



Use of temporary anchorage devices in orthodontics: A review of the literature

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Use of temporary anchorage devices in orthodontics: A review of the literature

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Abstract

Introduction: In the recent years, it is observed that there is increase in usage of Mini-screws in Orthodontic therapy as a temporary anchorage device, because of their absolute anchorage, easy positioning, easy removal, finally for their low cost. This study consists of a review of the articles published in the literature about these devices.

Objectives: They were chosen from "PubMed" several publications from 2006 to 2012 about mini-plates, mini-screws, palatal implants and dental implants as orthodontic anchorage. This review was carried out to evaluate utility and clinical efficacy of the skeletal anchorage devices to determine the most effective system of bone anchorage for orthodontic tooth movement.

Discussion: To obtain total control of the anchor during teeth movement, mini-screws represents an efficient in the terms of absolute anchorage compared with the traditional methods used. When a doctor decide to use this devices, it requires the maintenance of healthy good oral hygiene, because poor oral hygiene with an adjacent inflammation of the oral soft tissues to the head of the mini-screws determine a potential risk which leads to failure of the therapy.

Conclusions: In modern orthodontics, advent of TADS (Temporary Anchorage Devices) lead to identification of therapeutic alternatives to traditional methods of anchorage, makes possible orthodontic movements that are not possible with traditional biomechanics. The usage of TADS allow the orthodontist an extension of the therapeutic possibilities, with encouraging results in the correction of malocclusions.

Introduction

The need to resort skeletal anchorage in orthodontics was due to increase in number of adult patients who require orthodontic treatment. Different studies have made it clear that many patients can't be treated with conventional anchoring. The term anchor is defined as "the resistance to unwanted tooth movement"; or better, it is the ability to restrict the movement of

certain teeth, reaching the desired movement of the other dental elements. ⁽¹⁾

Most obvious solutions for the best anchorage control is to concentrate the forces required to produce tooth movement in desired location and dispel the forces of reaction to distribute them as much as possible on teeth, keeping pressure on the periodontal ligament of the tooth anchor as low as possible. Threshold for the tooth movement is rather low, it increases in proportion to the pressure on the periodontal ligament of anchorage teeth up to a certain point, beyond which it remains constant for wide range of pressure values up, to decrease when this becomes too high. The optimal forces for the orthodontic movements is the lightest able to produce such pressure as to induce a maximal response (light forces and continue). ⁽²⁾

The first anchoring devices to be used are the classic work by prosthetic loading, cylindrical or screw, with different surface characteristics, next evolution has led to production of mini-implants back molars osteo-integrated, until you get to today, with miniscrew and mini-plates, temporary anchorage devices (TADS) placed for the control of Tooth movement during orthodontic treatment and removed at the end of orthodontic treatment. The (TADS) are currently employed as an alternative to traditional orthodontic appliance anchor; they are inserted into bone and traction of the Tooth is accomplished through use of springs or elastic chains. close collaboration between orthodontist and periodontist is necessary for an accurate knowledge of anatomy of hard and soft tissues and ability to cope well with the position at which to insert anchor devices ⁽¹⁾. Diriment for proper planning and successful treatment are to be considered: design of the system, cost-benefit ratio, pre-operative diagnostic measures, quality and quantity of available bone in anatomical site of insertion procedure, biomechanics and orthodontic forces applied, possible risk and complications.

There are many advantages of these anchoring devices, infact, they are simple to use, inexpensive, instantly downloadable, no require for patient cooperation, provide results equivalent or superior when compared to conventional systems, they are not osteo-integrated, they are biocompatible and resistant to orthodontic forces applied, they have properties and small size. They can be used both in adults and

children with partial or complete dentition.

Methods

This study consists of review of articles published in the literature about these devices. They were chosen from "PubMed" several publications from 2006 to 2012 about mini-plates, mini-screws, palatal implants and dental implants as orthodontic anchorage. The main inclusion criteria of research are: The characteristics of orthodontic mini-screws, Advantages and Disadvantages of mini-screws, Insertion technique, Conditions of use, Success and Failure.

