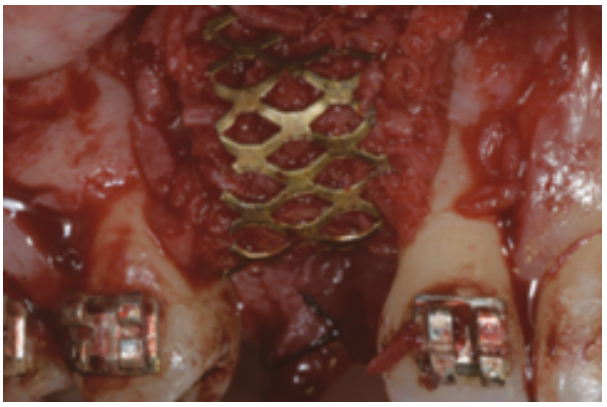

Figure 14- Titanium mesh placed over the graft to ensure it. (49)

If the augmentation takes place as expected, a second surgery will take place to place the implant and an evaluation of a secondary bone grafting will take place in the meanwhile. (40) Clinical studies demonstrated cases where the residual bone allows the implant insertion with primary stability and optimal implant position, where the implant placement and the ridge augmentation can take place simultaneously. (14)

8. CONCLUSION

The reviewed studies miss an agreed protocol related to the data collection and manipulation regarding the TDI. A meticulous worldwide diagnostic protocol to define and classify the TDI is needed, to permit the calculation of precise data reports. It should include a diagnosis performed by instructed health care workers and those studies should be implied to stipulate a detailed prevention program. The TDI is recognized as one of the worldwide most common accidents. Therefore the prevention can lead to decrease the number and

increase the awareness, moreover it can increase the information related to the treatments and restoring possibilities. (16)(42)

Studies are required to agree on a efficacious protocol of action for each case.

Depending on the basic requirements, implant placement has shown to guarantee a great long term success for the functional and aesthetic rehabilitation in most of the cases and studies.

Graft types, techniques and materials are continuously evolving, aiming to find the more suitable for each surgery and further investigations are required to determine if any protocol can work in the majority of cases. More research is required to increase the efficiency and developments of many materials that are required in the surgeries which should aim to be more sustainable, available and accessible in daily practices.

Further investigations are required to establish and determine if there is an age correlation for the implant placement time in growing patients.

9. RESPONSABILITY

In most of the countries, the costs of the treatments posterior to minor or major traumatic episodes are not affordable by the patients themselves.

Health care providers should find a compromise and the goal in the future should aim to make everyone access to basic oral and health treatment worldwide.

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A person's smile can affect the health, the social life and the career perspective of a person. In some cases, a surgery can make and have a perceptible impact on the patient's life.

A basic protocol which can be offered and applied to everyone to satisfy the basic functional and aesthetic needs should be agreed.

Graft bone materials banks should be improved, as so the efficiency of those products.

Moreover, the sustainability of the materials implied in the treatments and surgeries that follow traumatic injuries should focus to be economically and environmentally sustainable for the world and for the patient.

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ANNEXES - First page of articles

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The Indian Journal of Pediatrics (November 2019) 86(11):1043–1047
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REVIEW ARTICLE

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Guest Editor: Bhim S. Pandhi

Dental Trauma in Children: A Quick Overview on Management

Nitesh Tewari[1] · Kalpana Bansal[1] · Vijay Prakash Mathur[1]

Received: 3 May 2019 / Accepted: 13 May 2019 / Published online: 13 June 2019

Abstract
Traumatic dental injuries (TDI) or tooth trauma have a global prevalence of 10–15%. These are often the cause of first visit to emergency room. Prognosis of teeth after injury is dependent on type of TDI, emergency treatment and time elapsed till definitive care. The low level of awareness among general public and medical practitioners often leads to delay in seeking treatment which often leads to pain, severe symptoms and poor prognosis. Pediatricians can play a significant role in identification of TDI, health advise, emergency care and referral to dentists. This paper highlights the important features to be noted in children with history of TDI and the key steps which needs to be taken in these situations.

Keywords Dental trauma · Emergency · Fall · Fracture · Accident

Introduction

Traumatic dental injuries (TDI) or tooth trauma have a global prevalence of 10–15% [1]. These can occur in isolation or associated with pan-facial or bodily injuries. It exhibits two peaks of incidence in boys at 1–3 y and 10–12 y and one peak in girls at 1–3 y of age [1, 2]. The age of 2–3 y is the period of acquisition of walking skills with lesser control on motor co-ordination, which makes these children more vulnerable to falls and injury to front teeth [2]. These injuries to primary or milk teeth are often ignored by parents if they involve tooth's crown, however in severe forms the injury to supporting structures as alveolar bone is the cause of first visit to emergency services. The higher incidence of trauma to permanent teeth in boys is related to their increased indulgence in contact sports and adventure activities [3].

There have been multiple etiologies associated with TDI: falls, sports injuries, fights, road traffic accidents, animal injuries and iatrogenic tooth trauma caused during difficult oral intubation [2–6]. There are certain factors important for determining the type and severity of injury, its emergency and comprehensive management and the sequelae and prognosis [2]. These include age of the child, stage of tooth development, direction and intensity of force, size and shape of impacting object and type and the timing of emergency dental treatment provided [3, 7]. The factors as proclined upper front teeth and problems related to abnormality in gait or motor coordination makes children more susceptible to TDI [6]. Since these injuries generally occur while playing at home and school, there is an inherent need to increase the awareness for emergency measures to be taken in event of TDI among, parents, children, schoolteachers, health workers and medical practitioners including pediatricians and anesthesiologists [1].

Untreated traumatized teeth often lead to unsightly discoloration of fracture crowns of teeth. This may not only put the child at risk of future infection flare/ acute symptoms but also can cause psychological stress.

Types of Dental Trauma

Traumatic dental injuries are best classified with their description (Table 1) [2]. Many times these injuries occur in combinations and create unique presentations (Figs. 1 and 2).

The emergency health care worker, practitioner or pediatrician should be aware of these types of injuries and their emergency management so that prognosis of TDI can be improved with time [7].

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Oral Maxillofac Surg (2013) 17:269–274
DOI 10.1007/s10006-012-0371-4

ORIGINAL ARTICLE

An 11-year review of dental injuries associated with maxillofacial fractures in Turin, Italy

Fabio Roccia · Paolo Boffano · Francesca Antonella Bianchi · Guglielmo Ramieri

Received: 1 June 2012 / Accepted: 22 October 2012 / Published online: 9 November 2012

Abstract
Introduction The aim of the study was to analyze the incidence, characteristics, and correlations between maxillofacial fractures and dental injuries in patients who were treated at a first-level trauma center in a metropolitan center in northwest Italy in the last 11 years.
Material and methods Between January 1, 2001 and December 31, 2011, 2,110 patients with maxillofacial fractures were admitted. Only dentulous patients with complete clinical records who presented with associated dental injuries were included in this study. Data on the age, gender, mechanism of injury, damaged tooth, type of dental injury, site of facial fractures, and concomitant injuries were recorded.
Results On the whole, 267 patients (13.1 %), mainly males aged 20–29 years, presented with 759 dental injuries associated with maxillofacial fractures, especially following motor vehicle accidents. The maxillary teeth, most often the anterior elements with decreasing involvement from the incisors to the molars, were the teeth most frequently damaged overall. The main types of dental trauma in patients with maxillofacial fractures were luxations and dental fractures.
Discussion Our findings show that patients with mandibular fractures were statistically and significantly associated with dental injury, and the teeth in the upper jaw were the most frequently injured teeth, exhibiting mainly luxations and crown fractures. Confirmation of the predominant impact site in patients with dental injuries associated with maxillofacial fractures comes from the 177 lacerations noted in the chin and lip regions in 267 patients.

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Keywords Dental injuries · Maxillofacial trauma · Epidemiology · Facial Injury Severity Scale (FISS)

Introduction

Dental trauma is the most common facial trauma, after facial soft tissue injuries, especially among children and teenagers. It often occurs in falls and involves mainly the anterior dental region [1–5]. Motor vehicle accidents (MVAs), assaults, sports, and work accidents are also causes of dental injuries, and their prevalence varies according the country and local habits [6]. The presence of associated simple or complex fractures involving the maxillofacial region depends on the severity of the facial trauma. Dental injuries may complicate the treatment of these fractures, and patients usually need postoperative dental treatment, which adds to the cost and inconvenience [7].

As few articles [7–9] have described the type and frequency of dental injuries associated with facial trauma, we assessed our 11-year case history to analyze the incidence, characteristics, and correlations between maxillofacial fractures and dental injuries in patients who were treated at a first-level trauma center in a metropolitan center in northwest Italy.

Material and methods

This study is based on a systematic computer-assisted database that has continuously recorded patients hospitalized with maxillofacial fractures in the division of maxillofacial surgery, San Giovanni Battista Hospital, Turin, Italy, since January 2001, with a software update in 2009 [10]. Only patients who stated "dental injury" in the database field for

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International Journal of *Environmental Research and Public Health*

MDPI

Article

Violence as the Most Frequent Cause of Oral and Maxillofacial Injuries among the Patients from Low- and Middle-Income Countries—A Retrospective Study at a Level I Trauma University Emergency Department in Switzerland

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Received: 28 May 2020; Accepted: 3 July 2020; Published: 7 July 2020

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Abstract: Preventive strategies can be developed by gathering more information about oral and maxillofacial injuries and oral pathologies in immigrants from low- to middle-income countries (LMIC). Additional information on the quality of care can also improve the allocation of clinical resources for the management of these patients. We studied immigrants from LMIC who presented in the emergency department (ED) at Berne University Hospital with dental problems or oral or maxillofacial injuries. The patient data included age, gender, nationality, the etiology and type of trauma and infection in the oral-maxillofacial area, and overall costs. The greatest incidence of maxillofacial injuries was observed in the age group of 16–35 years (n = 128, 63.6%, p = 0.009), with males outnumbering females in all age groups. Trauma cases were most frequent in the late evening and were mostly associated with violence (n = 82, 55.4%, p = 0.001). The most common fracture was fracture of the nose (n = 31). The mean costs were approximately the same for men (mean = 2466.02 Swiss francs) and women (mean = 2117.95 Swiss francs) with maxillofacial injuries but were greater than for isolated dental problems. In conclusion, the etiology of dental and maxillofacial injuries in immigrants in Switzerland requires better support in the prevention of violence and continued promotion of oral health education.

Keywords: immigrants; low-income; middle income; facial trauma; maxillofacial trauma; oral health; dental trauma

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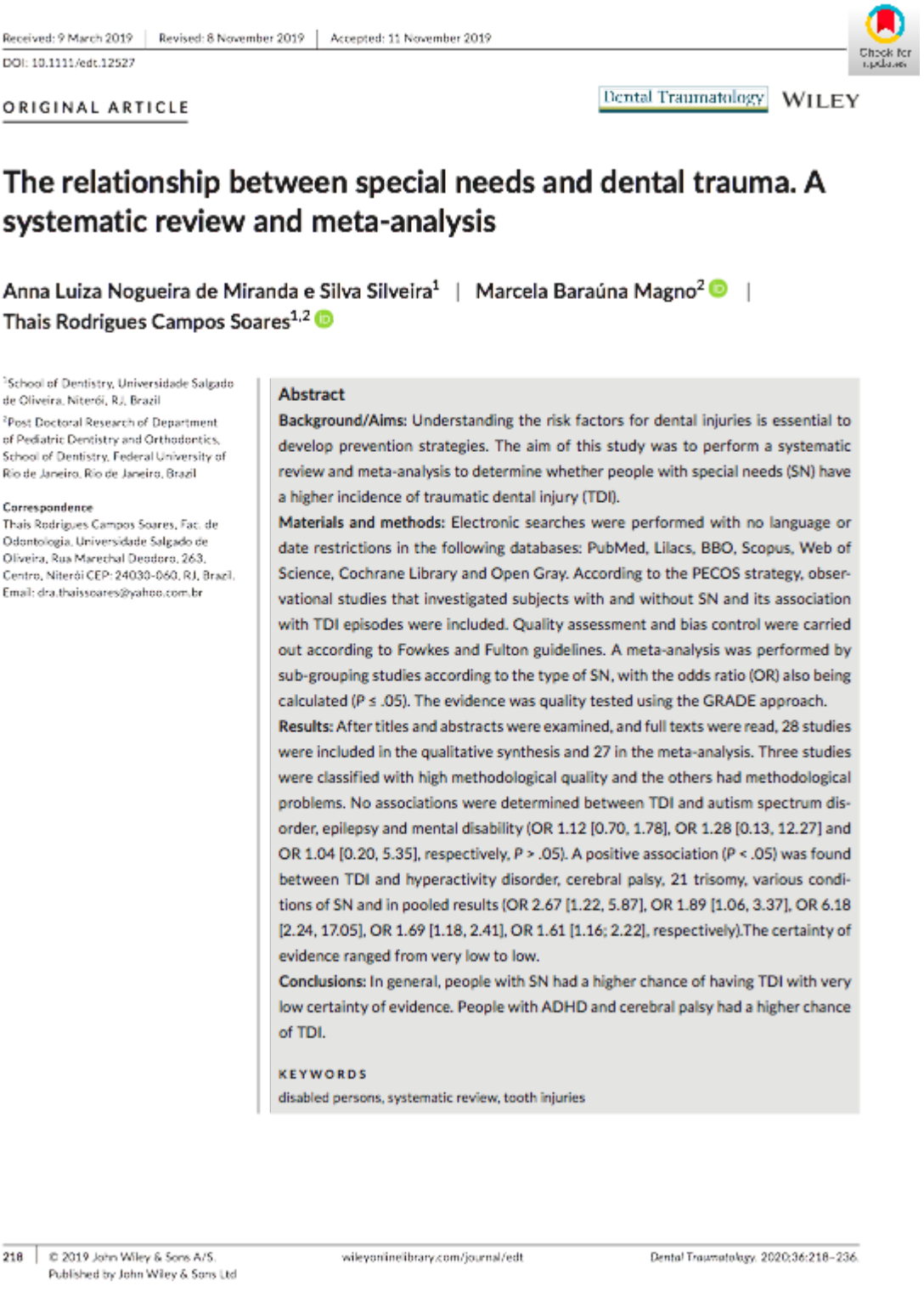

Received: 9 March 2019 | Revised: 8 November 2019 | Accepted: 11 November 2019
DOI: 10.1111/edt.12527

ORIGINAL ARTICLE

Dental Traumatology WILEY

The relationship between special needs and dental trauma. A systematic review and meta-analysis

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Abstract

Background/Aims: Understanding the risk factors for dental injuries is essential to develop prevention strategies. The aim of this study was to perform a systematic review and meta-analysis to determine whether people with special needs (SN) have a higher incidence of traumatic dental injury (TDI).

Materials and methods: Electronic searches were performed with no language or date restrictions in the following databases: PubMed, Lilacs, BBO, Scopus, Web of Science, Cochrane Library and Open Gray. According to the PECOS strategy, observational studies that investigated subjects with and without SN and its association with TDI episodes were included. Quality assessment and bias control were carried out according to Fowkes and Fulton guidelines. A meta-analysis was performed by sub-grouping studies according to the type of SN, with the odds ratio (OR) also being calculated ($P \leq .05$). The evidence was quality tested using the GRADE approach.

Results: After titles and abstracts were examined, and full texts were read, 28 studies were included in the qualitative synthesis and 27 in the meta-analysis. Three studies were classified with high methodological quality and the others had methodological problems. No associations were determined between TDI and autism spectrum disorder, epilepsy and mental disability (OR 1.12 [0.70, 1.78], OR 1.28 [0.13, 12.27] and OR 1.04 [0.20, 5.35], respectively, $P > .05$). A positive association ($P < .05$) was found between TDI and hyperactivity disorder, cerebral palsy, 21 trisomy, various conditions of SN and in pooled results (OR 2.67 [1.22, 5.87], OR 1.89 [1.06, 3.37], OR 6.18 [2.24, 17.05], OR 1.69 [1.18, 2.41], OR 1.61 [1.16; 2.22], respectively).The certainty of evidence ranged from very low to low.

Conclusions: In general, people with SN had a higher chance of having TDI with very low certainty of evidence. People with ADHD and cerebral palsy had a higher chance of TDI.

KEYWORDS
disabled persons, systematic review, tooth injuries

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Coll. Antropol. 36 (2012) 1: 307–311
Case report

Prosthetic Rehabilitation of a Patient with Mandibular Resection Prosthesis Using Mini Dental Implants (MDIs) – Case Report

Denis Vojvodić, Asja Čelebić, Ketij Mehulić and Domagoj Žabarović

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ABSTRACT

Physical disfigurement and functional impairments associated with facial trauma are a challenge to a prosthodontist, because even novel sophisticated surgical reconstructive techniques fail to provide adequate support for dental resection prosthesis. Therefore, different endosseous implants are often used as prosthesis-supporting elements. Manufacturers of dental implants have recently presented mini dental implants (MDIs) with diameter of only 1.8–2.4 mm. These implants allow very suitable prosthetic solutions within the range of their indications due to good osseointegration success rates, simple surgical technique, and immediate loading possibility. In this report, a case was presented for prosthetic rehabilitation including implantation of two Sendax type (IMTEC, Ardmore, Oklahoma, USA) MDIs in mental region, to obtain better retention and stability of the mandibular resection prosthesis and to improve function, phonation and aesthetics. The use of these implants, among aforementioned preferences, is also very cost-effective, so this implantation possibility should be taken into consideration during prosthetic treatment planning.

