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ORTHODONTICS AND DENTAL IMPLANTS: BROADING THE SPECTRUM OF TREATMENT OPTONS TO IMPROVE DENTAL AND MEDICAL HEALTH IN THE GENERAL POPULATION: A REVIEW

CARVALHO, Adilson Alves [1]
SANTANA, Washington Macedo[2]
NETO, João Rosa de Lima[3]
CARVALHO, Amilton Alves[4]
MOLINA, Omar Franklin[5]

RESUMO

Introdução: Odontologia, em geral, e ortodontia em particular, estão sempre desenvolvendo novos métodos, a fim de incentivar os pacientes, em ambos os setores público e privado de saúde, para melhorar a prática odontológica. Objetivo: Avaliar o papel, vantagens,

1 Associate Professor (Orthodontics), UFG-GO, Brazil. Av.Solon Batista 16, Setor Aeroporto CEP:76330-000 Jaraguá-GO. E-mail: Coerodontologia@gmail.com
2 Doctoral Program in Health Sciences (UNB, Coordinator Dental Implant Program, UNICID-GO, Brazil. Instituto Kennedy, Av.R-11, Número 202, Setor Oeste, Goiânia-GO. E-mail: coerodontologia@gmail.com
3 Prosthodontics (UFBE-M, Brazil). Alameda dos Buritis 486 Quadra 84, Lote 56 74015-080, Centro, Goiânia. E-mail: coerodontologia@gmail.com
4 UniEvangélica, Anápolis-GO, UFG-GO, Brazil. Av.Solon Batista 16, Setor Aeroporto CEP:76330-000 Jaraguá-GO. E-mail: coerodontologia@gmail.com
5 Post Doct in Orofacial Pain (Harvard U.), Professor Orofacial Pain UNIRG-TO. Av.Pará 1544, Gurupi-TO, 77400-020. E-mail: omar-nyorker-harvardtexas@hotmail.com

desvantagens, forças e outras variáveis mecânicas dos implantes dentários em ortodontia. Métodos: Uma revisão de literatura com 30 trabalhos científicos em ambas as línguas portuguesa e inglesa. Considerando os trabalhos científicos, 26 foram considerados aptos e com dados suficientes para apoiar a revisão. Resultados: A maioria dos aparelhos não relacionados com implantes, usados em ortodontia, dependem da colaboração dos pacientes. A ancoragem esquelética utilizando implantes dentários, mini-placas ou mini-parafusos fornecem ancoragem absoluta para o movimento dentário. Os implantes dentários podem ser usados como uma ajuda inestimável para atingir um número de movimentos dentários, incluindo retração, extrusão, intrusão, movimentos mesiais e distais, fechamento de espaços edêntulos, estabilização, tração ortopédica e alinhamento de dentes mal posicionados. Os implantes dentários podem também ser colocados em muitas áreas anatômicas, apresentando vantagens, tais como: fixação segura e absoluta. Conclusões: Os dispositivos de implantes utilizados na ortodontia aumentam a ancoragem ortodôntica e reduzem a necessidade de colaboração do paciente, reduzindo o tempo de tratamento. Um número de diferentes movimentos ortodônticos podem ser realizados por meio de implantes dentários, devido ao recente avanço destes novos dispositivos. Portanto, as opções de tratamentos aumentaram nos setores de saúde público e privado.
Palavras-chave: implantes dentários. Movimento dos Dentes. Vantagens. Saúde Publica/Privada. Efêmero

ORTHODONTICS AND DENTAL IMPLANTS: BROADING THE SPECTRUM OF TREATMENT OPTONS TO IMPROVE DENTAL AND MEDICAL HEALTH IN THE GENERAL POPULATION: A REVIEW

ABSTRACT

Introduction: Dentistry, in general, and orthodontics in particular are always developing new methods in order to encourage patients, in both private and public healthy sectors, to improve their dental practice. Objective: Evaluate the role, advantages, disadvantages, forces and other mechanical variables of dental implants in orthodontics. Methods: A review of literature using 30 scientific papers in both Portuguese and English languages. Considering the scientific papers, 26 were considered suitable and with sufficient data to support the review. Results: Most non-implant devices used in orthodontics rely on patients´ compliance. Skeletal anchorage using dental implants, mini-plates or mini-screws provide absolute anchorage for tooth movement. Dental implants can be used as an invaluable aid to attain a number of tooth movements including retraction, up righting, intrusion, mesial and distal movement, closing of edentulous spaces, stabilization, orthopedic traction and repositioning of badly positioned teeth. Dental implants can also be placed in many anatomic areas, presenting advantages such as: reliable and absolute anchorage. Conclusions: Implantable devices used in orthodontics practice increase the orthodontic anchorage and reduce the need of patient´s compliance, decreasing the treatment time. A number of different orthodontic movements can be achieved by Dental implants, due to the recent advance in these new devices. Therefore, treatments options were increased in private and public health sectors.