The mini-implants for orthodontic anchorage are "skeletal anchorage devices" that allows to get an intra-oral orthodontic anchorage but non-dental. Mini implants are divided into three types: Mini implants at insertion median palatal, anchor plates and mini-screws. Mini-screws skeletal anchorage devices are the most common and they are characterized by the ability to obtain: temporary absolute anchorage lack of cooperation from the patient to be small.

Anchor is absolute because the forces of reaction orthodontic downloading jaw bones, teeth and is also temporary because of healing process between implant and bone generally consists of small osteo-integration or in osteo-fibro-integration that allow at the end of treatment to remove the screw simply by mean of only action of unscrewing.

The miniscrew give possibility to apply biomechanical orthodontic permanently with abolition of the patient cooperation at orthodontic treatment enabling the orthodontist to reduce the time of treatment; they have reduced dimensions in fact diameter of fixture is between 1 and 2 mm and length between 5 and 10 mm, and the diameter reduced so allow for the first time of use by the orthodontist new area of alveolar process: septal root⁽³⁾.

Both mini-screws (temporary anchorage devices with reduced diameter compared to traditional dental implants) that palatal implants (temporary anchorage devices with reduced length compared to traditional dental implants) have been shown to be useful and efficient as skeletal orthodontic anchorage⁽⁴⁾

Review

Ortho-Implants, also called mini-screws, screw-systems, micro-implants currently used and

disclosed to provide skeletal anchorage in treatment of malocclusion. Unlike osteo-integrated implants, TADS does not remain completely still during orthodontic treatment. For installation miniscrew generally refers to devices of diameter less than 2.5 mm. These devices are made: titanium or stainless steel, design of the screw can be conical or cylindrical thread with symmetrical or asymmetrical, have diameter that varies from 1.2 to 2.5 mm and length from 6 to 11 mm. TAD must obviously penetrate through mucosal tissues or gingival tissue. Which varies mainly of such devices is form of the head which can be sphere with holes, or grooved surface. Most of these systems present on the market are self-tapping and other Self drilling.⁽¹⁾

Self-tapping require pre-drilling (also referred to as hole-pilot) of cortical bone, it performed with milling cutter of diameter less than diameter of the screw, appropriate length and diameter of the screw and adequate bone density⁽⁵⁾. Disadvantage is represented by orthodontist doesn't have the tactile perception during pre-drilling with rotary instruments, therefore, he hasn't awareness of any damage to adjacent tissue.

Self Drilling have sharp point and are able to pierce bone without need to make hole invitation. During insertion of the implant, comparing self-drilling and self-tapping devices, instruments have lower insertion torque-drilling facilities, both however showed similar resistance to the laterals forces⁽⁶⁾. Consequently, diameter of the screw, as well as thickness and hardness of the cortical bone and site of insertion, these are parameters to be taken into account to determine whether it is necessary to pre-drill. Bone is heavily compressed during insertion and can lead to high risk of fracture of bone around the implant site, if it insert screw without pre-drilling. When it encounters higher resistance, TAD is also subjected to greater torsion load that can lead to its breakage.

As result, self-piercing devices are best for regions with bone thinner and less dense cortical bone (maxilla)⁽⁷⁾. For regions with thicker and more dense cortical bone (mandible), the pre-drilling through the bone cortex is necessary for self-tapping devices and recommended for self-piercing devices⁽⁸⁾. Pre-drilling should be made to maximum of 500 rpm, with pilot drill (corresponding to the inner diameter of the TAD) with sterile water cooling to reduce the risk of thermal damage bone. Self-drilling screws, if inserted with an accurate technique, they are able to provide early orthodontic under load, better primary stability compared to those inserted after drilling. In areas where there is large thickness and density of cortical

bone (retro-molar mandibular zone, symphysis zone and edentulous alveolar processes) it is preferred to perform preperforation, which should not be performed for the entire length of the screw but only for 1-2 mm on the surface.