Key words: *prosthodontics, dental implants, mandibular prosthesis, mandibular injuries*

Introduction

Warfare facial injuries from high-velocity missiles (rifles) are often characterized with large exit wounds, severe distortion and loss of tissue and deep tissue injury from high energy cavitations within the body sometimes also demanding resection of the damaged tissue[1]. In civilian settings indications for resection of the mandible (or maxilla) are usually benign and malign tumors and trauma. Mortality rates, possible physical disfigurement, and functional impairments are usually lower when care is provided in certified trauma centers[2]. Surgical restorations of mandible resections have advanced dramatically with free-flap techniques, but it appears that even these novel surgical reconstructive techniques fail to provide adequate support for dental prostheses[3]. Therefore, it is often considered that the restoration of compromised morphologic conditions after the removal of tissue from lower mouth floor is only effective if endosseous implants are used as prosthesis-supporting elements. These cases are reported in the literature[3,4], but always the conventional implants were used. So, in the recent literature quotation on the use of mini dental implants (MDIs) as a support for resection prosthesis in compromised mandible was not found, although the use of MDIs as an obturator prosthesis support was reported[5].

It should be emphasized that the use of dental implants of smaller diameters in various forms has been present for almost 20 years. In general, these implants are 2.75–3.30 mm in diameter, and they are frequently used in cases of limited bone volume. The MDIs are even smaller, with diameters ranging from 1.8 to 2.4 mm[6].

In the beginning, the main usage of MDIs was only to serve as the helping and provisional instrument for insertion of provisional restorations during the osseointegration phase of conventional larger diameter endosseous implants[7,8] and for orthodontic purposes[9]. The assumption was that MDIs are unable to provide on-going application for implant-supported prostheses[6]. In the course of time, it was observed that these implants integrated very well clinically and were difficult to remove[5,6]. It became clear that, with minimally invasive implant inser-

Received for publication July 28, 2010

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Ayali and Bilginaylar *Head & Face Medicine* (2017) 13:5
DOI 10.1186/s13005-017-0139-z

Head & Face Medicine

RESEARCH Open Access

Evaluating the biomechanical effects of implant diameter in case of facial trauma to an edentulous atrophic mandible: a 3D finite element analysis

Aysa Ayali* and Kani Bilginaylar

Abstract

Background: Rehabilitation using an implant supported overdenture with two implants inserted in the interforaminal region is the easiest and currently accepted treatment modality to increase prosthetic stabilization and patient satisfaction in edentulous patients. The insertion of implants to the weakend mandibular bone decreases the strength of the bone and may lead to fractures either during or after implant placement. The aim of this three dimensional finite element analysis (3D FEA) study was to evaluate the biomechanical effects of implant diameter in case of facial trauma (2000 N) to an edentulous atrophic mandible with two implant supported overdenture.

Methods: Three 3D FEA models were simulated; Model 1 (M1) is edentulous atrophic mandible, Model 2 (M2), 3.5x11.5 mm implants were inserted into lateral incisors area of same edentulous atrophic mandible, Model 3 (M3), 4.3x11.5 mm implants were inserted into lateral incisors area of same edentulous atrophic mandible.

Results: In M1 and M2 highest stress levels were observed in condylar neck, whereas highest stress values in M3 were calculated in symphyseal area.

Conclusions: To reduce the risk of bone fracture and to preserve biomechanical behavior of the atrophic mandible from frontal traumatic loads, implants should be inserted monocortically into spongious bone of lateral incisors area.

Keywords: Mandible, Fracture, Dental implant, Overdenture, Finite element analysis

Background

Although dental implant placement has become a usual treatment in recent years, the treatment of patients with atrophic mandible is still challenging. In the moderately or severely resorbed edentulous mandible, rehabilitation using an implant supported overdenture with two implants inserted in the interforaminal region is the easiest treatment modality to increase prosthetic stabilization and patient satisfaction [1, 2]. Such surgical procedures are anticipated, however, complications can be seen such as infection, improper placement, neurosensory injury, bleeding and mandible fracture which has a reported occurrence rate of 0.2%. The rate of incidence seems to be low, but it leads to overwhelming outcomes such as malunion, non-union, paresthesia, osteomyelitis and prolonged functional and nutritional disturbances [3]. On the other hand, the mandible is the most common broken bone by cause of facial injuries with the ratio of 23–97% [4]. The insertion of implants to the weakend mandibular bone decreases the strength of the bone and may lead to fractures either during or after implant placement [5]. Numerous case reports of fractured athrophic mandible secondary to implant insertion were reported in the literature [3, 6–8].

The principal areas of mandibular fracture are located in the condylar neck, the body or the angle and the symphysis of the mandible. The biomechanical behaviour of the mandible is important to know to understand the mechanism of fractures and to optimize treatment scenarios [9]. Clinically, the pattern of mandible fracture is related to various causes such as intensity and direction of the force, location of the impact point, position of the

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Received: 2 December 2018 | Revised: 17 July 2019 | Accepted: 18 July 2019
DOI: 10.1111/edt.12504

CASE REPORT

Dental Traumatology WILEY

Initial management and long-term follow up after the rehabilitation of a patient with severe dentoalveolar trauma: A case report

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Abstract

Dental trauma is common and for patients who suffer significant oral injuries, rehabilitation can be challenging to the clinical team. This case report describes the successful prosthetic replacement of multiple missing teeth lost due to severe dentoalveolar trauma, using iliac crest bone grafting, an implant-retained removable dental prosthesis and implant-supported crowns. Good functionality and aesthetic outcome were achieved.

KEYWORDS

dento-alveolar trauma, gunshot wound, implant-supported prosthesis, oral rehabilitation

1 | INTRODUCTION

Over the past decade, multi-system injuries from violent crimes including gunfire have been on the rise in the United Kingdom.[1] These patients often require multi-disciplinary input in their acute management and subsequent functional rehabilitation.[2] Dental interventions could be categorized as the management of any anatomical/bony defect (bone augmentation, sinus lift or distraction) and provision of dental prostheses.[3–5] Dental prostheses to replace missing teeth and bone may be removable dental prostheses (RPD), fixed dental prostheses (FDP) or implant-supported prostheses.[6,7]

From a rehabilitation point of view, treatment plans need to be constructed around the degree of tissue loss, patient compliance with maintenance, existing dental conditions, aesthetic outcomes, technical feasibility and patient preference.[8–10] The choice of treatment relies on a variety of factors, and patient acceptance of therapy may depend on the implications of costs, desire for a fixed or removable solution, duration of treatment, complexity of therapy, previous experience and surgical risks.[8,9,11] Whilst an implant-supported prosthesis may in some circumstances have aesthetic and biomechanical superiority, the cost and surgical risks often limit their use.[7] A simple removable prosthesis could be a preferred choice due to ease of oral hygiene, cost-effectiveness, shorter treatment duration, low complexity and lip support for ridge atrophy or defects.[8,9] In cases where the levels of retention and function are unsatisfactory with a removable dental prosthesis, a fixed dental prosthesis could be considered as a treatment alternative.[4]

This case demonstrates the complexity of dental management in a patient with complex dentoalveolar trauma as a result of a gunshot wound. It also shows the significance of a delay in initiating various stages of treatments due to patient factors. Iliac crest bone augmentation, implant-supported crowns and an implant-supported removable dental prosthesis with its associated flange and composite stains were used in achieving a functionally and aesthetically pleasing outcome. No maintenance was needed from the time of initial management for a period of 12 years, at which time the patient represented as he lost his removable prosthesis.

2 | CLINICAL REPORT

The patient, a male aged 36 years, had sustained a series of gunshot injuries to his left jaw, left humerus, right femur and left chest in June 1993. The initial maxillofacial assessment revealed that the injuries involved a comminuted fracture of the left mandibular body, loss of teeth from the left maxilla and mandible (Figure 1), skin and tongue lacerations. His early stabilization management comprised tracheostomy, wound closure and rigid inter-maxillary fixation for

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Adverse Effects of Implants in Children and Adolescents: A Systematic Review

Rekhalakshmi Kamatham*/ Priyanka Avisa**/ Dileep Nag Vinnakota***/ Sivakumar Nuvvula****

Objective: *To determine the evidence on the adverse effects of placing dental implants in healthy growing children.* ***Study design***: *A systematic search was conducted in five electronic databases: PubMed, Ovid, Cochrane, EBSCO host, ProQuest. Studies on implants placed in children below the age of 19 years, with loss of tooth either due to trauma or caries were included, whereas, studies on mini implants and implants placed due to congenital absence of teeth were excluded. The articles that fulfilled the inclusion criteria were analyzed based on the predetermined criteria of success.* ***Results***: *A total of 8 publications fulfilled the inclusion criteria. All the included articles were case reports/ series, involving a total of 16 implants (15 maxillary, one mandibular) in 11 adolescents (7 boys and 4 girls). The age of implant placement ranged between ten to 17 years with a mean age of 13.4 years and the follow up period, 4.5 months to 13 years. Pain, paresthesia, mobility or peri-implant radiolucency was not reported in any case report, indicating good integration. Radiographic crestal bone loss, probing depth and implant esthetics were not mentioned. The infraocclusion was not reported in 5 cases (age: 11-17 years, follow up: 4.5 months-two years), however, it was an adverse effect in 6 cases (age: ten-17 years, follow up: three-13 years).* ***Conclusion***: *There is insufficient evidence to contradict the placement of dental implants in healthy growing children; the only reported adverse event is infraocclusion, the management of which too is discussed. However, as all the data is from case reports, the result should be interpreted with caution. Therefore, well-designed randomized controlled trials are needed to address this gap in the literature.*

Keywords: *Adolescents, Children, Dental, Implant*

INTRODUCTION

Implant dentistry, in recent times, has tremendous popularity and attention for the prosthetic replacement of the lost teeth in adults.[1-3] The benefits and long term success of implants is the basis for its wide use.[3,4,5] However, this topic has gained certain controversies in children and adolescents; few advocate,[6-12] whereas, others contradict their usage.[13-15] Hence, in spite of the drawbacks with the use of removable prosthesis, such as retention problems, child's cooperation to wear the prosthesis, failure of alveolar ridge development, psychological and emotional disturbances in children due to missing teeth, it has been the choice of treatment for the interim rehabilitation in growing children with partial or complete edentulism.[23-25]

The use of implants in young patients differs significantly from adults in many aspects, among which special focus has been given in the existing literature to the growth of child that can lead to changes in the dentition and jaws, except for the area around the dental implant.[23,24] This is supposed to lead to infraocclusion of the implant-supported prosthesis compared with the rest of the dentition.[9,13-15,19,25] This aspect has been posed as a significant risk, due to which implant dentistry could not gain its place in Pediatric dentistry. Despite this, there are certain reports that presented the use of implants in the growing children and successful management of the infra occlusion.[9,13-15,25] Taking these aspects into consideration, as an in depth investigation of the existing literature is the

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Understanding Peri-Implant Endosseous Healing

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Re-issued from: Journal of Dental Education
Volume 67, Number 8, August 2003

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2004
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Sakkas et al. International Journal of Implant Dentistry (2017) 3:23
DOI 10.1186/s40729-017-0084-4

International Journal of Implant Dentistry

RESEARCH Open Access

Autogenous bone grafts in oral implantology—is it still a “gold standard”? A consecutive review of 279 patients with 456 clinical procedures

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Abstract

Background: This study assessed the clinical outcomes of graft success rate and early implant survival rate after preprosthetic alveolar ridge reconstruction with autologous bone grafts.

Methods: A consecutive retrospective study was conducted on all patients who were treated at the military outpatient clinic of the Department of Oral and Plastic Maxillofacial Surgery at the military hospital in Ulm (Germany) in the years of 2009 until 2011 with autologous bone transplantation prior to secondary implant insertion. Intraoral donor sites (crista zygomatico-alveolaris, ramus mandible, symphysis mandible, and anterior sinus wall) and extraoral donor site (iliac crest) were used. A total of 279 patients underwent after a healing period of 3–5 months routinely computer tomography scans followed by virtual implant planning. The implants were inserted using guided oral implantation as described by Naziri et al. All records of all the consecutive patients were reviewed according to patient age, history of periodontitis, smoking status, jaw area and dental situation, augmentation method, intra- and postoperative surgical complications, and surgeon’s qualifications. Evaluated was the augmentation surgical outcome regarding bone graft loss and early implant loss postoperatively at the time of prosthodontic restauration as well a follow-up period of 2 years after loading.

(Continued on next page)

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Keith Horner, Andrew M. Shelley

Preoperative radiological evaluation of missing single teeth: A review

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Key words *dental implants, diagnostic imaging, edentulous, jaw, partially, patient selection, radiology*

Aims: Missing single teeth can be treated in several ways and preoperative radiological evaluation varies accordingly. The main area of controversy relates to the need for cross-sectional imaging in the context of implant treatment. In this context, the aim of the systematic component of this review was to determine whether the use of additional cross-sectional imaging has any impact on diagnostic thinking, treatment planning or outcome, compared with conventional imaging alone. An additional aim was to present information relating to diagnostic efficacy, dose of radiation, economic aspects of imaging and selection criteria.

Materials and methods: PubMed/MEDLINE, OVID/Embase and the Cochrane central register of controlled trials were searched up to and including June 2015. Studies were eligible for inclusion if they compared the impact of conventional and cross-sectional imaging when placing implants. Quality assessment of studies was performed. Synthesis was qualitative.

Results: Twelve studies were included, all of which had a 'before-after' design. Only three of these were limited to single implant treatments with none limited to immediate implants. There were methodological problems with most of the studies and results were sometimes contradictory regarding the impact of cross-sectional imaging.

Conclusions: It is tentatively suggested that cross-sectional imaging may not be required in straightforward, unchallenging, cases of missing single teeth being considered for implant treatment. Beyond this, no strong evidence exists to inform the choice of imaging. Existing guidelines on preoperative imaging for missing single teeth are not unanimous in their recommendations, either for implant or non-implant treatments.

Conflict-of-interest statement: *The authors declare that they are authors of one paper included in the systematic review part of this paper. Otherwise there are no conflicts of interest.*

Introduction

Treatment planning for replacement of missing single teeth requires a thorough history and clinical examination, usually supplemented by radiological examination. It is a fundamental principle of radiation protection that all clinical uses of ionising radiation must be justified in advance at the individual patient level[1]. Furthermore, some radiological modalities can be expensive, particularly those typically used in more complex treatments such as implants. Therefore, from both radiation protection and economic perspectives, it is important to use radiological diagnostic procedures only when it is appropriate to do

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Future of bone pathology, bone grafting, and osseointegration in oral and maxillofacial surgery: how applying optical advancements can help both fields

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Alan S. Herford

SPIE

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Clin Oral Impl Res 1999: 10: 24–33
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CLINICAL ORAL
IMPLANTS RESEARCH
ISSN 0905-7161

Implant placement and simultaneous ridge augmentation using autogenous bone and a micro titanium mesh: a prospective clinical study with 20 implants

von Arx T, Kurt B. Implant placement and simultaneous ridge augmentation using autogenous bone and a micro titanium mesh: a prospective clinical study with 20 implants.
Clin Oral Impl Res 1999: 10: 24–33. © Munksgaard 1999.

This prospective clinical study evaluated bone regeneration around 20 dental implants placed in 15 patients (mean age 39.7 years). Peri-implant bone defects were augmented with autogenous bone grafts harvested intraorally from the mandible (chin or retromolar area). Augmented sites were covered with an individually trimmed micro titanium mesh which was rigidly affixed with microscrews to the residual jaw bone. Height of implant exposure (mean 6.5 mm), i.e. dehiscencies (80%) or fenestrations (20%), and graft height (mean 6.2 mm) were measured in an apico-coronal direction using a periodontal probe. At re-entry (mean interval 6.6 months) the titanium mesh and microscrews were removed and bone regeneration assessed. The mean height of the integrated bone graft was 5.8 mm corresponding to a mean bone fill of 93.5%. The overall postop healing course was excellent with only one site developing a soft tissue dehiscence with subsequent mesh exposure (complication rate 5%). This study demonstrated that a micro titanium mesh in combination with autogenous bone grafts is effective for treatment of peri-implant bone defects.