Keywords: Dental Implants. Tooth Movement. Advantages. Private/Public Health.

INTRODUÇÃO

By definition, anchorage is defined as body´s resistance to displacement. The main role of anchorage is to resist unwanted tooth movement. In orthodontic tooth movement, segments of teeth that resist movement and serve as “anchors units” are used to pull against other segments that have to be moved. In this regard, the anchor segment should contain more teeth with greater root surface area when compared to the segment of teeth that will be moved (HEIMANN & TULLOCH, 2006). Orthodontists have been searching for the perfect anchorage to mitigate undesired tooth movements, thus, headgear, elastics, adjacent teeth and many other appliances have all been suggested as anchorage elements. However, most of these devices rely on patients´ compliance (WAHL, 2008). The selection of a proper anchorage is the key factor for successful orthodontic therapy. It is known that every orthodontic device, which produces a force onto the teeth, generates an opposite force that affects the anchorage. On the other hand, a bone implant, remains stable ensuring a secure anchorage when there is no use of teeth (LABANAUSKAITE et al.,2005).

Some conventional means for enhancing orthodontic anchorage are not a good way forward, because they can rely on structures that are themselves potentially mobile (teeth), or even on heavily patients` compliance (BUSER et al., 1999). Moreover, some anchorage devices including lip bumpers, Nance´s appliance and others are uncomfortable, inconvenient and non-hygienic (PARK & KWON, 2004). It has been demonstrated that skeletal anchorage using dental implants, mini-plates or mini-screws provides absolute anchorage for tooth movement. Besides, osseous integration is a direct structural and functional connection between living bone and the surface of a load-carrying implant (BRANEMARK, ADELL & BREITNER, 1969). Many implant systems have been developed and their use in orthodontics have increased dramatically, but it seems to be a paucity of studies in the field of clinical performance, advantages, inconvenient, control of forces of some systems used currently in orthodontics, thus, the **proposal** of this study is delineated as follows:

1.Evaluate the role of dental implants in orthodontics;

2,Assess the advantages of using implants as anchorage, means in orthodontics;

3.Evaluate disadvantage and complications of dental implants;

4.Discuss forces and biomechanical variables.

LITERATURE REVIEW

Orthodontic tooth movement has always been limited to action-reaction reciprocal force mechanics in the absence of a fixed anchorage point in the mouth. Anchorage is defined as the resistance of an unwanted tooth movement or as the resistance to reaction forces generated by the influence of other teeth, or even by anatomic structures outside the mouth (HIGUCHI & SLACK, 1991). Inadequate anchorage is one of the most limiting aspects of orthodontic therapy. Improved orthodontic biomechanics would be attained through the use effective means in order to achieve direct osseous loading (HIGUCHI & SLACK, 1991). Traditionally, orthodontics have used teeth, intraoral and extra-oral appliances to control anchorage, minimizing the movement of certain teeth, while movement required of other dental units is completed (ANWAR, RAJA & NAUREEN, 2010). However, based on Newton´s third law of motion, anchorage units experience an equal and opposite force and this reactionary force is the focus of biomechanical consideration in orthodontic (ANWAR, RAJA & NAUREEN, 2010). When a tooth is moved, an unwanted movement of the anchorage unit, resulting from the reaction force, must be considered and for this reason, skeletal anchorage is being favored over tooth anchorage (LEE et al., 2008). However, all intraoral appliances show some loss of anchorage, thus, extra-oral anchorage does not provide reliable anchorage without patient´s compliance (PARK, JEONG & KWON, 2006).

Anchorage has fundamental importance in orthodontic treatment. Besides, a common method of reinforcing anchorage in the maxillary arch is the use of an extra-oral attachment to the first molar. However, this device is not popular with patients as it is not frequently worn as prescribed, leading to poor treatment results and it may also be dangerous for the eyes (BENSON et al., 2007). Some orthodontic devices used to gain or guarantee anchorage are awkward or uncomfortable for patients, often leading to less than desired levels of compliance, and thus, treatment outcome may be compromised (HEIMANN & TULLOCH, 2006).

Additional anchorage aids such as headgears and inter-maxillary elastics can be used. Nonetheless, there are some disadvantages of visibility, compliance dependence and also the risk of undesirable side effects due to not enough collaboration from all patients to ensure the expected clinical results (ASSCHERICKX et al., 2005). Moreover, some appliances still used today to ensure anchorage have unpleasant side effects, including protrusion, extrusion and tipping of some teeth (THIRUVENKATACHARI et al., 2006).