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Key words: ridge augmentation – implant placement – autogenous bone graft – micro titanium mesh – simultaneous approach

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Accepted for publication 24 August 1998

The use of dental implants in oral rehabilitation has become a standard of care in dentistry. The ability to augment the alveolar ridge has dramatically expanded the scope of implant dentistry. For the last 10 years, ridge augmentation techniques, either prior to or simultaneous with implant insertion, have become established treatment modalities. In 1988 Dahlin et al. reported the successful regeneration of bone defects by guided tissue regeneration in an animal study. One year later the same group published an experimental study in rabbits with formation of new bone around titanium implants using the membrane technique (Dahlin et al. 1989). The first clinical studies of implant placement and simultaneous ridge augmentation using the membrane technique were published in 1990 by Becker & Becker and by Nyman et al. At the same time Buser et al. (1990) reported the successful regeneration and enlargement of jaw bone using GBR prior to implant insertion. Since, different treatment procedures have emerged for localized ridge augmentation in implant dentistry. Treatment options include the application of different surgical techniques and the use of a great diversity of materials (Table 1). Many clinical studies have shown that implant placement and ridge augmentation can be performed simultaneously. However, this treatment approach should only be chosen if the residual bone allows implant insertion with primary stability and an optimal implant position from a prosthetic point of view. Otherwise, a staged approach, i.e. ridge augmentation prior to implant placement, is recommended. Choosing the right surgical approach (i.e. simultaneous versus staged approach) has been simplified by enhanced radio-

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Vol. 130 No. 1 July 2020

Nonfixated inlay graft for anterior localized mandibular defect

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Localized vertical bone defects within the anterior mandibular alveolar ridge frequently pose a unique challenge for functionally and aesthetically pleasing rehabilitation of this area. Causes for significant bone loss in this region may include periodontal disease, post-extraction atrophy, trauma, and orthodontic treatment. In the presence of such a defect, ridge augmentation may be obligatory before installation of dental implants. Several surgical procedures, notably bone augmentation techniques, including guided bone regeneration, onlay bone grafting, and interpositional grafts, have been described. However, loss of a single incisor or a few incisors may render these methods complicated for surgical manipulation. In this article, we aim to report the outcome of 4 cases with localized vertical osseous deficits in the anterior mandible, treated by using a technique whereby we utilized the bony defect's margins through a vestibular approach to wedge inlay grafts without additional fixation or distraction hardware, thus overcoming the surgical difficulties and achieving a favorable outcome. (Oral Surg Oral Med Oral Pathol Oral Radiol 2020;130:e1–e4)

Localized vertical bone resorption of the anterior mandibular alveolar ridge poses a surgical challenge for rehabilitation through the use of dental implants. Among the causes for such a defect is postextraction atrophy, periodontal disease, infection, trauma, neoplasia, and careless orthodontic treatment.[1-4] In such cases, ridge augmentation is obligatory before installation of dental implants. Different surgical procedures for ridge augmentation have been described in the literature and are used extensively, with good outcomes and predictable results.[5] Among these techniques are guided bone regeneration, onlay bone grafts, interpositional bone grafts, and various combinations of these procedures.[6-9] However, the morphologic characteristics of the resorbed anterior mandibular alveolar ridge may render these techniques complicated because of buccolingual deficiency and a short mesiodistal span between the remaining teeth, making the use of fixation hardware difficult to perform.

The present article describes an approach for augmentation of local defects in the mandibular incisors area to overcome the difficulties mentioned above.

MATERIALS AND METHODS

Patients

This observational study includes data obtained from 4 patients, who presented with a localized vertical bone defect in the anterior mandible area, which had to be augmented before implant placement (Table I).

Informed consent for the planed surgical procedure was obtained from all patients.

The inclusion criteria for participating in the study were as follows: (1) indication for implant-supported rehabilitation of 1 to 3 missing incisors in the mandibular region and (2) presence of vertical alveolar bone resorption.

The exclusion criteria for participation in the study were (1) medical contraindication for the installation of dental implants, including unstable diabetes mellitus, prior irradiation treatment to the head and neck region, treatment with intravenous bisphosphonates, and American Society of Anesthesiologists (ASA) score higher than 3; and (2) lack of consent to participate in the study.

All patients were clinically evaluated before the surgical procedure by performing thorough intraoral examination and radiographic inspection, which included periapical plain radiography and cone beam computed tomography (CBCT) of the anterior mandibular alveolar ridge.

Treatment and surgical technique

All patients were treated under local anesthesia. A single horizontal vestibular incision was made in the lining oral mucosa, 7 mm bellow the mucogingival line, underneath the resorbed alveolar ridge (Figure 1A). No crestal or vertical release incisions were made. Meticulous subperiosteal undermining dissection was performed coronally to expose the margins of the bony defect at the alveolar crest and apically for the exposure of the mandibular

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Received for publication Apr 15, 2019; returned for revision Jun 18, 2019; accepted for publication Aug 26, 2019.

2212-4403/$ - see front matter
https://doi.org/10.1016/j.oooo.2019.08.010

Statement of Clinical Relevance

This article describes an efficient technique osseous augmentation of narrow bone defects within the anterior mandible. This modality is designed to overcome a clinical surgical challenge of bone grafting in this region.

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Accepted: 8 February 2018
DOI: 10.1111/edt.12389

COMPREHENSIVE REVIEW

WILEY Dental Traumatology

World traumatic dental injury prevalence and incidence, a meta-analysis—One billion living people have had traumatic dental injuries

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Abstract

Traumatic dental injuries (TDIs) account for a considerable proportion of bodily injuries. Nevertheless, global TDI frequency is unknown, probably because TDI diagnosis is not standardized. This study estimated world TDI frequency. A literature search (publication years 1996-2016) was aimed at covering as many countries, communities, ethnic groups as possible, thus achieving high generalizability. In particular, non-specific keywords, no language restrictions, and large databanks were used. Observational studies reporting proportions of individuals with at least one TDI (prevalence) and who developed TDI (incidence rate) were considered. Prevalence rates to permanent dentition, primary dentition and in 12-year-olds, incidence rate to any tooth for any age, male-to-female prevalence ratio (PR) in 12-year-olds, with 95% confidence intervals (95 CIs), were extracted/calculated. Study quality, Z-score distribution, funnel plot symmetry analysis, between-study heterogeneity, sensitivity, and subgroup analyses were performed. Selected primary studies were 102 (permanent dentition; 268 755 individuals; median age, 13.8 years), 46 (primary dentition; 59 436 individuals; median age, 3.4 years), 42 (12-year-olds; 33 829 individuals), 11 (incidence rate; 233 480 person-years; median age, 7.8 years), and 31 (PR; 16 003 males, 16 006 females). World TDI frequency resulted as follows: permanent dentition prevalence 15.2% (95 CI, 13.0%-17.4%); primary dentition prevalence 22.7% (95 CI, 17.3%-28.7%); 12-year-olds prevalence 18.1% (95 CI, 15.3%-21.0%); incidence rate, 2.82 (95 CI, 2.28%-3.42%) per 100 person-years; PR, 1.43 (95 CI, 1.34%-1.52%). Differences between WHO Regions were found. This study shows that more than one billion living people have had TDI. TDI is a neglected condition which could rank fifth if it was included in the list of the world's most frequent acute/chronic diseases and injuries.

KEYWORDS
epidemiology, global burden of disease, meta-analysis, traumatic dental injury

1 | INTRODUCTION

Traumatic dental injuries (TDI) are very frequent in the society and comprise 85% of patients presenting with injuries to the oral region,[1] although the oral region comprises as small an area as 1% of the total body area, oral injuries account for 5% of all bodily injuries in all ages, and in pre-school children the proportion is as high as 17%.[2] For example, according to a national US survey, one in four individuals aged 6-50 years had evidence of TDI.[3] In the UK, one in five children have experienced TDI to their permanent anterior teeth

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Journal of Dental Research
2017, Vol. 96(4) 380–387

DOI: 10.1177/0022034517693566
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Global, Regional, and National Prevalence, Incidence, and Disability-Adjusted Life Years for Oral Conditions for 195 Countries, 1990–2015: A Systematic Analysis for the Global Burden of Diseases, Injuries, and Risk Factors

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Abstract

The Global Burden of Disease 2015 study aims to use all available data of sufficient quality to generate reliable and valid prevalence, incidence, and disability-adjusted life year (DALY) estimates of oral conditions for the period of 1990 to 2015. Since death as a direct result of oral diseases is rare, DALY estimates were based on years lived with disability, which are estimated only on those persons with unmet need for dental care. We used our data to assess progress toward the Federation Dental International, World Health Organization, and International Association for Dental Research's oral health goals of reducing the level of oral diseases and minimizing their impact by 2020. Oral health has not improved in the last 25 y, and oral conditions remained a major public health challenge all over the world in 2015. Due to demographic changes, including population growth and aging, the cumulative burden of oral conditions dramatically increased between 1990 and 2015. The number of people with untreated oral conditions rose from 2.5 billion in 1990 to 3.5 billion in 2015, with a 64% increase in DALYs due to oral conditions throughout the world. Clearly, oral diseases are highly prevalent in the globe, posing a very serious public health challenge to policy makers. Greater efforts and potentially different approaches are needed if the oral health goal of reducing the level of oral diseases and minimizing their impact is to be achieved by 2020. Despite some challenges with current measurement methodologies for oral diseases, measurable specific oral health goals should be developed to advance global public health.

Keywords: caries, periodontal diseases, tooth loss, dental public health, epidemiology, global health

Introduction

Governments and nongovernmental agencies have made great efforts to improve oral health in recent decades. Subsequent World Health Organization (WHO) findings suggest that prevalence of caries experience has declined in many locations in the world. The largest decline—a 90% reduction in the number of decayed, missing, and filled (DMF) teeth for 12-y-olds—occurred in early 1970s to mid-1990s in the United States and Western and Nordic European high-income countries. The decline was less obvious in low-income countries (Lagerweij and van Loveren 2015). Trends in periodontal health and tooth loss are less well documented than trends in dental caries. Available evidence suggests that the prevalence of periodontal disease (Dye et al. 2007; Bergström 2014) and tooth loss (Sanders et al. 2004; Slade et al. 2014; Bernabe and Sheiham 2014b) has declined in selected high-income countries, but there are recent suggestions of a higher prevalence of periodontitis in the adult US population than previously reported (Thornton-Evans et al. 2013; Eke et al. 2015), coincident with changes in examination criteria from partial- to full-mouth assessment. Also, although the lifetime prevalence of dental caries experience in children, as measured by the DMF index, may have declined in the last 40 y in many high-income countries (Marthaler 2004; Bernabe and Sheiham 2014a), information is

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A supplemental appendix to this article is available online.

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Dental Traumatology

Dental Traumatology 2016; **32**: 58–64; doi: 10.1111/edt.12218

Incidence and causes of dental trauma in children living in the county of Värmland, Sweden

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Key words: dental trauma; trauma incidence; facial trauma; playground safety; school safety; sports accident

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Accepted 15 July, 2015

Abstract – *Aim*: The aims of this study were to determine the incidence of injuries to permanent incisors in 2011–2013 in children aged 8–10 years living in the county of Värmland, Sweden, and to compare it with the incidence rates in 1989/1990 in the county of Västmanland, as well as to determine the cause of dental trauma in relation to time and place. *Method*: The study analysed the patient records from dental visits (2011–2013) of trauma to the permanent incisors in children aged 8–10 years. The incidence rates were the incidence per 1000 children at risk. Standardized incidence rates were calculated for the comparison between different years. Information about month, location where the trauma occurred as well as cause of trauma was recorded. *Results*: A total of 2.2% of 21 721 children aged 8–10 years had experienced at least one trauma. The incidence rate in Värmland increased from 18.9 in 2011 to 21.3 in 2012 to 28.5 in 2013. The standardized incidence rate in Värmland in 2011 and 2012 was not significantly different than in Västmanland in 1989/1990 ($P > 0.05$), but the standardized rates in 2013 were significantly higher than in 1989/90 ($P < 0.001$). Dental trauma occurred most often outdoors, followed by sports arenas/sports fields, and more often at school than at home. Falling and slipping was the most common cause of trauma, followed by accidents during leisure activities, playing and sports. *Conclusion*: The incidence rate for dental trauma has not decreased in the past 20 years, and there is an indication that parents and teachers should be more aware of the risks of dental trauma at leisure times and at school as well as during sports and exercise.

Dental trauma during childhood and adolescence can have an effect on oral health throughout life. The prevalence of dental trauma was reported to be similar in children from all socio-economic status (1–4). Trauma to the facial area may create mild damage to teeth such as concussion or subluxation, or more severe damage such as tooth fractures, root fractures, lateral luxations, intrusions, extrusions or avulsions. The initial impact on pulp may be reversible or may create a latent effect on the vitality of pulp some years after the incident (5–7).

Traumatic dental injuries in both primary and permanent dentitions mostly involve maxillary incisors (8). The incidence of injury is higher between the ages of 1–3 years for primary dentitions and 8–9 years for permanent dentitions, and the incidence is higher in boys for both dentitions. Children with dental malocclusion anterior open bite are reported to have a significantly increased risk for dental damage after a trauma to the facial areas compared to other children (9–13). Diseases such as epilepsy, cerebral palsy and attention deficit hyperactive disorder have also been shown to increase the incidence rate (14–16).

The prevalence of dental traumatic injuries across the world has been reported to be approximately 15–30% in primary teeth in children aged 1–5 years old and between 16–40% in permanent teeth in children aged 6–12 years old (8). In Sweden, the incidence per 1 year among children aged 0–19 years living in the county of Västmanland was reported to be 13.2 injury episodes per 1000 children between October 1989 and September 1990 (17).

A review reports oral injury to account for approximately 5% of all injuries with 92% of these involving damage to the teeth (18). Treatment was considered to be time-consuming, while costs for the injured teeth were reported to be moderate. A trauma to a permanent tooth was reported to require more than one dental visit (19). A Swedish study that collected data from the insurance company Folksam and from telephone interviews with the patients or parents on dental injuries in children aged 0–19 years during a 2-year period in 1993 estimated the total direct and indirect cost of a dental trauma to be SEK 1746 (EUR 188) for trauma to primary teeth and SEK 4569 (EUR 492) for permanent teeth (20). These figures might be underestimated

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Int. J. oral Surg. 1972: **1**: 235–239
(Key words: *teeth, trauma; epidemiology, dental*)

Original Reports

Epidemiology of traumatic dental injuries to primary and permanent teeth in a Danish population sample

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ABSTRACT – The epidemiology of traumatic dental injuries to primary and permanent teeth was studied in a Danish population sample consisting of 487 children. 30 % of the children had sustained injuries to primary teeth, whereas 22 % had injured permanent teeth. 46 % of the children had a history of traumatic injuries to primary and/or permanent teeth. Boys showed more frequent injuries to permanent teeth compared to girls, whereas in the primary dentition only a slight sex difference was found. Individuals showing traumatic injuries to primary teeth did not exhibit a significantly higher frequency of injuries in the permanent dentition compared to a group with no history of traumatic injuries to primary teeth. The annual incidence of traumatic injuries was determined for the examined population. Among boys, peak incidences occurred in the following age-groups: 2–4 years, and 9–10 years. In girls only one peak incidence was found, in the age-group 2–3 years.

(Received for publication 25 September, accepted 6 November 1972)

An apparent contradiction is found in the literature concerning the frequency of traumatic injuries to primary teeth. Thus Gerdin (1969b) found in a Swedish population that 12 out of 718 children (1.7 %) had sustained injuries to primary teeth. In another Swedish population a frequency of 12.5 % was recorded (Lind, Wallin, Egermark-Eriksson & Bernhold 1970), and Schützmannsky (1963) recorded a frequency of 18.9 % in a German population.

Another yet unsolved problem is whether a relation exists between traumatic injuries in the primary and permanent dentition, i.e. whether certain individuals are in fact accident prone throughout childhood and adolescence.

Very little information exists in the literature concerning the incidence of traumatic injuries in the primary dentition. Only a single study has dealt with this problem (Schützmannsky 1963), and no data exist on the incidence of traumatic injuries in children below 4 years of age.

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Dental Traumatology

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Epidemiology of traumatic dental injuries – a 12 year review of the literature

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Accepted 09 February, 2008

Abstract – *Background/Aim:* A traumatic dental injury (TDI) is a public dental health problem because of its frequency, occurrence at a young age, costs and that treatment may continue for the rest of the patient's life. The aim of this paper is to present a12-year, international review of the prevalence and incidence of TDIs including some background factors and a quick, easy method in registering TDIs to receive a primary understanding of the extent and severity of dental trauma. *Material and method:* The databases of Medline, Cochrane, SSCI, SCI and CINAHL from 1995 to the present were used. *Result:* The results indicate a high prevalence of TDIs in primary and permanent teeth and that TDIs exists throughout the world. The prevalence show that one third of all preschool children have suffered a TDI involving the primary dentition, one fourth of all school children and almost one third of adults have suffered a trauma to the permanent dentition, but variations exist both between and within countries. Activities of a person and the environment are probably more determining factors of TDIs than gender and age. A risk profile why some patients sustain multiple dental trauma episodes (MDTE) is necessary to present. All dental clinics should have a prospective ongoing registration of TDIs. The NUC method (N = no TDI, U = uncomplicated TDI, C = complicated TDI) presents if there has been any TDI and the severity of that trauma. *Conclusion:* The trend of TDIs seems to be stable on a high level with variations largely reflecting local differences. Because of the complexity of TDIs, every dental clinic should have a prospective ongoing registration of number and severity of TDIs.

Is a traumatic dental injury (TDI) a public dental health problem today? The answer is an overwhelming 'yes' and the reasons are fourfold. First, trauma to the oral region occurs frequently and makes up 5% of all injuries for which people seek treatment in all dental clinics and hospitals in a county(1). Second, TDIs tend to occur at a young age during which growth and development take place (2). In preschool children, for example, the figure is as high as 18% of all injuries (1). Third, treating a TDI can often be complicated and expensive (3), frequently involving participation of specialists in several disciplines. Fourth, in contrast to many other traumatic injuries treated on an outpatient basis, a TDI is mostly irreversible and thus treatment will likely continue for the rest of the patient's life (2, 3).

Other questions about TDIs are of interest. Will TDIs in the future look the same as they do today? Will it still be 10 to 12-year-old boys that are the most likely victims of dental trauma (4)? Or, will it be an increase among girls because of their increasing interest in sports? Or, are we going to see elderly people who still have their own teeth, with an increased risk of a TDI because of falling (5)? Another new category could be individuals who have lost an anterior tooth because of a TDI and, as an elegant solution, have received an implant. What happens to the implant and the bone when they encounter another TDI? Recent case reports have focused on this type of problem (6–8).

Evidence suggests that there is also an impact of treatment of dental trauma on the quality of life (QoL) of the individual. Recent studies of adolescents have indicated that treatment of permanent incisors with enamel-dentin fractures does not eliminate the impact of trauma on daily life (9, 10). On average, children with an untreated TDI were 20 times more likely to report an impact on QoL because of the injury when compared with children without any TDI (9). More adolescents with a history of treatment of an enamel-dentin fracture suffered from reduced QoL than adolescents with no history of dental trauma. Until now, only a few studies have presented findings on this subject matter (10).

The aim of this 12-year review is to present a broad international review of the prevalence and incidence of TDIs including back ground variables. A quick, easy method of registering TDIs to receive a primary understanding of the extent and seriousness of dental trauma in every dental clinic will also be presented.

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Self-reported dental and oral injuries in a population of adults aged 18–50 years

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Locker D. Self-reported dental and oral injuries in a population of adults aged 18–50 years.

Abstract – Few population-based studies of traumatic dental injury in adults have been undertaken. The objective of this study was to assess the prevalence and severity of injuries to the mouth and teeth among adults aged 18–50 years living in the Canadian province of Ontario. A telephone survey was undertaken based on random digit dialling and 2001 adults in the target age range were interviewed. Overall, 15.5% reported a history of injury to the mouth and teeth. Of these, one-third reported two or more episodes of injury. Males were more likely than females to report injury and to have experienced more than one injury. There was no association with age but a U-shaped relationship with education. When asked about the nature of the worst injury experienced, 85% with a history of trauma reported damage to the teeth and of these, 38.5% reported one or more teeth were chipped and 26.0% broke one or more teeth. One quarter (25.4%) reported avulsions and 6.5% reported luxations. Other types of injury were reported by 3.5%. Two-thirds of the injuries reported occurred before the age of 18 years and one-third after this age. One-fifth of those with tooth injuries had not been treated by a health professional. This was not associated with the nature of the damage that occurred; rather subjects from the lower educational groups were less likely than those from higher educational groups to have received treatment. There was a significant association between injuries to the mouth and teeth and injuries in other body locations. One-third of those reporting two or more episodes of the latter reported having experienced injuries to the mouth and teeth. The results of this self-report study indicate that dental trauma constitutes a significant health issue among adults and that a minority may be injury prone. Health promotion programmes to reduce the incidence of injury among lower socioeconomic groups are needed since these have high rates of injury and the lowest rate of receipt of treatment.

Key words: traumatic dental injury; adults; prevalence; epidemiological survey

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Accepted 4 October, 2005

Over the last three decades there has been a substantial improvement in the oral health of most child populations, as evidenced by declines in the prevalence and severity of dental decay. While caries remains an important public health issue and a significant source of disparities in oral health (1), this decrease in what was the principal dental disorder in childhood suggests that increasing attention is being paid to other oral conditions affecting children (2). One of these is traumatic dental injury. These injuries range from minor fractures of the enamel to more major damage involving the displacement or avulsion of teeth. Such injuries entail significant emotional and social costs to children and their families (3). In addition, the treatment of such injuries involves economic

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DENTAL TRAUMATOLOGY

Post-traumatic use of dental implants to rehabilitate anterior maxillary teeth

Schwartz-Arad D, Levin L. Post-traumatic use of dental implants to rehabilitate anterior maxillary teeth. Dent Traumatol 2004; 20: 344–347. © Blackwell Munksgaard, 2004.

Abstract – The treatment sequel of post-traumatic teeth for the use of dental implants in the anterior maxillary region to rehabilitate anterior maxillary missing teeth was evaluated. Files of 53 healthy patients reporting anterior dental trauma were reviewed. All patients had an anterior maxillary dental implant because of tooth loss after trauma. At initial examination, 18 patients (34%) had root canal treatment and an inflammatory lesion, 15 (28.3%) had a missing tooth on admission, 12 (22.6%) had a prior operation (i.e. root-end surgery or crown lengthening), 4 (7.5%) presented an ankylotic root, and 4 (7.5%) had a root remnant not suitable for rehabilitation, with no inflammatory periapical lesion. Treatment sequences and complications were recorded. Augmentation procedure (i.e. onlay bone graft or guided bone regeneration) was performed in 43 patients (81.1%), and 2 patients (3.8%) had orthodontic extrusion prior to tooth extraction and implantation. Implants were placed immediately in 25 patients (47.2%) and 4 (7.5%) had immediate loading at the time of implantation. Complications and postoperative incidents (fistula, inflammation, swelling hematoma, etc.) were observed in 24 patients (45.3%). There was no difference in complication and postoperative incident rates with regards to the implantation technique. Complications were found at the prosthetic phase in seven patients (13.2%; six fistula and one implant failure). When patients were divided into two groups, with and without an inflammatory lesion, a significantly lower complication and postoperative incident rate were found in the non-inflammatory group ($P = 0.057$). This study reaffirmed the necessity for scrupulous diagnosis of teeth and alveolar bone after a traumatic injury. Treatment is multidisciplinary, requiring surgical, orthodontic, endodontic, operative, and prosthetic compliance. A specially designed treatment plan for each patient is necessary. General rules do not apply.

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Key words: dental trauma; immediate implantation; anterior maxillary implants

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Anterior maxillary implantation is a challenging treatment for both the surgeon and prosthodontist because of the high esthetic demands in this area. As this area is the most traumatized and exposed to habits (1–5), prompt and appropriate management is necessary to significantly improve the prognosis for many of the dentoalveolar injuries, especially in the young patient. Unfortunately, much of this trauma remains untreated, mistreated, or overtreated (6), leading to a more complicated treatment at the time of tooth loss.

The facial cortical plate over the roots of the maxillary teeth is very thin and porous. In young patients, treatment options of traumatized untreatable teeth should consider preserving the ridge dimension and facial cortical plate. Periapical infections, as well as prolonged and stubborn surgical treatments (repeated root-end surgeries),

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Received: 27 August 2016 | Revised: 26 December 2016 | Accepted: 10 January 2017
DOI: 10.1111/cid.12476

ORIGINAL ARTICLE

WILEY

Autogenous bone block grafting provides facial implant tissue stability long-term

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Abstract

Background: Mucosal recession (MR) and bone loss can compromise anterior implant esthetics.

Purpose: To evaluate tissue stability and clinical outcomes of anterior implants augmented with autogenous block transplants long-term.

Materials and Methods: This prospective cross-sectional clinical study analyzed facial tissue recession of anterior implants augmented with autogenous bone blocks and compared them to adjacent teeth in forty patients 52 months post-augmentation. Clinical parameters, MR and implant transparency, were assessed at delivery and follow-up. The hypothesis is that the facial mucosa of augmented implant sites is more resistant to trauma than the gingival margins of adjacent teeth.

Results: Teeth were seven times more likely to present a facial recession than adjacent augmented implants at 52-month follow-up (RR: 7; $P < .001$; 95%CI: 2.7-18.0). Augmented implant sites were six times more likely to present "no-tissue-recession" than adjacent teeth (RR: 6.2; $P < .001$; 95%CI: 2.4-15.7). Mean tooth facial tissue recession was significantly higher than adjacent implants, 1.18 ± 1.05 mm (range: 0-3.5 mm) vs. 0.06 ± 0.2 mm (95%CI: 0.8-1.5; $P < .0001$). Thick biotype teeth were 2 times more resistant to recession than thin biotype teeth (RR: 2.03; $P = .03$; 95%CI: 1.2-3.5). Implant success rates were 100%. Lack of transparency and MR at facial implant sites lasted an average of 52 months and up to 144 without signs of inflammation or pocket formation regardless of the individual's biotype. Facial bone thicknesses of 2.2 mm seem optimal for tissue stability.

Conclusions: Autogenous bone block augmentation with staged implant placement seems to be a predictable, short-healing, reconstructive protocol in the esthetic zone maintaining stable peri-implant tissues long-term. Implant augmented sites seem more resistant to develop a recession than adjacent teeth.

KEYWORDS
bone graft, bone regeneration, bone transplant, endosseous implants, gingival recession, periodontal attachment loss, ridge augmentation

1 | INTRODUCTION

Sufficient quantity and quality of bone is essential for successful implant rehabilitation. Recent human studies have evaluated the long-term predictable outcomes and the influence of the periodontal biotype on the volume maintenance of autogenous block grafts without the use of other membranes but the periosteum.[1-4] Computerized tomographic assessment demonstrated that autogenous osseous transplants predictably maintain stable bone volume around implants after an average of 42 months and up to 5.5 years. However, the occurrence of facial mucosal recession (MR) at augmented anterior sites, after a period of function, warrants further investigation. There are significant differences in bone

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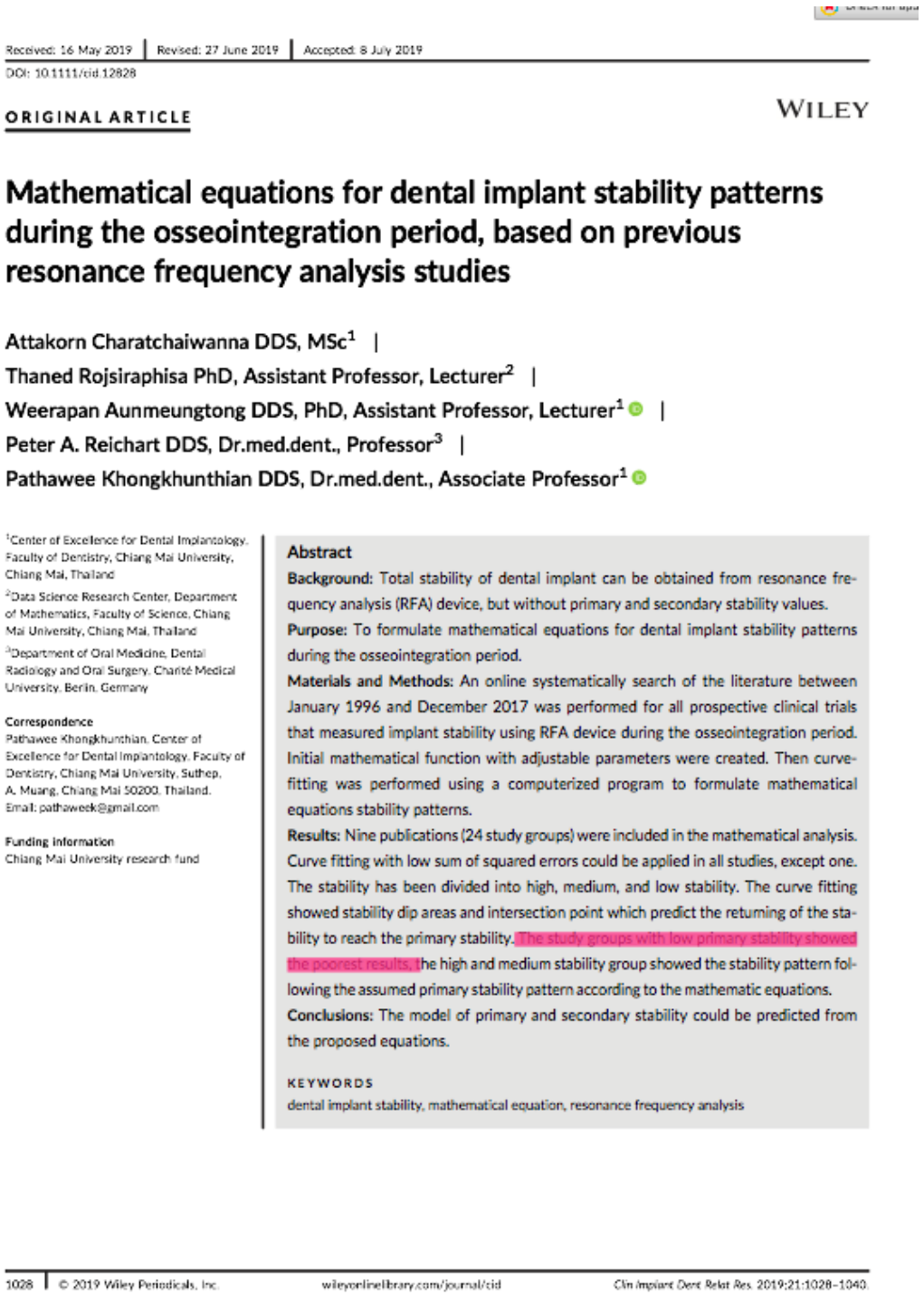

Received: 16 May 2019 | Revised: 27 June 2019 | Accepted: 8 July 2019
DOI: 10.1111/cid.12828

ORIGINAL ARTICLE

WILEY

Mathematical equations for dental implant stability patterns during the osseointegration period, based on previous resonance frequency analysis studies

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Funding information
Chiang Mai University research fund

Abstract

Background: Total stability of dental implant can be obtained from resonance frequency analysis (RFA) device, but without primary and secondary stability values.

Purpose: To formulate mathematical equations for dental implant stability patterns during the osseointegration period.

Materials and Methods: An online systematically search of the literature between January 1996 and December 2017 was performed for all prospective clinical trials that measured implant stability using RFA device during the osseointegration period. Initial mathematical function with adjustable parameters were created. Then curve-fitting was performed using a computerized program to formulate mathematical equations stability patterns.

Results: Nine publications (24 study groups) were included in the mathematical analysis. Curve fitting with low sum of squared errors could be applied in all studies, except one. The stability has been divided into high, medium, and low stability. The curve fitting showed stability dip areas and intersection point which predict the returning of the stability to reach the primary stability. The study groups with low primary stability showed the poorest results. The high and medium stability group showed the stability pattern following the assumed primary stability pattern according to the mathematic equations.

Conclusions: The model of primary and secondary stability could be predicted from the proposed equations.

KEYWORDS
dental implant stability, mathematical equation, resonance frequency analysis

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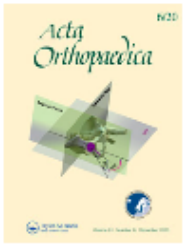

Acta Orthopaedica Scandinavica

ISSN: 0001-6470 (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/iort19

Osseointegrated Titanium Implants: *Requirements for Ensuring a Long-Lasting, Direct Bone-to-Implant Anchorage in Man*

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To cite this article: T. Albrektsson, P.-I. Brånemark, H.-A. Hansson & J. Lindström (1981) Osseointegrated Titanium Implants: *Requirements for Ensuring a Long-Lasting, Direct Bone-to-Implant Anchorage in Man*, Acta Orthopaedica Scandinavica, 52:2, 155-170, DOI: 10.3109/17453678108991776

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Prague Medical Report / Vol. 119 (2018) No. 1, p. 43–51

Chronological Age as Factor Influencing the Dental Implant Osseointegration in the Jaw Bone

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Received October 19, 2017; Accepted March 19, 2018.

Key words: Chronological age – Dental implant – Osseointegration – Marginal bone level – Intraoral X-rays

Abstract: The objectives of this study were to evaluate osseointegration of dental implant in the jaw bone in the young and elderly population and comparing the results to assess indicators and risk factors as age for the success or failure of dental implants. A retrospective study of 107 implants (Impladent, LASAK, Czech Republic) was prepared. The patients at implants surgery were divided in three groups. The patients were followed-up for a 7-year period. We evaluated osseointegration from long term point of view as a change of marginal bone levels close to dental implant. Marginal bone levels were recorded and analysed with regard to different patient- and implant-related factors. An influence of chronological age on change of marginal bone levels during 6-year retrospective study vas evaluated. The study examined 47 patient charts and 107 implants from the Second Faculty of Medicine, Charles University and University Hospital Motol. We proved that young healthy patients with long bridges or Branemarks have the same progression of marginal bone levels changes. The chronological age hasn't therefore direct influence on the osseointegration from long term point of view. But we found that the length of dental suprastrucure-prosthetic construction negatively influences marginal bone changes, though these results weren't

This study was supported by project 00064203 (FN MOTOL).