Direct anchorage utilizes forces from a current implant, such as dental implants, which takes the place of a missing tooth and eventually supports a dental restoration. Indirect anchorage uses the implant to stabilize specific dental units and then, clinical forces are applied. For instance, a mid-palatal implant attached to a trans-palatal arch is placed solely for orthodontic purposes (BLOCK & HOFFMAN, 1995). Over the past twenty years, Dentistry has seen a dramatic increase in the use of dental implants. Thus, an extensive research base now supports the treatment modality that once was an experimental or unproven treatment. The vast majority of dental implant research is centered around the use of endo-osseous implants for replacement of a missing teeth (HEIMANN & TULLOCH, 2006) and a wide range of implants including bone screws, bone plates, and palatal implants are used for orthodontic anchorage (BENSON et al., 2007).

Osseo integrated implants are invaluable in orthodontic treatment of partially edentulous patients deficient of adequate tooth bone anchorage, as they provide skeletal anchorage to facilitate correction of malocclusion in partly edentulous patients (BENSON et al., 2007). Bone integrated implants have been developed in order to provide rigid intraoral anchorage, thus, the use of titanium fixtures has provided a modality to permit unidirectional tooth movement without reciprocal action or anchorage loss (HIGUCHI & SLACK, 1991). Bone integrated implants can also afford anchorage for movement of teeth, which were not possible with conventional tooth borne anchorage or without patient´s cooperation. When such implants are placed within the dental arches, they can also give support for the prosthetic replacement of a missing teeth during and following orthodontic treatment. Therefore, orthodontist and prosthetic dentist benefit of integrating implants and orthodontics in the partially edentulous patient (BENSON et al., 2007).

Recently, the mini-screw system of temporary anchorage device (TAD) for orthodontic purposes is being increasingly used (ANWAR, RAJA & NAUREEN, 2010). Thus, orthodontists currently use headgear, elastics, dental implants, mini screws and many other appliances, so they can obtain the perfect anchorage system to minimize undesired tooth movements (WAHL, 2008).

Indications and/or clinical applications of dental implants in Orthodontics

A variety of dental implants have been indicated for different clinical situations:

1.To retract anterior teeth in class II division 1 malocclusion;

2.To upright lower or upper molars and attain mesial and distal tooth movement;

3.To intrude posterior molars to correct open bite malocclusions;

4.To achieve mesial movement of molars (SINGARAJU & MURTHY, 2009);

5.To close edentulous spaces in first molar extraction sites;

6.To achieve correction of the midline in patients with missing posterior teeth;

7.In reestablishing proper transverse anterior posterior positions of isolated molar abutments;

8.To stabilize teeth with a reduced bone support minimizing movement of certain teeth;

9.When the clinicians need to apply orthopedic traction to intrude and extrude teeth (WAHL, 2008);

10.To retract and realign anterior teeth when posterior teeth are absent;

11.To reposition badly positioned teeth and to protract and retract one arch (HEIMANN & TULLOCH, 2006);

Classification of anchorage and dental implants

Direct anchorage refers to any situation in which forces originated from the current (actual) implant itself are used to increase the anchorage, for instance, a restored dental implant with an orthodontic bracket is bonded to the restoration, thus, the implant is used as an stable anchor (HEIMANN & TULLOCH, 2006). Indirect anchorage refers to a situation in which a dental implant stabilizes multiple teeth, which then works as an anchor unit. A common method of achieving indirect anchorage is by placing a dental implant most commonly in the mid-palatal or retro-molar region, and fixing the implant to the natural teeth by means of a wire or other rigid fixation device (HEIMANN & TULLOCH, 2006). Indirect anchorage uses the implant to stabilize specific dental units by applying clinical forces. This method of implant, usually a mid-palatal fixture attached to a trans-palatal arch is placed solely for orthodontic purposes and it is frequently removed, once its anchorage duties have been fulfilled (BLOCK & HOFFMAN, 1995).

According to the shape and size, dental implants for orthodontic anchorage can be classified as conical/cylindrical (mini-screws, palatal implants, and prosthodontics implants, mini-plates and disc implants). Based on the implant bone contact, they can be classified as integrated to bone or non-integrated to bone. According to the application, implants are usually classified as orthodontic and prosthodontics implants (SINGARAJU & MURTHY, 2009). The classification of dental implants is also based on the position, material, construction and design. The position of the implant can be sub-periosteal, trans-osseous, or endo-osseous. Implants can also be classified as interradicular, septum, supra-apical, infra-zygomatic, retro-molar, mandibular, median, para-median and anteriorly in the palate (ASSCHERICKX et al., 2005). Titanium is, currently, the preferred material for implants fabrication and for implant surface, it can be rough or smooth, and even have an additional hydroxyapatite or titanium spray coating (WAHL, 2008).

Advantages of implant placement

It has been reported that implantable devices used in contemporary orthodontic practice will increase orthodontic anchorage, eliminating patients` compliance needs and decrease the overall treatment time (HEIMANN & TULLOCH, 2006). Additionally, orthodontic mini-screws have the advantage of being available in a range of sizes, easy to place and remove and further, it can be loaded immediately, they are relatively inexpensive, non obstructive and more acceptable to patients (ANWAR, RAJA & NAUREEN, 2010). Because of their small size, mini-screws can be placed in the intra-arch alveolar bone without discernible damage to tooth roots and orthodontic forces can act almost immediately after placement, in contrast to dental conventional implants (PARK & KWON, 2004).