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Influence of Different Surface Characteristics on Peri-implant Tissue Behavior: A Six-Year Prospective Report

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Purpose: The aim of this study was to evaluate the behavior of hard and soft tissue around implants with different surface treatments. ***Materials and Methods:*** Eight patients were identified for this study. Each patient received at least 2 implants (1 control, 1 test) into an edentulous quadrant, for a total of 10 pairs of implants. Two types of implants were used: hybrid implants (control) with a dual acid-etched surface in their apical portion and a machined coronal part, and test implants with an acid-etched surface throughout their entire length. Standardized periapical radiographs were taken at baseline, 3 months, 6 months, and 1 year post implant placement and then annually until the 6-year follow-up. Bleeding on probing (BOP) and Plaque Index (PI) were recorded annually. Probing depth (PD) was recorded at the 6-year follow-up. ***Results:*** Moderate crestal bone remodeling was observed during the 1-year post-implant placement evaluation ($P = .001$), and test implants revealed smaller marginal bone resorption ($P = .030$). No significant changes in bone level were observed between the 1-year and the 6-year follow-up appointments, and a significantly smaller bone resorption was found at test implants. No statistically significant differences in bone resorption were found between maxilla and mandible. No statistically significant differences were detected between test and control implants for BOP, PI, or PD. ***Conclusions:*** The preliminary results suggest that implant surface characteristics might affect the bone remodeling phase subsequent to the surgical trauma. However, once osseointegration was established, implant surfaces did not affect bone maintenance over time. Implant surfaces did not affect soft tissue behavior. The results of this pilot study need to be confirmed in a study with a larger sample size and over a longer time frame. *Int J Prosthodont 2015;28:389–395. doi: 10.11607/ijp.4066*

The long-term predictability of osseointegrated implants and maintenance of bone levels over time have been widely documented.[1–5] However, coronal bone loss and implant failure are also occasionally encountered. The reasons for these negative treatment events in some patients are not completely understood. Triggering factors for peri-implant bone loss and implant failure are generally gathered under two main categories: biological factors (eg, presence of an aggressive bacterial strain) and biomechanical factors (eg, excessive mechanical stress).[6–8] However, multifactorial aspects (eg, surgical technique, prosthodontic characteristics, host characteristics) potentially affect bone healing and bone maintenance over time.[8–10]

It is known that the surface topography may influence orientation and proliferation of fibroblasts and osteoblasts on titanium surfaces.[11,12] Human and animal histomorphometric evaluations have shown greater bone-to-implant contact at acid-etched implants compared with machined surface implants.[13,14] In a consensus report published in 2009, it was concluded that "moderately rough and rough surfaces provided enhanced bone integration compared with smooth and minimally rough surfaces."[15]

Some studies have focused on the characteristics of implant surfaces and their potential roles in promoting cell adhesion and plaque accumulation as well as the subsequent pathology of the peri-implant tissues.[16] In particular, rough surfaces accumulate up to 25 times

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Hindawi Publishing Corporation
International Journal of Dentistry
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Review Article

Risk Factors of Periodontal Disease: Review of the Literature

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Received 3 April 2014; Accepted 7 April 2014; Published 20 May 2014

Academic Editor: Jagan Kumar Baskaradoss

Objectives. This paper aims to review the evidence on the potential roles of modifiable and nonmodifiable risk factors associated with periodontal disease. *Data.* Original articles that reported on the risk factors for periodontal disease were included. *Sources.* MEDLINE (1980 to Jan 2014), PubMed (using medical subject headings), and Google Scholar were searched using the following terms in different combinations: "periodontal disease," "periodontitis," "risk factors," and "causal." This was supplemented by hand-searching in peer-reviewed journals and cross-referenced with the articles accessed. *Conclusions.* It is important to understand the etiological factors and the pathogenesis of periodontal disease to recognize and appreciate the associated risk factors. As periodontal disease is multifactorial, effective disease management requires a clear understanding of all the associated risk factors.

1. Introduction

Periodontitis is one of the most ubiquitous diseases and is characterized by the destruction of connective tissue and dental bone support following an inflammatory host response secondary to infection by periodontal bacteria [1, 2]. Severe periodontitis, which may result in tooth loss, is found in 5–20% of most adult populations worldwide [3–5]. Children and adolescents can have any of the several forms of periodontitis such as aggressive periodontitis, chronic periodontitis, and periodontitis as a manifestation of systemic diseases [6–8].

It is now generally agreed that almost all forms of periodontal disease occur as a result of mixed microbial infections within which specific groups of pathogenic bacteria coexist [9–11]. Evidence is reviewed on the potential roles of modifiable and nonmodifiable risk factors associated with periodontal disease. An understanding of risk factors is essential for clinical practice.

1.1. Search Strategy. MEDLINE (1980 to Jan 2014), PubMed (using medical subject headings), and Google Scholar were searched using the following terms in different combinations: "periodontal disease," "periodontitis," "risk factors," and "causal." This was supplemented by hand-searching in peer-reviewed journals and cross-referenced with the articles accessed.

2. Risk Factors of Periodontal Disease

2.1. Modifiable Risk Factors

2.1.1. Microorganisms and Periodontal Disease. The oral bacterial microbiome includes over 700 different phylotypes, with approximately 400 species found in subgingival plaque [12, 13]. The subgingival microflora in periodontitis can harbor hundreds of bacterial species but only a small number has been associated with the progression of disease and considered etiologically important. Subgingival plaque from deepened periodontal pockets is dominated by gram-negative anaerobic rods and spirochetes [14, 15]. Strong evidence has implicated *Porphyromonas gingivalis* [16] and *Aggregatibacter actinomycetemcomitans* [17, 18] to the pathogenesis of adult periodontitis. In addition, *Bacteroides forsythus* [19], *Prevotella intermedia* [18], *Peptostreptococcus micros* [20], and *Fusobacterium nucleatum* [21] have been strongly linked with the progression of adult periodontitis.

2.1.2. Tobacco Smoking. There is accumulating evidence for a higher level of periodontal disease among smokers [22, 23]. Tobacco smoking exerts a substantial destructive effect on the periodontal tissues and increases the rate of periodontal disease progression [24]. Risk factors including tobacco smoking modify the host response to the challenge of bacteria

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Short Communication

Implants in adolescents

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Abstract:

Implants have gained tremendous popularity as a treatment modality for replacement of missing teeth in adults. There is extensive research present on the use of implants in adults, but there is a dearth of data available on the same in adolescents. The treatment planning and execution of implant placement in adolescents is still in its infancy. This review article is an attempt to bring together available literature.

Key words:

Adolescents, anodontia, growth determinants, implants

Access this article online

Website: www.jsponline.com

DOI: 10.4103/0972-124X.119335

Quick Response Code:

INTRODUCTION

Long-term success of oral implants in partially edentulous cases has been the basis for other clinicians to broaden the use of implants to younger patients in whom teeth are missing due to agenesis and/or trauma. Anodontia either primary or acquired occasionally creates the opportunity for the use of dental implants.

Removable prosthesis has always been a choice in children with partially edentulous mouths. Not only are they unaccepted by younger patients, they may lead to increased caries rate, increased residual alveolar resorption and other periodontal complications. Since removable dentures and acid etch bridges are uncomfortable and cumbersome, young patients and their parents often insist to reduce the waiting time and insert implants as soon as possible.

Furthermore, the risk of ongoing alveolar bone resorption after tooth extraction encourages the clinician to go ahead with the oral implants immediately. In the absence of maxillary teeth, the alveolar ridges will not develop and the maxilla will remain underdeveloped both sagittally and vertically. In contrast, the mandiblular growth is not dependent on the presence of teeth. Therefore, in the presence of hypodontia or anodontia, the relationship between two jaws will tend to be disproportionate with class III development as growth continues throughout the normal growth period. Furthermore, physiological and psychological factors increase the pressure to start early treatment. Moreover pediatric implants have also proven to stimulate alveolar bone development.[1]

According to World Health Organization – adolescents are young people between the age of 10 years and 19 years.[2] However, the use of implants in adolescents differs significantly from adult implants. Special importance has to be given to the growth of the child, because a variety of changes occur in the dentition and jaws of the adolescent.

The benefits of implant use in adolescents are as important as the concerns for their premature use, but, they can be beneficial to the growing adult if meticulous diagnosis and treatment plan are followed.

IMPLANTS IN GROWING BONE

There has always been a controversy regarding placement of implants in children and adolescents with few researchers and clinicians advocating their use in this group of patients and a few others strictly contraindicating their usage.

One of the pioneering studies concerning growth patterns of the dental arches and replicating the implant insertion was carried out by Bjork[3] wherein he implanted 0.5 mm × 1.5 mm. tantalum pins in the jaws of growing children as stable landmarks for longitudinal cephalometric studies. Although most pins were stable, pins affected by growth were not. Orthodontic tooth movement also displaced the pins. Nearly all the pins placed in the resorptive areas such as the anterior mandibular ramus, were lost and had to be replaced. In addition, pins placed in areas of appositional bone growth gradually became embedded.[3]

Oesterle *et al.*,[4] and Brahim[5] compared dental implants to ankylosed primary teeth. An osseointegrated implant would behave much like an ankylosed primary tooth, with the same lack of alveolar growth and dental eruption. These authors proposed that implants placed in the posterior maxilla in children may become buried

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Submission: 08-12-2012
Accepted: 20-06-2013

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Oral Maxillofac Surg (2008) 12:49–60
DOI 10.1007/s10006-008-0109-5

REVIEW

Concepts for the treatment of adolescent patients with missing permanent teeth

M. Behr · O. Driemel · V. Mertins · T. Gerlach · C. Kolbeck · N. Rohr · T. E. Reichert · G. Handel

Published online: 2 July 2008

Abstract
Introduction Missing permanent teeth is observed with syndromes or is frequently hereditarily propagated in families. The treatment of these patients is a multi-task of specialists of oral surgery, orthodontics and prosthodontics. *Discussion* Despite functional and aesthetic considerations, the main problem of all treatment is that it had to be performed in a growing child. This article discusses the conventional and implant-driven concepts to treat patients from childhood to adolescence with selective or multiple missing permanent teeth.

Keywords Missing permanent teeth · Implants · Prosthodontics · Treatment concepts · Growing child

Introduction

Formation of hard tooth substance and periodontium results from a series of epithelial and mesenchymal interactions. However, this complex process is susceptible to dysfunctions [75]. A distinction needs to be drawn between malformations of the dentine, enamel and cement—which may result in the mutation of a tooth's phenotype—and the congenital missing permanent teeth that can be further divided into anodontia, oligodontia and hypodontia [15, 41, 63, 61, 82]. The term anodontia stands for total agomphiasis, whereas oligodontia refers to the missing of more than six permanent teeth and hypodontia refers to the missing of less than six permanent teeth. The aim of this study is twofold: first, to assess the clinical environment in which dysfunctions such as missing permanent teeth occur and in which such dysfunctions have to be regarded and, secondly, to exemplify therapeutic concepts by means of case studies.

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Prevalence

The prevalence of congenital missing permanent teeth has been investigated in numerous studies. In their meta-analysis of 2004, Polder et al. found a prevalence of permanent missing teeth in 1.5% to 3.1% of patient groups investigated [133]. The most affected teeth were the mandibular second premolar followed by the upper lateral incisor and the upper second premolar. Central incisors, canines or molars were rarely affected. Approximately 48% of patients had only one tooth missing, 35.1% suffered the missing of two permanent teeth and less than 1% of patients suffered the missing of more than six permanent teeth [133]. Women were more frequently affected than men by a factor of 1.37 [133]. No statistically significant difference could be found between upper and lower jaw. Remarkably, these studies [1, 4, 9, 10, 19, 23, 26, 31, 40, 41, 43, 53, 56, 57, 63, 66, 76, 79, 105, 107, 108, 117, 132, 145, 150, 158, 168, 170, 176, 178—the oldest was conducted in 1936 [41]—show the highest prevalence in publications dating between 1971 and 1980. [43, 53, 57, 63, 66, 76, 79, 105, 107, 108, 117, 132, 145]

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Orthodontic aspects of the use of oral implants in adolescents: a 10-year follow-up study

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SUMMARY The aim of the present study was to evaluate the long-term effect of implants installed in different dental areas in adolescents. The sample consisted of 18 subjects with missing teeth (congenital absence or trauma). The patients were of different chronological ages (between 13 and 17 years) and of different skeletal maturation. In all subjects, the existing permanent teeth were fully erupted. In 15 patients, 29 single implants (using the Brånemark technique) were installed to replace premolars, canines, and upper incisors. In three patients with extensive aplasia, 18 implants were placed in various regions. The patients were followed during a 10-year period, the first four years annually and then every second year. Photographs, study casts, peri-apical radiographs, lateral cephalograms, and body height measurements were recorded at each control.

The results show that dental implants are a good treatment option for replacing missing teeth in adolescents, provided that the subject's dental and skeletal development is complete. However, different problems are related to the premolar and the incisor regions, which have to be considered in the total treatment planning.

Disadvantages may be related to the upper incisor region, especially for lateral incisors, due to slight continuous eruption of adjacent teeth and craniofacial changes post-adolescence. Periodontal problems may arise, with marginal bone loss around the adjacent teeth and bone loss buccally to the implants. The shorter the distance between the implant and the adjacent teeth, the larger the reduction of marginal bone level. Before placement of the implant sufficient space must be gained in the implant area, and the adjacent teeth uprighted and paralleled, even in the apical area, using non-intrusive movements. In the premolar area, excess space is needed, not only in the mesio-distal, but above all in the bucco-lingual direction. Thus, an infraoccluded lower deciduous molar should be extracted shortly before placement of the implant to avoid reduction of the bucco-lingual bone volume.

Oral rehabilitation with implant-supported prosthetic constructions seems to be a good alternative in adolescents with extensive aplasia, provided that craniofacial growth has ceased or is almost complete.

Introduction

The number of long-term reports on endosseous implant treatment in children and adolescents with missing teeth is limited. Consequently, it has become increasingly clear that there is a need for more information as to whether dental implants in young dentitions should be used at all, and if so, how and when. It has to be realized that this treatment protocol, creating an intimate contact between implant and bone, i.e. osseo-integration, was designed and evaluated for the mature skeleton (Brånemark *et al.*, 1977). Today, the method is well established in the management of totally and partially edentulous jaws, and for single tooth replacement in adult patients (Esposito *et al.*, 1993; Henry *et al.*, 1996; Lekholm *et al.*, 1999). Observations in the growing pig have

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Received: 18 May 2019 | Accepted: 20 May 2019
DOI: 10.1111/edt.12484

COMPREHENSIVE REVIEW

Dental Traumatology WILEY

Timing of implant placement after traumatic dental injury

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Abstract

Dental implants are reliable to replace teeth lost because of traumatic dental injury. However, dental implants behave like ankylosed teeth and should not be placed in growing individuals because of the risk of infraposition. This risk may be reduced by ensuring arrested skeletal growth and ideal incisal support. The timing of implant placement may be immediate, early, conventional, or late and is determined by the extent of the trauma, remaining growth, and conditions of the hard and soft tissues. Timing should allow an observation period to properly evaluate the prognosis of concomitantly traumatized neighboring teeth. Orthodontic alignment is often necessary after traumatic dental injury in young individuals to provide symmetric dental conditions around the facial midline, to allow implant placement in the correct 3-dimensional position for the later prosthetic reconstruction, and to ensure sufficient mesiodistal space that leaves a minimum of 1.5 mm of healthy alveolar bone between the future implant and neighboring teeth. Space and stable occlusion should be maintained by bonded retainers and a splint used during the night. A partial prosthesis is usually recommended as a temporary replacement. If a fixed provisional prosthesis is required, it is crucial that it does not interfere with the remaining growth and incisal support and allows proper oral hygiene.

KEYWORDS
dental implant, growth, implant infraposition, provisional tooth replacement, timing, traumatic dental injury

1 | INTRODUCTION

Dental implant therapy constitutes a reliable treatment option in case of tooth loss because of traumatic dental injury (TDI).[1] However, TDI most often occurs in young patients[2] in whom continuous growth of the facial skeleton contraindicates placement of dental implants because of the risk of infraposition. In addition, concomitant damage to the gingiva and alveolar bone often warrants a prolonged healing period.[3] Finally, even though the situation may appear dramatic and the prognosis hopeless immediately after the TDI, thorough replantation, fixation, and suturing may provide favorable healing conditions for long-term tooth preservation and should be considered as the first choice whenever feasible (www.dentaltraumaguide.org).