Mini-screws implants require less surgical intervention, cause less discomfort to the patient and compared with other systems, the surgical procedure, for placing and removal is very simple and non invasive, allowing the procedure to be carried out by an orthodontist, thus, eliminating the need for a surgical referral (HEIMANN, 2006). One advantage of implant placement is that they can be placed in different anatomic areas in the maxilla and in the mandible. Dental implants can be used to effect a variety of orthodontic movements in the maxilla, mandible or both at the same time or separately (WAHL, 2008).

Additionally, micro-implants can provide reliable and absolute anchorage of lingual orthodontic treatment and of a conventional buccal treatment (WAHL, 2008). The apparent advantages in using a mini-plate system include a long history of biological compatibility, variety of shapes and sizes, minimally invasive surgical procedure, and little risk of damaging nerves or tooth roots (HEIMANN & TULLOCH, 2006). The advantages of the OrthoImplant system is its simple placement and utilization, being a true endo-osseous implant. In addition, its integration may be far more predictable as compared to the sub-periosteal OnPlant (BLOCK & HOFFMAN, 1995).

Disadvantages and complications

Complications of implant placement include soft or hard tissue infection, failure of the implant and risk of damage to adjacent tooth roots in the case of implants (such as the mini-screws) placed on the buccal aspect (BENSON et al., 2007). Some disadvantages of endo-osseos implants and Omplants include a long waiting period for bone healing and bone integration, comprehensive clinical and laboratory work, difficult removal after treatment, high cost, severity of surgery, discomfort of the initial healing period and the difficulty to keep a proper oral hygiene (WAHL, 2008).

Regarding the surgical procedure and anchorage, one disadvantage of mini-implants is that a full thickness flap is required for their placement and the plates must be retrieved after treatment (WAHL, 2008). Additional disadvantages using dental implants for orthodontic anchorage include longer treatment time, financial constrains, anatomical limitations and one or two expensive surgeries for most patients (HUANG, SHOTWELL & HUANG, 2005). Infection, local soft tissue irritation, maxillary sinus perforation, infringement upon tooth roots and loosening of the mini-screw are potential risks that have also been reported (HEIMANN & TULLOCH, 2006).

Loosening may be troublesome when screws are loaded in a manner that results in a force oriented in a direction that unscrews the screw and lateral shearing forces are more detrimental to the stability of implantable devices than other forces (HEIMANN & TULLOCH, 2006). Monitoring the healing of some implant systems may be problematic. The Onplant, being a submerged fixture, is impossible to be evaluated during stage 1 healing, and is disconcerting to both clinician and patient to discover a non-integrated fixture at the stage II uncovering, particularly after waiting the prescribed four months. There is no clinical method to monitor the progress of integration (BLOCK & HOFFMAN, 1995). Regarding the OrthoImplant, the patients must be attentive to not exert pressure with the tongue or traumatize the implant site, as this can have a deleterious effect on integration (BLOCK & HOFFMAN, 1995). A recent study (COSTA, RAFFANI & MELSEN, 1998) indicates that the use of implants to attain anchorage may create the risk of producing and or maintaining infection that may occur in every type of trans-mucosal implant.

In some cases, there may be the risk of sinus perforation when a micro-screw is placed on the infra-zygomatic crest as well. Moreover, in a few clinical cases, the risk of contact with nerves and vessels could also be possible. Regarding conventional or endo-osseous implant systems, some disadvantages are that implants can be inserted only in edentulous areas with adequate bony support. Furthermore, since the treatment has to be coordinated with multiple specialists (Prosthodontist, Restorative specialist, Orthodontist, Periodontist and/or even Oral Surgeon), this option is more complex and perhaps, most time consuming (HEIMANN & TULLOCH, 2006).

Criteria for implant placement and insertion sites

Some clinicians consider that implants should not be placed into the mouth if some criteria were not fulfilled: The implant material must be nontoxic, compatible biologically, possess mechanical properties and should provide resistance to stress, strain and corrosion. Implant fixtures must also achieve primary stability, withstand mechanical forces, and the maximal force should be proportional to the total bone-implant contact surface (HUANG, SHOTWELL & HUANG, 2005). The following insertion sites to obtain pure orthodontic anchorage implants have been described: The interradicular septum, supra-apical, infra-zygomatic, and retro-molar areas in the mandible and the median or para-median anterior palate en the maxilla (ASSCHERICKX et al., 2005).

Regarding methods of implants placement, the available literature indicates that the pre-tapping method in which the mini-screws are driven into the tunnel of bone formed by drilling, making it tap during implant, but a mini-screw may also be driven directly into the bone without drilling. In the self-tapping method, a slight notch is made and then the screw is tapped into the bone (SINGARAJU & MURTHY, 2009).

Most common types of implants or available implant systems

Currently, only limited number of implantable devices may be used in orthodontic treatment and such options include conventional titanium endo-osseous dental implants, palatal implants such as the Onplants and the Straumann system, titanium mini-screws, micro or mini-implants and mini-bone plates (HEIMANN & TULLOCH, 2006). Conventional titanium endo-osseous dental implants can be used as sources of absolute or direct anchorage for orthodontic treatment in areas of edentulous spaces within an arch when adjacent or opposing teeth are not positioned ideally (HEIMANN & TULLOCH, 2006).

Bone integrated implants constitute excellent anchorage systems even for the most complicated tooth movement as they do not show any clinical significant reactive movement to orthodontic forces. In addition, they remain stable in position, even under orthodontic occlusal loading conditions (ASSCHERICKX et al., 2005). Palatal implants are those devices or instruments placed in the median suture of the palate following ossification of the median suture of the palate. Loading is placed only after bone integration is complete (usually 3-6 months), perforation of the mucosa and bone preparation are needed in order to place the implant. Usually, local pain and swelling remains for a week. These devices are used for orthodontic anchorage, they should be removed following treatment, and they have 3-4mm diameter and 4-6mm in length (SINGARAJU & MURTHY, 2009). Experimental investigations in dogs (SINGARAJU & MURTHY, 2009), indicated that anchorage implants in the median palatal suture in dogs should cause a restriction of the normal transverse expansion of the maxilla in the canine region. Palatal implants should be placed in the center of the anterior palate. They may be connected to a trans-palatal arch and to the first and second premolars, which serve as anchorage units. Treatment time varies from patient to patient and such devices may be used to correct overjet, to attain distal movement of posterior teeth and to retract canine teeth ((LEE et al., 2008).

Mini-screws or micro-screws

These devices are very small and can be placed in areas where other implantable devices cannot. Some of these devices are so small that they can actually be placed even in bone between the roots of certain individual teeth. These screws are very similar or identical to those used for osteotomy fixation following orthognatic surgery (HEIMANN & TULLOCH, 2006). Mini-screws are small implant devices having 1-3mm in diameter and 6-14mm in length. They can be placed in any structure where enough cortical bone is present, age is not a counter-indication, and they are able to support immediate loading (SINGARAJU & MURTHY, 2009).

Mini-screws placement requires only minimal perforation of the oral mucosa, they cause only minimum patient´s discomfort they are used for orthodontic anchorage and should be removed following treatment (SINGARAJU & MURTHY, 2009). Recent studies (LEE et al., 2008), indicate that mini-screws can also be placed bilaterally in the alveolar bone between maxillary second premolars and first molars, between the mandibular first and second molars, and also bilaterally in the alveolar bone between maxillary second premolars and first molar.

These devices are unique in the sense that they do not require integration on the bone (HEIMANN & TULLOCH, 2006). Mini-screws implants have many benefits including ease of placement, removal and inexpensiveness. Because of their small size, they can be placed in the intra-arch alveolar bone without discernible damage to tooth roots and orthodontic force application can initiate almost immediately following placement (PARK & KWON, 2004).

Onplants

OnPlants are button type implants used in the palatal region and function as anchorage source for expansion as well as for maxillary protraction (SINGARAJU & MURTHY, 2009). The OnPlant, which resembles a button, is a relatively flat, disc-shaped fixture available in diameters of 8-10mm. Such devices have a textured, hydroxyapatite-coated surface for integration with the palatal bone (BLOCK & HOFFMAN, 1995). These devices are placed after ossification of the median suture of the palate. Loading should be placed after integration to bone which usually takes 3-6 months, flap surgery is needed to place these devices, pain and swelling remains for a week (SINGARAJU & MURTHY, 2009).

OnPlants are used for orthodontic anchorage, have 10mm in diameter and 2mm in thickness. OnPlants are placed sub-periostically on the posterior aspect of the hard palate. A tunneling procedure is used to place these anchors, a thin muco-periosteal incision is needed on the anterior aspect of the hard palate, and tunnels are reflected posteriorly so as to allow the OnPlant to be placed away from the incision to reduce the potential for soft tissue reactions that prevent osseous integration (HEIMANN & TULLOCH, 2006). OnPlants differ from implants, since they adhere only to the outer surface of the bone. An OnPlant grows and adheres to the cortical plate covering the bone and thus, provides anchorage by bonding in the surface of a titanium disk with hydroxyapatite (WAHL, 2008).

OrthoImplant

This device is a true endo-osseous implant that is inserted into a carefully created osteotomy site in the mid palatal region. Following an appropriate location, a soft tissue trephine is used to remove a small core of palatal mucosa. Then, a round bur is used to score the hard palate and a spade is adapted to the exact dimension and proportions of the OrthoImplant, which is screwed into the osteotomy site. Then, a cover screw or cap is placed to control soft tissue overgrowth. The advantage of this device is the simplicity of placement and utilization. Moreover, because this device is a true endo-osseous implant, its integration may be far more predictable than that of the sub-periosteal OnPlant (BLOCK & HOFFMAN, 1995).