When previously traumatized teeth are deemed hopeless and dental implants are considered the treatment of choice for tooth replacement, the ideal timing of implant placement needs to be determined.[4] This article will discuss the timing of implant placement after TDI in adults, the challenge of treating growing individuals, prerequisites for later implant therapy, and methods to monitor growth and provide a list of options for provisionalization and retention until dental implants can be predictably placed.

2 | DISCUSSION

The timing of implant placement after TDI in adults depends on the extent of the TDI and the local anatomic conditions at the implant

This article is being published concurrently in Journal of Endodontics. The articles are identical. Either citation can be used when citing this article.

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Received: 15 April 2019 | Revised: 15 July 2019 | Accepted: 24 July 2019
DOI: 10.1111/cid.12834

ORIGINAL ARTICLE

WILEY

Clinical and radiographic outcomes of allogeneic block grafts for maxillary lateral ridge augmentation: A randomized clinical trial

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Abstract

Background: A main drawback of bone block graft surgery is the resorption occurring in early stages of healing. To our knowledge, there are no studies comparing outcomes of freeze-dried bone allograft (FDBA) blocks with different architecture.

Purpose: The aim of this work was to investigate different factors that can affect graft resorption and to compare the resorption rates of two different types of allogeneic blocks, corticocancellous and cancellous.

Materials and Methods: A randomized clinical trial was designed. Twenty-eight patients referred for onlay bone augmentation prior to implant placement were included in the study. Preoperative computerized tomography (CT) was taken for all patients. Patients received FDBA blocks of either cancellous or corticocancellous bone obtained from the iliac crest. After a 4-month follow-up, postoperative CT was taken. Then, another surgery was performed, with the purpose to place dental implants. The aforementioned groups were compared for bone resorption and implant outcome using analysis of covariance (ANCOVA) and repeated ANOVA measures, respectively. Demographic data, trabecular bone density, and graft sites were also analyzed.

Results: A total of 93 implants were placed in the augmented bone sites over 28 patients. A 100% survival rate was achieved during a mean follow-up period of 24 months in both groups. Higher bone resorption rate was found with cancellous bone grafts (29.2% ± 2.6) compared with corticocancellous grafts (19.3% ± 2.3). Moreover, higher resorption rates in patients with lower bone density (<185 Hounsfield Units) (31.7% ± 3.1) and smokers (26.39% ± 2.3) were observed when compared with patients with higher bone density (>185 Hounsfield Units) (16.8% ± 2.1) and nonsmokers (22.1% ± 2.3), respectively.

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Original Article

Evaluation of Long-Term Dental Implant Success and Marginal Bone Loss in Postmenopausal Women

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Abstract

Aim: The aim of this study was to examine long-term implant success and marginal bone loss (MBL) of dental implants in postmenopausal women with osteoporosis/osteopenia. **Materials and Methods:** Postmenopausal women who underwent dental implant treatment at least 3 years ago were divided into two study groups [Test (osteoporosis/osteopenia) Group and Control Group] according to bone mineral density (BMD) measurements. Besides clinical periodontal and radiographic examinations, any implant failures were also recorded. **Results:** A total of 52 patients with a mean age of 59.51 ± 5.66 years (Test Group; 26 patients, mean age: 60.61; Control Group; 26 patients, mean age: 58.42) were included in the study. Implant survival rates were 96.2% and 100% with a mean follow-up 60.84 ± 22.13 and 60.07 ± 20.93 months in Test and Control Groups, respectively ($P > 0.05$). While peri-implant PI (plaque index) and PD (probing depth) were not different between the groups, BoP (bleeding on probing) was significantly higher in Test Group ($P = 0,026$). Although MBL in Test Group was higher than Control Group (0.82 ± 0,63 mm and 0.44 ± 0,33 mm respectively), the difference was not found statistically significant ($P = 0.069$). **Conclusion:** Within the limits of this retrospective study, it can be concluded that postmenopausal osteoporosis/osteopenia does not affect MBL and long-term implant success. The findings suggest that dental implant therapy is a reliable treatment modality in these patients to improve the quality of life by increasing function and aesthetics.

Keywords: *Dental implant success, marginal bone loss, osteoporosis/osteopenia, postmenopausal women*

Received: 30-May-2018;
Revision: 26-Jun-2019;
Accepted: 09-Sep-2019;
Published: 06-Feb-2020

Introduction

Dental implant therapy has become a popular treatment modality for the rehabilitation of missing teeth. Although the long-term success of dental implants has been reported in many studies, several risk factors associated with implant, surgery, and patient-related components may disturb long-term implant survival.[1] Sufficient amount and satisfactory quality of bone at the implant recipient site are absolutely crucial for successful implant osseointegration.

Osteoporosis is a systemic skeletal disease characterized by deterioration of bone microarchitecture with reduced bone mass and strength and increased fragility.[2] It is the most common bone disease in humans, particularly in postmenopausal women (PW) due to reduction in ovarian estrogen production. During postmenopausal osteoporosis (PO) a negative balanced bone turnover causes a continuous reduction in bone volume and quality.[3] Systemic bone loss is the main cause of fractures in PW and may also affect jawbone impairing osseointegration. Therefore, PO is thought to be a possible risk factor for bone healing around implants and the rate of bone-to-implant contact. Little is known about the outcomes of PO on the success of dental implants but it is known that implants placed in low-density bone tissues are more likely to

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Access this article online
Quick Response Code:
Website: www.njcponline.com
DOI: 10.4103/njcp.njcp_295_19

How to cite this article: Toy VE, Uslu MÖ. Evaluation of long-term dental implant success and marginal bone loss in postmenopausal women. Niger J Clin Pract 2020;23:147-53.

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Hindawi Publishing Corporation
Plastic Surgery International
Volume 2011, Article ID 165824, 7 pages
doi:10.1155/2011/165824

Review Article

Reconstruction of Mandibular Defects Using Bone Morphogenic Protein: Can Growth Factors Replace the Need for Autologous Bone Grafts? A Systematic Review of the Literature

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Received 7 July 2011; Revised 7 September 2011; Accepted 11 September 2011

Academic Editor: Neal D. Futran

Autogenous bone is still considered the "gold standard" of regenerative and reconstructive procedures involving mandibular defects. However, harvesting of this material can lead to many complications like increasing morbidity, expanding of the surgical time, and incomplete healing of the donor site. In the last few years many authors looked for the development of effective reconstruction procedures using osteoinductive factors without the need for conventional bone grafting. The first-in-human study involving the use of Bone Morphogenic Proteins (rhBMP) for mandibular reconstruction was performed in 2001 by Moghadam. Only few articles have been reported in the literature since then. The purpose of this study was to search and analyze the literature involving the use of rhBMP for reconstruction of mandibular defects. In all the studies reported, authors agree that the use of grown factors may represent the future of regenerative procedures with more research necessary for confirmation.

1. Introduction

Tissue engineering holds great promise for revolutionizing many grafting procedures. Continuity defects of the mandible frequently result from tumor removal or significant trauma, and reconstruction of these defects can be challenging. For defects with extensive hard and soft tissue loss, microvascular free tissue transfer often provides an excellent reconstructive option. However, significant site morbidity as well as non ideal bone stock for dental implant rehabilitation may occur [1].

The development of bone morphogenic proteins (BMPs) has offered an alternative to traditional bone grafting, which has been the gold standard for oral and maxillofacial reconstruction [2]. Clinical application of BMPs has evolved to include defects of the facial skeleton including those involving the mandible and maxilla [3]. There have been many reports of the use of BMPs regarding orthopaedic as well as alveolar augmentation. There have been few studies addressing the use of BMP in reconstructing critical-size defects of the mandible.

The purpose of this study is to evaluate the different study present in the literature concerning the use of growth factors for the reconstruction of mandibular defects, comparing the method and the finals results. A well-identified guideline is in fact not still available and, because of that, significative differences could be find analysing the literature on that topic.

2. Background

Failure to adequately restore mandibular continuity defects often result in poor function for the patient postsurgically. Various bone grafting and bone manipulation techniques are available for restoring large mandibular bony defects. An ideal osseous grafting treatment should involve use of a bone inductive material that would be reliable, biocompatible, long-lasting, and capable of restoring mandibular continuity with minimal morbidity. Particulate marrow and cancellous

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Dental Traumatology

Dental Traumatology 2015; **31**: 42–48; doi: 10.1111/edt.12134

Adipose-derived stem cells incorporated into platelet-rich plasma improved bone regeneration and maturation *in vivo*

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Key words: mesenchymal stem cells; platelet-rich plasma; osteogenesis; bone regeneration

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Accepted 15 August, 2014

Abstract – *Background/Aim*: Some cases of tooth loss related to dental trauma require bone-grafting procedures to improve the aesthetics before prosthetic rehabilitation or to enable the installation of dental implants. Bone regeneration is often a challenge and could be largely improved by mesenchymal stem cells therapy. However, the appropriate scaffold for these cells still a problem. This study evaluated the *in vivo* effect of human adipose-derived stem cells incorporated into autogenous platelet-rich plasma in bone regeneration and maturation. *Material and methods*: Adipose-derived stem cells were isolated from lipoaspirate tissues and used at passage 4. Immunophenotyping and multilineage differentiation of cells were performed and mesenchymal stem cells characteristics confirmed. Bicortical bone defects (10 mm diameter) were created in the tibia of six beagle dogs to evaluate the effect of adipose-derived stem cells incorporated into platelet-rich plasma scaffolds, platelet-rich plasma alone, autogenous bone grafts, and clot. Samples were removed 6 weeks postsurgeries and analyzed by quantification of primary and secondary bone formation and granulation tissue. *Results*: Adipose-derived stem cells incorporated into platelet-rich plasma scaffolds promoted the highest bone formation (primary + secondary bone) ($P < 0.001$), the highest bone maturation (secondary bone) ($P < 0.001$), and the lowest amount of granulation tissue ($P < 0.001$). *Conclusions*: Adipose-derived stem cells incorporated into platelet-rich plasma scaffolds promote more bone formation and maturation, and less granulation tissue in bone defects created in canine tibia. Therefore, platelet-rich plasma can be considered as a candidate scaffold for adipose-derived stem cells to promote bone regeneration.

Despite efforts by practitioners in Dental Traumatology, in some cases, dental trauma sequelae lead to tooth loss. Some of these situations require bone-grafting procedures to improve the aesthetics before prosthetic rehabilitation procedures or to enable the installation of dental implants. Autogenous bone grafts (ABG) remain the gold-standard biomaterial due to the excellent biological properties. However, because of the main drawbacks of ABG, which are the donor site morbidity and the limited amount of grafted materials, several reports still trying to develop a bone substitute (1).

The main approaches applied in bone regeneration include the tissue engineering by the use of scaffolds, growth factors, and cells. Mesenchymal stem cells (MSCs) have been received much attention from bone tissue engineering due to the capacity in differentiating into many cell types and the paracrine effects (2, 3). One excellent MSCs option for clinical application are adipose-derived stem cells (ASCs) because they are abundant, easily accessible and isolated, able to promote minimal donor site morbidity, and demonstrate a fast attachment and proliferation in cell culture (4). However, the appropriate scaffold for these cells still a problem.

Platelet-rich plasma (PRP) is an autogenous blood product produced by the centrifugation of venous blood (5). PRP is an interesting option of bioactive scaffold for MSCs because it does not present risk of disease transmission. In addition, its preparation technique is simple and presents a gel consistency after its activation, which facilitates the manipulation and accommodation in the bone defects in several clinical applications of oral and maxillofacial surgery. Moreover, PRP contains numerous growth factors, including platelet-derived growth factor (PDGF), transforming growth factor-β (TGF-β), vascular endothelial growth factor (VEGF), fibroblast growth factor (FGF), and insulin-like growth factor (IGF) (6–8). These growth factors play an essential role in tissue regeneration through cells proliferation, migration, and differentiation (7, 9). Therefore, the purpose of this study was to evaluate the *in vivo* effect of human

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Original Article

Immediate dental implant placement with or without autogenous bone graft: A comparative study

ABSTRACT

Introduction: Immediate dental implants are the most accepted contemporary treatment option for the replacement of missing teeth. One pitfall of immediate implant use, however, is the inevitable residual space that remains between the implant and the socket wall, called the jumping distance, which may lead to bone resorption and formation of a bony defect, decreasing the implant stability. When this jumping distance is more than 2 mm, use of bone grafts is recommended. However, the use of grafts when the jumping distance is <2 mm is not defined in the literature.

Aim: To evaluate the peri-implant hard and soft tissue changes following immediately placed implants with a jumping distance of 2 mm with or without autogenous bone grafts.

Settings: The study was conducted between January 2016 and December 2017 in the Department of Oral and Maxillofacial Surgery.

Subjects and Methods: This was a prospective, single-center, two-arm, parallel, randomized study on patients undergoing replacement of missing anterior teeth with immediate implants. There were two groups: the study group which received bone graft and the control group which did not receive any graft. Temporary prosthesis was placed following implant placement which was replaced with definitive prosthesis 4 months later. Patients were followed up for a period of 9 months. The alveolar bone loss was evaluated radiologically using cone-beam computed tomography, and pain, suppuration, mobility, and periodontal probing depth were evaluated clinically.

Results: There were 16 participants in the study group and 17 in the control group. The alveolar bone loss was greater in the study group; however, pain, suppuration, and mobility showed no difference between the groups.

Conclusion: The immediate implants placed with or without bone grafts had similar alveolar hard and soft tissue changes when the jumping distance was <2 mm.

Keywords: autogenous bone grafts, immediate dental implant, jumping distance

INTRODUCTION

Dental implants are the most accepted contemporary treatment option for the replacement of missing teeth. Historically, implants have been placed in a delayed fashion, i.e., a few weeks or months after extraction, to allow for bone healing in the socket area. Immediate placement of implants has taken the forestage in recent times due to its numerous advantages such as preservation of alveolar bone, better implant orientation, esthetics, and psychosocial benefits provided to the patients. Besides, it overcomes the drawbacks of delayed implants such as prolonged treatment time, multiple appointments, reduction in alveolar bone dimensions, and migration of teeth into the edentulous space.[1-5]

One pitfall of immediate implant use, however, is the inevitable residual space that remains between the implant

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Received: 30 September 2019, **Revised:** 05 November 2019, **Accepted:** 25 December 2019, **Published:** 18 June 2020

Access this article online	
Website: www.njms.in	Quick Response Code
DOI: 10.4103/njms.NJMS_59_19	

How to cite this article: Kabi S, Kar R, Samal D, Deepak KC, Kar IB, Mishra N. Immediate dental implant placement with or without autogenous bone graft: A comparative study. Natl J Maxillofac Surg 2020;11:46-52.

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REGENERATIVE BIOLOGY AND MEDICINE IN OSTEOPOROSIS (T WEBSTER, SECTION EDITOR)

Regenerative Medicine Strategies in Biomedical Implants

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Published online: 20 April 2018

Abstract

Purpose of Review Recently, significant progress has been made in the research related to regenerative medicine. At the same time, biomedical implants in orthopedics and dentistry are facing many challenges and posing clinical concerns. The purpose of this chapter is to provide an overview of the clinical applications of current regenerative strategies to the fields of dentistry and orthopedic surgery. The main research question in this review is: What are the major advancement strategies in regenerative medicine that can be used for implant research?

Recent Findings The implant surfaces can be modified through patient-specific stem cells and plasma coatings, which may provide methods to improve osseointegration and sustainability of the implant.

Summary Overall understanding from the review suggesting that the outcome from the studies could lead to identify optimum solutions for many concerns in biomedical implants and even in drug developments as a long-term solution to orthopedic and dental patients.

Keywords Regenerative medicine · Biomedical implants · Stem cells · Surface modifications

Introduction

Diseases such as osteoarthritis, spondylosis, and tooth decay result in irreversible structural damage to the affected tissues. When noninvasive therapies fail to reduce symptoms to a manageable level, surgical intervention is often the next logical treatment option. Removal of damaged tissue and replacement with a synthetic implant is widely used to restore function and reduce pain, which includes orthopedic implants (total hip replacements, total knee replacements, intervertebral disc replacements, etc.), and dental implants. Further, in recent years, common procedures (such as total joint arthroplasty and artificial tooth replacement) have seen a gradual increase in frequency, and these trends are expected to continue into the foreseeable future [1–3].

This article is part of the Topical Collection on *Regenerative Biology and Medicine in Osteoporosis*

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The 2017 annual report from the American Joint Replacement Registry, representing more than 4700 orthopedic surgeons, revealed that over 860,000 total hip (THA) and knee (TKA) arthroplasties were performed in 2016 alone, a significant increase from years prior [1]. THA and TKA procedures often provide symptomatic relief for the majority of recipients but also carry a moderate risk of complications. The rates of one or more complications that occur either in a hospital or after discharge are estimated to be 7% and 8%, respectively. Complications include infection, fracture, bleeding, deep vein thrombosis, pulmonary embolism, etc. [4]. Complications may undermine implant stability and necessitate a revision procedure. Fortunately, the revision burden for both total hip and total knee replacement appears to be decreasing in recent years. Data suggests that the revision burdens for total hip and knee replacements in 2016 (8.1% and 5.6%, respectively) decreased significantly from data collected during the years 2012–2015 (mean = 13.9% and 6.5%, respectively) [1].