Biomechanics, forces, loading time and implant maintenance

There are significant differences between orthodontic and functional occlusal forces. Orthodontic loads are continuous, horizontal, and usually range from 20 to 300g. Occlusal forces are discontinuous, vertical or lateral and sometimes reach several kilograms. It has been shown that although in clinical practice different loads are used in different implant systems, the results show favorable implant stability. Forces are extremely variable and vary from 60, 120, 100, 150, 180, 200 and 300g in different implant systems (HUANG, SHOTWELL & HUANG, 2005). Implants systems must achieve primary stability and withstand mechanical forces. The maximal load should be proportional to the bone-implant contact surface. Moreover, major factors determining the contact area are length, diameter, shape and surface design. Currently, a smooth rough and thread configuration is preferred over other designs (HUANG, SHOTWELL & HUANG, 2005).

Direct orthodontic forces generate less stress on implants due to limited force imposed (<3N or about 300g). The stressor tension is far less for indirect anchorage as implants are used to stabilize teeth. With dense bone and satisfactory stability, immediate loading might be possible. Threaded implants provide superior mechanical interlock as compared to cylindrical designs, thus, waiting time should be longer for non threaded implants. Stable mechanical retention or partial bone integration is required, and implants should never be overloaded during the healing period (HUANG, SHOTWELL & HUANG, 2005).

In one study (HEIMANN & TULLOCH, 2005), implants were subjected to continuous orthodontic loading, they were removed and analyzed following treatment and findings from the histologic evaluation indicated that despite orthodontic loading, they were well integrated into the bone. It seems that under relatively orthodontic continuous forces implants have a tendency to conserve their integration to bone. Clinical experience indicates that there is a threshold for force duration in humans in the 4-8 hours range per day. Effective tooth movement is produced if force is maintained for longer durations (HEIMANN & TULLOCH, 2006). Continuous forces produced by fixed appliances when not affected by what the patient does, produces more tooth movement than removable appliances unless the removable appliance is present almost all the time (HEIMANN & TULLOCH, 2006).

One investigation (PARK, JEONG & KWON & 2006), indicates that when an excessive load is applied, partially osseous integrated screw implants can become severely mobile and eventually fail. Under condition of light forces, screw implants can be maintained with minimal mobility. Dental implants are usually loaded in all directions in addition to vertical occlusal forces, but orthodontic screw implants are usually loaded with unidirectional lateral forces, thus, minimal mobility can be allowed in orthodontic screw implants. In another research (PARK et al., 2003), the mean period of force application to the mini-screw implant was 15 months, a time sufficient to provide proper anchorage in most orthodontic patients. The most critical time period demanding anchorage control for successful orthodontic treatment is for anterior tooth retraction following extraction.

One study (PARK, JEONG & KWON, 2006), demonstrated that there was no significant difference in the success rate with respect to the onset of force application, which might indicate that immediate loading of screw implants might be possible. Furthermore, an animal experiment demonstrated that there was osseous integration after immediate loading of the screw implant indicating that immediate loading was not a concern and that treatment time could be reduced. Thus, screw implants can be loaded immediately after placement without a discernible deterioration of stability. It seems that the mean period of force application to such a device is about 15 months, a period sufficient to provide proper anchorage in most orthodontic patients (PARK, JEONG & KWON, 2006).

The OrthoImplant can be loaded sooner than the OnPlant, its SLA surface may show successful integration in alveolar bone in six weeks, although a 10-week period is currently indicated ((WEHRBEIN, GLATZMAIER & YILDIRIM, 1997). Excessive forces (more or less 425g) applied to implants in experimental monkeys, may cause suture remodeling and failure of implant stability in a few monkeys ((TURLEY et al., 1988).

Causes of failures of dental implants in orthodontics

Screw implants can fail for various reasons including osteoporosis, uncontrolled diabetes and parafunctional habits. Surgical factors include improper surgical technique, lack of initial stability, overheating during placement and the fitness of the pilot hole to the diameter of the screw implant (PARK, JEONG & KWON, 2006). Management factors include poor home care, inflammation or infection, poor oral hygiene and excessive loading. A previous investigation (PARK, JEONG & KWON, 2006) found that 6-12 screw implants failed within two months following placement.

In the previous study , 87 consecutive patients received four different types of mini-screw implants for orthodontic anchorage. The surgical procedure included local anesthesia, a small vertical stab incision, reflection of flaps, a pit made with a round bur, a hole made with a pilot drill and placement of the screw implant with screwdriver. The overall success rate in this study was about 91,6% with a mean of 15 months of force application and 5 screw implants were fractured during the removal process. More successful implant results were observed in the maxilla than in the mandible. Inflammation observed in some implants could produce damage to the adjacent bone surrounding the neck of the screw and progressive damage to the cortical bone. A low frequency of failures (19/227) was observed in this investigation.

Excessive force application seems to be an important failure factor in implant placement. In this regard, one study ((TURLEY et al., 1988) applied 425g of force to bioglass-coated ceramic implants in order to achieve orthodontic expansion of the palate in monkeys. Failure of implant stability was reported in 2/3 cases. The maximal load applied on the implant is directly related to the design of the fixture, the biomechanical requirements, anatomic limitations and degree of osseous integration. Even though, different forces may be used with different devices and techniques, it seems that the clinical result may still be favorable (HUANG, SHOTWELL & HUANG, 2005).

Implants and clinical results

One clinical study (THIRUVENKATACHARI et al, 2006), used micro-implants placed between the roots of the second premolars and first molars in orthodontic patients. Results indicated that titanium micro-implants can function as simple and effective anchors units for canine retraction when maximum anchorage is desirable. A more recent investigation ((ANWAR, RAJA & NARUREEN, 2010), evaluated the success rate in orthodontic patients receiving bone screws for anchorage and reported that the use of mini-screws is a practical alternative to more conventional anchorage enhancement techniques.

One investigation (HIGUCHI & SLACK, 1991), used titanium implants in seven adult patients. Orthodontic forces directed to the implants to correct a variety of malocclusions were in the range of 150-400g. Researchers found that all 14 placed implants, remained stable during the course of treatment. Benson et al., (2007), compared the clinical results of mid-palatal implants and headgears used as orthodontic anchorage devices in orthodontic patients and found that both forms of anchorage were effective and that there were no statistically significant differences between tooth movements in patients with implants versus in those using headgears. It has also been reported (PARK & KWON, 2004), that retraction of upper anterior teeth can be attained successfully without anchorage loss using micro-screw implant systems when anchorage is necessary in orthodontic cases.

DISCUSSION

The role of dental implants in orthodontics

Dental implants were introduced in Dentistry mainly to increase the possibilities of carrying out different treatment methods and to provide proper anchorage to carry out more effectively tooth movements in orthodontics. Dental implants are used to extrude impacted teeth, retract anterior teeth and to correct tooth position when prosthetic treatment has been planned. Osseous integrated implants are used as anchorage units to assist orthodontic tooth movement because these devices provide maxillary anchorage and do not depend on patients´cooperation (OHNISHI et al., 2005). MORAIS et al (2007), concur with these uses of dental implants and add that micro-implant devices rather than conventional ones are now used as anchorage devices as they have few implantation site limitations, a simple insertion procedure and easy mechanical force control.

Other functions or applications of dental implants include to intrude teeth, close edentulous spaces, repositioning of badly positioned teeth, to reinforce anchorage, treat partial edentulism and to correct undesirable occlusion by providing orthodontic anchorage (HUANG, SHOTWELL & HUANG, 2005). One investigation (HEIMANN & TULLOCH, 2006), defends the notion that other functions or roles of dental implants include stabilizing teeth with reduced bone support, to reestablish proper transverse and anterior-posterior position of isolated molar abutments, to protract or retract one arch and perhaps, many other applications or roles are possible.

Advantages of using dental implants as anchorage devices in orthodontics.

A number of advantages have been attributed to dental implants including serving as a method to increase orthodontic anchorage, no need of patient compliance, decreasing overall treatment time and allow to carry out a type of orthodontic treatment which was usually impossible before the advent of implants (HEIMANN & TULLOCH, 2006). One additional advantage of dental implants is that they constitute an alternative when dental elements serving as anchorage units are insufficient in quantity and quality, and thus, the desirable orthodontic movement may not be feasible without the use of dental implants (MORAIS et al., 2007). Additionally, one specific advantage of commercially pure titanium implants is that their mechanical properties are suitable and present excellent biological compatibility with dental tissues (PARK, JEONG & KWON, 2006).

One advantage of mini-implants is that they constitute a better choice to prevent the discomfort of a severe surgical process (MORAIS et al., 2007). Mini-implant systems present with few limitations regarding anatomic site placement, the insertion procedure is simple and the control of mechanical force is easy (PARK et al., 2003). These devices present additional advantages including small size, non-invasive surgery, less surgical interventions, and minimal discomfort to the patient (LABANAUSKAIT et al., 2005).

Mini-screw devices do have many advantages over the traditional implants including acceptable bone support intra oral anchorage, and many pre prosthodontic applications. They can be used in many anchorage related tooth movements including mesial or distal movement of buccal teeth, distal movement of canines or premolars, lingual or labial movement of anterior teeth, vertical intrusive movements of anterior teeth (LABANAUSKAITE et al., 2005). Mini-screws or TDAS present a number of advantages over endo-osseous implants and OnPlants including better orthodontic connection, easier removal following treatment and lower cost (LOU et al., 2004).