Similarly, a significant demand for dental implants exists. A National Health and Nutrition Examination Survey published in 2015 found that 52% of adults aged 20–64 had lost one or more permanent teeth [5]. Dental implants, while largely successful, share similar limitations that are faced by THA and TKA. Most notably, postoperative infection of the

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Journal of Dental Sciences (2020) 15, 243–248

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.e-jds.com

Original Article

Autogenous bone grafts and titanium mesh-guided alveolar ridge augmentation for dental implantation

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Received 5 June 2020
Available online 18 June 2020

KEYWORDS
Alveolar ridge augmentation;
Autograft;
New bone formation;
Dental implantation;
Guided tissue regeneration

Abstract *Background/purpose:* Alveolar bone deficiency is sometimes found in the patients who need dental implantation. This study used autogenous bone grafts and titanium mesh-guided alveolar ridge augmentation for the patients with alveolar bone deficiency but requiring dental implantation.
Materials and methods: In this study, autogenous bone grafts and titanium mesh-guided alveolar ridge augmentation was performed in four patients with different situations of alveolar bone deficiency. The titanium mesh was used as the barrier membrane and provided support to the compartment which was filled with calcium sulfate materials. Autogenous bone fragments harvested from adjacent implant osteotomy or from cortical bone of the recipient site were spread on the external surface of titanium mesh as the resources of osteoblasts for new bone formation.
Results: Four months after above-mentioned procedures, cone-beam computed tomography showed adequate alveolar bone formation. The titanium mesh was removed and dental implant was placed in the augmented alveolar ridge at the same time. We found that secondary bone graft combined with autogenous bone and inorganic bovine bone were covered by the pseudo-periosteum and suitable for dental implantation in our four patients. The implants were submerged for 3–4 months till uncovering, and then the prostheses were delivered one month afterwards with successful clinical outcomes.
Conclusion: The clinical outcomes of our four patients indicate that the vital autogenous bone grafts and the titanium mesh possess the ability to induce and guide new bone formation in four months and can be successful used for alveolar ridge augmentation and subsequent dental implantation.

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PLOS ONE

RESEARCH ARTICLE

Increased risk of dental trauma in patients with allergic rhinitis: A nationwide population-based cohort study

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OPEN ACCESS

Citation: Siao M-J, Chen G-S, Lee W-C, Horng J-T, Chang C-W, Li C-H (2017) Increased risk of dental trauma in patients with allergic rhinitis: A nationwide population-based cohort study. PLoS ONE 12(7): e0182370. https://doi.org/10.1371/journal.pone.0182370

Editor: Luo Zhang, Beijing Tongren Hospital, CHINA

Received: March 10, 2017

Accepted: July 16, 2017

Published: July 31, 2017

Data Availability Statement: Data are available from the National Health Insurance Research Database (NHIRD) published by Taiwan National Health Insurance (NHI) Bureau. Due to legal restrictions imposed by the government of Taiwan in relation to the 'Personal Information Protection Act', data cannot be made publicly available. Requests for data can be sent as a formal proposal to the NHIRD. (http://nhird.nhri.org.tw).

Funding: The authors received no specific funding for this work.

Abstract

Allergic rhinitis (AR) is associated with various developmental issues that affecting dentition. We aimed to determine whether AR is associated with an increased risk of traumatic dental injuries (TDIs) in Taiwanese individuals. We used the Taiwan National Health Insurance Research Database (NHIRD) to conduct a nested case-control study. We compared an AR cohort with a matched cohort of patients without AR. New TDI cases were determined during our study period. To compare TDI risk between our study cohorts, we used Cox proportional regression analysis, and hazard ratios (HR) with 95% confidence intervals (CI) were calculated to quantify the association between AR exposure and TDI risk. In total, 76749 patients with AR (31715 male; 45034 female) were identified. In the AR and the non-AR cohorts, 312 patients in total had TDI. Patients with AR had a significantly higher risk of TDI than those without AR (aHR = 1.92; 95% CI = 1.459–2.525; P < 0.001). The risk of TDI was markedly higher in the AR cohort, except in the 3–12-year-old group, and with a CCI ≥ 1. AR patients had a future risk of TDI, indicating a potentially linked disease pathophysiology. The association between AR and TDI is greater among general patients. Clinicians and caregivers should be aware of potential TDI co-morbidity in patients with AR.

Introduction

Allergic rhinitis (AR) is the most common airway-obstructing disease, affecting 17.9%–26.3% of adolescents [1,2]. This chronic airway pathology is associated with several symptoms: absent nasal airflow and sneezing, snoring, possible obstructive sleep apnea syndrome, and increased respiratory infections [3,4]. Additionally, it has been reported to increase the risks of inattention and hyperactivity in children [5]. Other studies have also investigated the effect of AR and/or mouth breathing on the general development of cranial-complex [6] and the

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RIDGE DEVELOPMENT/PRESERVATION

Ridge Preservation Strategies in Children Following Anterior Tooth Trauma

David R. Steiner, DDS, MSD; and David P. Mathews, DDS

Abstract: The sequelae associated with anterior oral trauma during childhood growth may require a protracted period of clinical management to achieve an optimal foundation for future prosthetic therapy. This article presents two case examples of long-term ridge development and preservation in children after anterior dental and alveolar trauma. These two patients were managed for periods of 11 years, one from age 8 to 19 and the other from age 9 to 20, until they were old enough to receive implant-supported restorations. Two different treatment plans were prescribed based on whether or not the teeth in question were ankylosed. In one case, fractured roots that were not ankylosed were retained; in the other, decoronation of an ankylosed tooth was performed.

LEARNING OBJECTIVES

- Discuss factors involved in treatment of children who have experienced oral trauma
- Describe the long-term clinical management of injured central incisors with immature root formation
- Discuss a technique for preservation of the anterior alveolar ridge after decoronation of an ankylosed tooth

DISCLOSURE: The authors had no disclosures to report.

It has been reported that the highest frequency of oral trauma occurs in children between the ages of 8 and 10 years.[1] At this age permanent teeth have erupted, but the roots have not matured; also, children still have most of their skeletal and facial growth yet to come. After loss of a tooth the ridge atrophies rather than develops. In addition, an ankylosed tooth leads to arrested development of the associated alveolar ridge.

To achieve the optimal prosthetic outcome, an intact alveolar ridge in the anterior esthetic zone is crucial. Bone grafting or augmentation

Fig 1. Age 8. Facial view of teeth Nos. 8 and 9 at initial examination. **Fig 2.** Age 8. Radiograph of teeth Nos. 8 and 9 at initial examination. **Fig 3.** Age 10. Radiograph of teeth Nos. 8 and 9, 3 months after the fractured coronal segment of No. 9 was removed. Note the coronal level of the root relative to tooth No. 10.

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The official journal of the Australian Dental Association

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doi: 10.1111/adj.12397

Responses of the pulp, periradicular and soft tissues following trauma to the permanent teeth

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ABSTRACT

Trauma to the permanent teeth involves not only the teeth but also the pulp, the periodontal ligament, alveolar bone, gingiva and other associated structures. There are many variations in the types of injuries with varying severity and often a tooth may sustain more than one injury at the same time. In more severe trauma cases, there are many different cellular systems of mineralized hard and unmineralized soft tissues involved, each with varying potential for healing. Furthermore, the responses of the different tissues may be interrelated and dependent on each other. Hence, healing subsequent to dental trauma has long been known to be very complex. Because of this complexity, tissue responses and the consequences following dental trauma have been confusing and puzzling for many clinicians. In this review, the tissue responses are described under the tissue compartments typically involved following dental trauma: the pulp, periradicular and associated soft tissues. The factors involved in the mechanisms of trauma are analysed for their effects on the tissue responses. A thorough understanding of the possible tissue responses is imperative for clinicians to overcome the confusion and manage dental trauma adequately and conservatively in order to minimize the consequences following trauma.

Keywords: Periradicular healing, pulp healing, pulp necrosis, resorption, transient apical breakdown.

Abbreviations and acronyms: HERS = Hertwig's epithelial root sheath; MMPs = matrix metalloproteinases; PCC = pulp canal calcification; PDL = periodontal ligament; PTH = parathyroid hormone; TAB = transient apical breakdown.

INTRODUCTION

Dental trauma is the injury sustained by a tooth and its supporting structures from acute transmission of impact energy. Six types of injuries to the periradicular tissues (i.e. luxation injuries), seven types of tooth fractures, and their combinations have been described in the literature.[1] The dental pulp, the periradicular and the surrounding soft tissues can all be affected by the trauma, where tissue integrity is disrupted. In order to re-establish the integrity, these tissues respond with inflammation at the local level to defend the body against infection and foreign substances, as well as to dispose of necrotic damaged tissues, which facilitates repair and regeneration from adjacent viable tissues. There are many tissue types involved including pulp, periodontal ligament (PDL), gingiva and mucosa, as well as enamel, dentine, cementum and alveolar bone. The possible responses of these tissues can be very complex due to the types of the injuries and their combinations (e.g. a crown-root fracture in combination with a luxation injury), as well as the interaction between individual tissues. Furthermore, a multitude of factors will directly or indirectly affect the magnitude of the tissue inflammatory process, resulting in the manifestation of even more complex and variable responses of these tissues.

The responses of these tissues will determine the treatment required and the outcome/consequence of the involved teeth. This paper will present the tissue responses to trauma under the tissue compartments typically involved following dental trauma: the pulp, the periradicular tissues (including the periodontal ligament and alveolar bone), and their interaction with the injured root in teeth with complete or incomplete root development, as well as the associated soft tissues (including gingiva and marginal periodontium). The factors affecting the outcomes of the tissue responses will be considered subsequently under the categories of mechanical and biological factors.

Tissue responses can be favourable or unfavourable in nature. Favourable responses need no or minimal intervention apart from follow-up by regular reviews to monitor the pulp, periradicular and soft tissue status over time to ensure no adverse tissue changes occur that require treatment. Fortunately, the most

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Oral Maxillofac Surg (2008) 12:49–60
DOI 10.1007/s10006-008-0109-5

REVIEW

Concepts for the treatment of adolescent patients with missing permanent teeth

M. Behr · O. Driemel · V. Mertins · T. Gerlach · C. Kolbeck · N. Rohr · T. E. Reichert · G. Handel

Published online: 2 July 2008

Abstract
Introduction Missing permanent teeth is observed with syndromes or is frequently hereditarily propagated in families. The treatment of these patients is a multi-task of specialists of oral surgery, orthodontics and prosthodontics. *Discussion* Despite functional and aesthetic considerations, the main problem of all treatment is that it had to be performed in a growing child. This article discusses the conventional and implant-driven concepts to treat patients from childhood to adolescence with selective or multiple missing permanent teeth.

Keywords Missing permanent teeth · Implants · Prosthodontics · Treatment concepts · Growing child

Introduction

Formation of hard tooth substance and periodontium results from a series of epithelial and mesenchymal interactions. However, this complex process is susceptible to dysfunctions [75]. A distinction needs to be drawn between malformations of the dentine, enamel and cement—which may result in the mutation of a tooth's phenotype—and the congenital missing permanent teeth that can be further divided into anodontia, oligodontia and hypodontia [15, 41, 63, 61, 82]. The term anodontia stands for total agomphiasis, whereas oligodontia refers to the missing of more than six permanent teeth and hypodontia refers to the missing of less than six permanent teeth. The aim of this study is twofold: first, to assess the clinical environment in which dysfunctions such as missing permanent teeth occur and in which such dysfunctions have to be regarded and, secondly, to exemplify therapeutic concepts by means of case studies.

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Prevalence

The prevalence of congenital missing permanent teeth has been investigated in numerous studies. In their meta-analysis of 2004, Polder et al. found a prevalence of permanent missing teeth in 1.5% to 3.1% of patient groups investigated [133]. The most affected teeth were the mandibular second premolar followed by the upper lateral incisor and the upper second premolar. Central incisors, canines or molars were rarely affected. Approximately 48% of patients had only one tooth missing, 35.1% suffered the missing of two permanent teeth and less than 1% of patients suffered the missing of more than six permanent teeth [133]. Women were more frequently affected than men by a factor of 1.37 [133]. No statistically significant difference could be found between upper and lower jaw. Remarkably, these studies [1, 4, 9, 10, 19, 23, 26, 31, 40, 41, 43, 53, 56, 57, 63, 66, 76, 79, 105, 107, 108, 117, 132, 145, 150, 158, 168, 170, 176, 178—the oldest was conducted in 1936 [41]—show the highest prevalence in publications dating between 1971 and 1980. [43, 53, 57, 63, 66, 76, 79, 105, 107, 108, 117, 132, 145]

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The Indian Journal of Pediatrics (November 2019) 86(11):1043–1047
https://doi.org/10.1007/s12098-019-02984-7

REVIEW ARTICLE

Guest Editor: Bhim S. Pandhi

Dental Trauma in Children: A Quick Overview on Management

Nitesh Tewari[1] · Kalpana Bansal[1] · Vijay Prakash Mathur[1]

Received: 3 May 2019 / Accepted: 13 May 2019 / Published online: 13 June 2019

Abstract
Traumatic dental injuries (TDI) or tooth trauma have a global prevalence of 10–15%. These are often the cause of first visit to emergency room. Prognosis of teeth after injury is dependent on type of TDI, emergency treatment and time elapsed till definitive care. The low level of awareness among general public and medical practitioners often leads to delay in seeking treatment which often leads to pain, severe symptoms and poor prognosis. Pediatricians can play a significant role in identification of TDI, health advise, emergency care and referral to dentists. This paper highlights the important features to be noted in children with history of TDI and the key steps which needs to be taken in these situations.

Keywords Dental trauma · Emergency · Fall · Fracture · Accident

Introduction

Traumatic dental injuries (TDI) or tooth trauma have a global prevalence of 10–15% [1]. These can occur in isolation or associated with pan-facial or bodily injuries. It exhibits two peaks of incidence in boys at 1–3 y and 10–12 y and one peak in girls at 1–3 y of age [1, 2]. The age of 2–3 y is the period of acquisition of walking skills with lesser control on motor coordination, which makes these children more vulnerable to falls and injury to front teeth [2]. These injuries to primary or milk teeth are often ignored by parents if they involve tooth's crown, however in severe forms the injury to supporting structures as alveolar bone is the cause of first visit to emergency services. The higher incidence of trauma to permanent teeth in boys is related to their increased indulgence in contact sports and adventure activities [3].

There have been multiple etiologies associated with TDI: falls, sports injuries, fights, road traffic accidents, animal injuries and iatrogenic tooth trauma caused during difficult oral intubation [2–6]. There are certain factors important for determining the type and severity of injury, its emergency and comprehensive management and the sequelae and prognosis [2]. These include age of the child, stage of tooth development, direction and intensity of force, size and shape of impacting object and type and the timing of emergency dental treatment provided [3, 7]. The factors as proclined upper front teeth and problems related to abnormality in gait or motor coordination makes children more susceptible to TDI [6]. Since these injuries generally occur while playing at home and school, there is an inherent need to increase the awareness for emergency measures to be taken in event of TDI among, parents, children, schoolteachers, health workers and medical practitioners including pediatricians and anesthesiologists [1].

Untreated traumatized teeth often lead to unsightly discoloration of fracture crowns of teeth. This may not only put the child at risk of future infection flare/ acute symptoms but also can cause psychological stress.

Types of Dental Trauma

Traumatic dental injuries are best classified with their description (Table 1) [2]. Many times these injuries occur in combinations and create unique presentations (Figs. 1 and 2).

The emergency health care worker, practitioner or pediatrician should be aware of these types of injuries and their emergency management so that prognosis of TDI can be improved with time [7].