Disadvantages and complications of dental implants

Even though the use of dental implant systems is now widespread, the usage of these devices is rather limited due to their size, time consumption for integration to bone and financial constraints. These problems have been minimized with the introduction of new implant systems such as the palatal and/or the mini-screw implant (LABANAUSKAITE et al., 2005). Even though, bone screws, bone plates and palatal implants are easy to use and simple to place, soft or hard-tissue infections, failures of the implants and damage to adjacent roots, may occur (BENSON et al., 2007).

One investigation (MIZRAHI & MIZRAHI, 2007), reviewed the literature on dental implants and reported that contact with adjacent roots, implants lossening and breakage, damage to anatomic structures and soft tissue overgrowth are the most common side effects of dental implants. Because of the severity of the surgical process, mini-plates are often considered troublesome for some patients. Discomfort during the initial healing period and difficulties to maintain proper oral hygiene are additional problems. In the case of conventional prosthetic implants, the relatively large size may lead some professionals to choose mini-implants instead of conventional ones ((OHNISHI et al., 2005). Failures may occur with any implant systems and in some cases when various teeth are intruded at a time using mini-screws, intrusive forces that are too intense may cause screw failure ((MIZRAHI & MIZRAHI, 2007).

One disadvantage of conventional dental implants is that they can be placed only in limited sites, such as the retro-molar and edentulous areas (MORAIS et al., 2007), they are troublesome for patients because of the severity of the surgical process, discomfort of initial healing period and difficulties in maintaining oral hygiene (OHMAE et al., 2001). Endo-osseous implants and OnPlants are limited in their clinical application as they are used only in edentulous or retro-molar areas because of their size and complicated fixture designs, they need a long waiting period for bone healing, comprehensive clinical and laboratory work is necessary, removal is difficult following treatment and high costs (WAHL, 2008). Mini-screws have the potential for local infection, tissue irritation, maxillary sinus perforation, impingement upon tooth roots and loosening of the screw (HEIMANN & TULLOCH, 2006).

Forces and mechanical variables

It is known that a healing period is usually necessary before applying load to conventional dental implants and this period ranges from 4 to 6 months in humans. When the load is applied prematurely, histological analysis have indicated that there is no uniform intimate bone-implant contact due to the presence of fibrous tissue (MORAIS et al., 2007). Orthodontic treatment forces vary greatly depending upon the type of movement required. Lower orthodontic forces ranging form 0,2 to 2N are used to move few teeth. Orthodontic forces from low to medium values are used to move a high number of teeth and a force of N is the most common force used in orthodontic treatment and has been used experimentally in animals (MORAIS et al., 2007).

One investigation (ROBERTS et al., 1984), reported that forces ranging between 1 and 3N applied after 6-8 weeks of healing do not compromise the stability of the implants. Excessive forces may cause deleterious effects in some components of the periodontal system. One investigation (OHNISHI et al., 2005), indicates that external apical root absorption may occur during treatment with dental implants when forces at the apex exceeded the resistance and reparative capability of the periapical tissues.

Excessive force during treatment increases the risk of periapical absorption specifically if heavy continuous forces are used. Based on this principle, light forces should be used to produce appropriate pressure within the periodontal ligament (OHNISHI et al., 2005). Direct orthodontic forces generate less stress on implants due to limited force imposed, usually less than 3N = approximately 300g. The stress is far less for indirect anchorage as implants are used to stabilize teeth. With dense bone and satisfactory stability, immediate loading might be feasible (HUANG, SHOTWELL & HUANG, 2005). Mini-screws can be loaded immediately with forces in the range of 50 to 300g. In the case of palatal implants and OnPlants, loading should be applied only after bone integration which usually takes 3-6 months. It has been indicated that mini-implants should be loaded after healing (SINGARAJU & MURTHY< 2009), however, a high level of integration to bone using endo-osseuos implants can be maintained despite loading an implant with orthodontic forces (ROBERTS et al., 1984).

CONCLUSIONS

Based on the results of the current literature review to carry out this study, the following conclusions can be drawn:

1.Implants in orthodontic treatment were developed to improve treatment methods, to provide proper anchorage, to execute different functions in orthodontics, implants and prosthetic dentistry;

2.Dental implants increase orthodontic anchorage, decrease overall treatment time, present easiness of placement and removal, can be placed in multiple sites and some devices require less surgical intervention;

3.Disadvantages and complications of dental implants include higher costs, surgical intervention, need for other specialists, possibility of soft or hard tissue infections and damage to adjacent roots, discomfort during healing and difficulties in maintaining adequate oral hygiene.

4.Forces used in implant systems vary greatly depending on the intended movement. Low and medium forces are better tolerated by the tissues, forces should be applied preferentially following the healing period, excessive forces may be destructive to the periodontal tissues, and heavy continuous forces should not be used.

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