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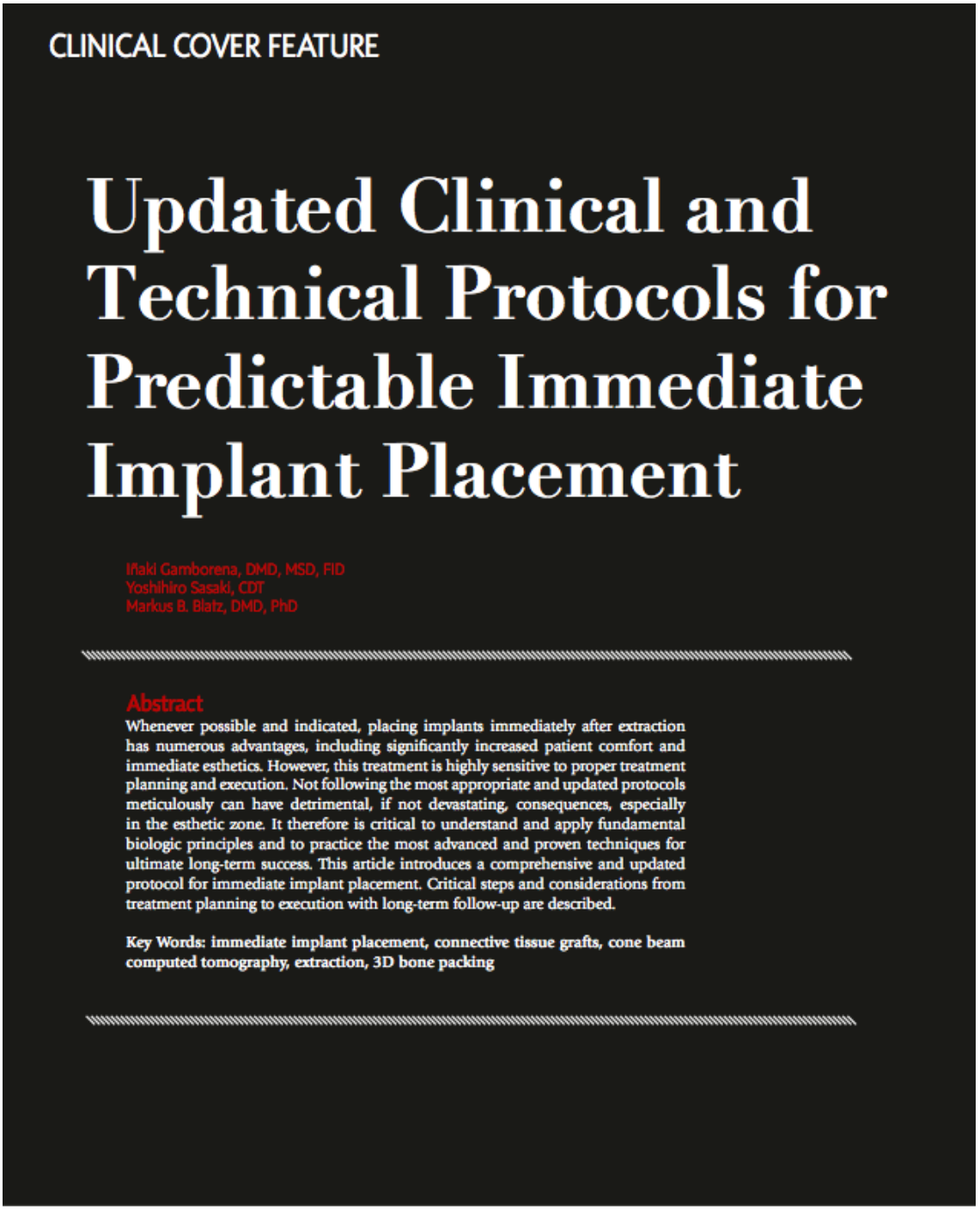

CLINICAL COVER FEATURE

Updated Clinical and Technical Protocols for Predictable Immediate Implant Placement

Iñaki Gamborena, DMD, MSD, FID
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Abstract

Whenever possible and indicated, placing implants immediately after extraction has numerous advantages, including significantly increased patient comfort and immediate esthetics. However, this treatment is highly sensitive to proper treatment planning and execution. Not following the most appropriate and updated protocols meticulously can have detrimental, if not devastating, consequences, especially in the esthetic zone. It therefore is critical to understand and apply fundamental biologic principles and to practice the most advanced and proven techniques for ultimate long-term success. This article introduces a comprehensive and updated protocol for immediate implant placement. Critical steps and considerations from treatment planning to execution with long-term follow-up are described.

Key Words: immediate implant placement, connective tissue grafts, cone beam computed tomography, extraction, 3D bone packing

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Augmentation procedures for the rehabilitation of deficient edentulous ridges with oral implants

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Key words: Alveolar ridge augmentation, atrophy, humans, osseointegrated implants

Abstract

Objectives: To analyze publications related to augmentation procedures and to evaluate the success of different surgical techniques for ridge reconstruction and the survival/success rates of implants placed in the augmented areas.

Material and methods: Clinical investigations published in English involving at least 5 patients and with a minimum follow-up of 6 months were included. The following procedures were considered: a) Guided bone regeneration (GBR); 2) Onlay bone grafts; 3) Inlay grafts; 4) Bone splitting for ridge expansion (RE); 5) Distraction osteogenesis (DO); and 6) Revascularized flaps. Success rates of augmentation procedures and related morbidity, as well as survival and success rates of implants placed in the augmented sites were analyzed.

Results: Success rates of surgical procedures ranged from 60% to 100% for GBR, from 92% to 100% for onlay bone grafts, from 98% to 100% for ridge expansion techniques, from 96,7% to 100% for DO, and was 87.5% for revascularized flaps, whereas survival rates of implants ranged from 92% to 100% for GBR, from 60% to 100% for onlay bone grafts, from 91% to 97.3% for RE, from 90.4% to 100% for DO, and, finally, was 88.2% for revascularized flaps.

Conclusion: On the basis of available data it was shown that it was difficult to demonstrate that a particular surgical procedure offered better outcome as compared to another. The main limit encountered in this review has been the overall poor methodological quality of the published articles. Therefore larger well-designed long term trials are needed.

Dental rehabilitation of partially or totally edentulous patients with oral implants has become common practice in the last decades, with reliable long-term results (Albrektsson et al. 1986; van Steenberghe et al. 1989, 1990; Lindquist et al. 1996; Buser et al. 1997; Arvidson et al. 1998; Lekholm et al. 1999a; Weber et al. 2000; Leonhardt et al. 2002). However, unfavorable local conditions of the alveolar ridge, due to atrophy, periodontal disease and trauma sequelae, may provide insufficient bone volume or unfavorable vertical, transverse, and sagittal interarch relationship, which may render implant placement impossible or incorrect from a functional and esthetic viewpoint.

Five main methods have been described to augment the local bone volume of deficient sites: (a) osteoinduction by the use of appropriate growth factors (Urist 1965; Reddi et al. 1987); (b) osteoconduction where a grafting material serves as a scaffold for new bone formation (Burchardt 1983; Reddi et al. 1987); (c) distraction osteogenesis (DO), by which a fracture is

To cite this article:
Chiapasco M, Zaniboni M, Boisco M. Augmentation procedures for the rehabilitation of deficient edentulous ridges with oral implants. *Clin. Oral Impl. Res.* 17 (Suppl. 2), 2006; 136–159

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Regenerating Mandibular Bone Using rhBMP-2: Part 2—Treatment of Chronic, Defect Non-Union Fractures

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Submitted April 2013
Accepted July 2013

DOI:10.1111/j.1532-950X.2013.12122.x

Objective: To describe a surgical technique using a regenerative approach and internal fixation for reconstruction of critical size bone defect non-union mandibular fractures.
Study Design: Case series.
Animals: Dogs (n = 6) that had internal fixation of defect non-union mandibular fracture.
Methods: In 5 dogs, the repair was staged and extraction of teeth performed during the initial procedure. After 21–98 days (mean, 27 days) pharyngotomy intubation and temporary maxillomandibular fixation were performed. Using an extraoral approach, a locking titanium miniplate was contoured and secured to the mandible. A compression resistant matrix (CRM) infused with rhBMP-2 was implanted in the defect. The implant was then covered with a soft tissue envelope followed by surgical wound closure.
Results: All dogs healed with intact gingival covering over the mandibular fracture site defect and had immediate return to normal function and correct occlusion. Hard-tissue formation was observed clinically within 2 weeks and solid cortical bone formation within 3 months. CT findings in 1 dog at 3 months postoperatively demonstrated that the newly regenerated mandibular bone had 92% of the bone density and porosity compared to the contralateral side. Long-term follow-up revealed excellent outcome.
Conclusion: Mandibular reconstruction using internal fixation and CRM infused with rhBMP-2 is an excellent solution for the treatment of critical size defect non-union fractures in dogs.

Individual mandibular fractures occasionally fail to heal resulting in non-union, defined as failure of the opposing fracture ends to unite and to ossify.[1] The amount of healing that occurs varies from fibrous connective tissue, cartilaginous bridge that does not mineralize, or absolute lack of bridging.[1] According to the Weber–Cöch classification, a defect non-union occurs when a section of the bone is lost during a trauma, because of sequestration or after surgery.[1,2] The resulting gap between the remaining viable bone ends is too great to be bridged without surgical intervention.[1,2] Common predisposing causes for non-union include comminution, infection, ischemia, hyperemia, excessive manipulation and hardware placement, periosteal stripping too early or excessive mobility and imperfect reduction.[1] Radiologically, features such as absence of callus, evidence of a fracture gap, sclerosis of the fractures end, and displacement are typically present.

A common result of defect non-union fractures is malocclusion because of mandibular drift.[3–6] Malocclusion may result in difficulty in eating and drinking, prehension and pain of the contralateral temporomandibular joint (TMJ).[3–5,7] Therefore, the primary objective for repair of mandibular fractures, including non-union, is a quick return to normal function and restoration of normal occlusion.[8] However, while mandibular reconstruction represents the ideal solution the aspects of this technique including choice of graft material to bridge the defect and matching anatomic geometry make this approach challenging.[9,10] Autologous bone grafts and bone graft substitutes are examples of the techniques available to address the problem.[6,9,11,12] However, these are still far from ideal because of donor site morbidity, especially in small dogs.[9,13,14]

Work performed in the Department of Surgical and Radiological Sciences, School of Veterinary Medicine, and Department of Biomedical Engineering, College of Engineering, University of California, Davis.

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Autogenous bone graft alone or associated with titanium mesh for vertical alveolar ridge augmentation: a controlled clinical trial

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Key words: autogenous bone graft, bone augmentation, bone resorption, dental implants, ridge augmentation, titanium mesh

Abstract

Objectives: The aim of this controlled clinical trial is to evaluate alveolar ridge augmentation using an autogenous onlay bone graft alone or associated with a titanium mesh (Ti-Mesh).

Material and methods: A group of 23 partially edentulous patients, presenting the need for vertical bone augmentation of at least 4 mm, were treated before implant placement. Surgical procedure was performed by the same operator and was identical at 12 test (bone graft + Ti-Mesh) and 12 control (bone graft alone) sites. During the first surgery, an autogenous bone graft was harvested from the mandibular ramus and secured by means of titanium screws. Particulate bone was added. In patients assigned to the test group only, a Ti-Mesh was used to stabilize and protect the graft.

Results: No major complications were recorded at recipient or donor sites. After a mean interval of 4.6 (SD 0.7) months, the mean vertical augmentation obtained was 5 mm (range 4–7 mm) for the test group and 3.4 mm (range 3–6 mm) for the control. The sites with Ti-Mesh coverage underwent bone resorption of 13.5%, while the sites with no coverage showed a corresponding value of 34.5%. The differences between the two groups were statistically significant. Implants were placed at all grafted sites.

Conclusion: The results of this study suggest that an onlay osseous graft protected by a Ti-Mesh demonstrated significantly less bone resorption when compared with an onlay bone graft alone. This benefit was reduced in case of short-term mesh exposure, with limited drawbacks.

Date:
Accepted 13 March 2006

To cite this article:
Roccuzzo M, Ramieri G, Bunino M, Berrone S. Autogenous bone graft alone or associated with titanium mesh for vertical alveolar ridge augmentation: a controlled clinical trial. *Clin. Oral Impl. Res.* 18, 2007; 286–294
doi: 10.1111/j.1600-0501.2006.01301.x

Vertical regeneration of resorbed alveolar ridges is still a challenging surgical procedure, especially in case of extensive bone atrophy. Several augmentation techniques have been proposed, even in cases with limited bone support and inadequate nourishment. If implant stability or appropriate positioning cannot be achieved, ridge augmentation must be performed before implantation. Under these circumstances, various methods of bone grafting can be used with varying degrees of expected success. One of the major challenges, however, is to minimize the resorption of the grafted bone.

In order to do so, some authors [Buser et al. 1996; Tinti & Parma Benfenati 1998; Simion et al. 2004] have presented augmentation procedures in conjunction with a non-resorbable barrier membrane, while others [Chiapasco et al. 1999; Zeiter et al. 2000; Cordaro et al. 2002; Capelli 2003;

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Periodontology 2000, Vol. 19, 1999, 151–163
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PERIODONTOLOGY 2000
ISSN 0906-6713

Localized ridge augmentation with autografts and barrier membranes

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In the past decade, the use of osseointegrated implants, anchored in jaw bone with direct bone-implant contact, became an increasingly important treatment modality for the replacement of missing teeth in fully and partially edentulous patients (7, 8, 44, 45). To expect a predictable long-term prognosis for osseointegrated implants, a sufficient volume of healthy jaw bone should be present at potential implant sites. However, preoperative analysis often demonstrates localized bone defects in the alveolar process due to a trauma or extraction of teeth with advanced periodontal disease, root fracture or a periapical lesion. Thus, reconstructive surgery is needed to regenerate such defects, if endosseous implants are to be inserted with a good long-term prognosis.

In the past 15 years, several bone augmentation techniques have been developed and proposed (Table 1). One of these techniques is based on the principle of guided bone regeneration utilizing barrier membranes. Barrier membranes were first tested in the late 1950s and early 1960s for the healing of bone defects in orthopedic applications utilizing Millipore filters (2, 22). Later, they were also utilized in oral surgery for the reconstruction of bone defects in the jaws (5, 6). However, these pioneering studies did not lead to a broad clinical application of membranes. The potential of the membrane technique was recognized by a Scandinavian research team under Nyman & Karring, who systematically determined the relative contribution of different tissues to the healing of periodontal structures in various experimental and clinical studies in the early 1980s (36). Later, these studies lead to the evaluation of barrier membranes for the regeneration of bone defects in the jaw. Experimental studies (19, 20, 46) demonstrated that membranes – when applied over bone defects – act as a physical barrier, preventing the ingrowth of competing, non-osteogenic cells from the overlying mucosa into the membrane-protected space. Simultaneously, they allow the ingrowth of angiogenic and osteogenic cells derived from the marrow space to populate and regenerate the secluded space with bone. These studies confirmed the potential of barrier membranes but provided no detailed information about the sequence and pattern of bone healing in membrane-protected defects. Details were described in a histological study in fox hounds by Schenk et al. (40) evaluating barrier membranes applied over extended alveolar bone defects in the mandible. The study demonstrated that bone regeneration in membrane-protected defects – once activated by the creation of a bone lesion – follows the pattern of normal bone growth and development, and that tissue formed underneath expanded polytetrafluoroethylene membranes was normal bone. Another study in fox hounds by Buser et al. (14) provided the histological evidence that this regenerated bone responds to implant placement like pristine, nonregenerated bone and has comparable load-bearing capacity. In this study, all 15 nonsubmerged titanium implants – inserted in bone previously regenerated underneath membranes during 6 months – achieved functional ankylosis after 3 months of heal-

Table 1. Various bone augmentation procedures to facilitate the placement of dental implants

Split crest technique
Onlay technique with autografts
Guided bone regeneration (expanded polytetrafluoroethylene or membrane technique)
Vertical ridge augmentation with autografts from the iliac crest
Sinus floor elevation or sinus grafting
Le Fort I osteotomy

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REGENERATION OF THE ALVEOLAR CREST USING TITANIUM MICROMESH WITH AUTOLOGOUS BONE AND A RESORBABLE MEMBRANE

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KEY WORDS

Alveolar crest
Guided bone regeneration

Guided bone regeneration (GBR) has been used for the regeneration of bone in conjunction with the placement of oral implants. The aim of the present study was to clinically and histologically evaluate the use of a titanium micromesh and a resorbable membrane in the GBR technique in patients with alveolar crest defects due to periodontitis, trauma, and extractions. Eighteen patients participated in this study, and 50 implants were inserted. The postoperative healing was uneventful, no dehiscences were observed, and all implants were functioning successfully at 7-year follow-up. At reentry, in all cases, the space under the titanium mesh was completely filled by bone. From a clinical point of view, in all patients, no residual bone defects were observed and a significant increase of the alveolar width or height was found. In all cases, a good esthetic result of the restorative procedures was present.

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INTRODUCTION

Guided bone regeneration (GBR) has been used in recent years for the regeneration of bone in conjunction with the placement of oral implants, augmentation of resorbed alveolar ridges, and treatment of localized ridge deformities.[1–9] An adequate bone volume for complete circumferential coverage of the implants is important for obtaining long-term success of oral implants.[10] The minimum amount of bone seems to be 4 mm horizontally and 7 mm vertically.[10] The barrier membrane can be used either in a 2-stage technique, where bone is formed before the implantation or directly at the time of implant insertion.[11] One of the most important aspects in obtaining results with membranes for lateral ridge augmentation is the creation and maintenance of a secluded space under the membrane.[9] The development of this space is the prime determinant of the amount of newly formed bone.[2] The sites for localized ridge augmentation are non–space-making defects because they are not supported by the bone walls.[9] In these