Discussion

Advantages:

- Easy insertion and removal;
- Favourable cost-benefit ratio;
- Provide comfort for the patient;
- It is not necessary patient compliance;
- Application in different anatomical areas: pit incisive , canine pit , crest infra-zygomatic, pre-maxillary region, symphysis mandibular, retro-molar zone, pit beneath the jaw ;
- They are stable , but they cannot remain absolutely still for the duration of the orthodontic load .

Disadvantages:

- Different insertion sites that have different anatomical features;
- Rotational Instability;
- Mobility of screw fracture after removal;
- impairment of anchorage;
- Irritation of mucous membrane;
- Injury to roots or neurovascular bundles.

In relation to rate of success of these devices:

- Studies on animals have shown success rates of 87 mini-screws 0.5 to 100 %, loss of mini-screws were associated with inflammation of tissues around the implant. Melsen ⁽⁹⁾ and Costa⁽²⁾ have concluded that screws immediate load are able to work well as anchoring system for dental movements that could not otherwise be performed with traditional devices ;
- Studies in humans have shown success rates of 70-100% , however, not related to amount of force applied, also mini-screws with small diameter (1.0 mm) have greater tendency to break from the mini-screws diameter of 1.5 to 2.3 mm ⁽⁶⁾ .

Recent histological studies on animals have shown that osteo-integration of TADS titanium is about half of that of dental implants. There is no substantial difference in histological bone if these devices are not under load, while some differences were demonstrated between maxillary and mandibular bone. The greater presence of compact bone in the jaw may be responsible for the differences when you compare the integration of insertion in maxilla with that in mandible. The fact that there is no absolute an osteo-integration represents great advantage in use of

TADS titanium. Total absence of osteo-integration allows easy removal of mini-screws , despite mini-screws can still carry load of orthodontics. Selection of material type (steel, titanium type 4 or 5) may become important when trying to optimize their use in orthodontics and increase their resistance to breakage. Orthodontic forces are not large enough to cause the rupture of these devices, forces associated screwing and removal can cause breakage of TADS , especially in cases of partial osteo-integration . Tendency to produce screws with reduced diameter could lead to dangerous reduction of their mechanical strength.

Clinical indications for use of TADS are:

- Insufficient number of dental elements and / or lack of occlusion drive anchor, for example patients with partial edentulism or agenesia.
- Extrusion or intrusion of individual teeth or groups of teeth without antagonists (ie in the absence of vertical opposing forces that act on them, for the need to maintain or restore proper occlusion and to avoid the establishment of functional disorders) ⁽¹⁰⁾
- asymmetric tooth movement
- Shrinking and / or intrusion of anterior teeth with insufficient anchorage reactive unit ⁽¹¹⁾
- Moving mesial of the molars where the front sector cannot be moved ⁽¹²⁾ .
- proclination of the front teeth is not available if a rear anchor.
- Closure of spaces.
- Moving in distal direction of molars ⁽¹³⁾ .
- Correction of an open-bite ⁽¹⁾ .

Since the anchoring devices have decisive role in orthodontics modern careful assessment of patient is essential to assess existence of any health conditions or factors that contraindicate use of mini-implants. Local risk factors such as bone quality and oral hygiene, general risk factors related mainly to overall health status of the patient ⁽¹⁴⁾ . Best treatment plan must include the fewest number of TADS needed to deal with the case. Excessive use cannot be considered prudent.

The Contraindications for use are represented by:

- Patients with metabolic bone diseases;
- Patients taking suppressive therapy of the immune system;
- Patients on chronic therapy with steroids or bisphosphonates;
- Patients with severe neurological or psychological problems;
- Patients with poor quality or quantity of bone tissue for the primary stability;

- Patients with infections or circulatory problems;
- Patients with allergic reactions to specific materials;
- Patients receiving radiotherapy in the head and neck region or recurrent disease of the oral mucosa;
- Patients with insulin-dependent diabetes, being more susceptible to infections;
- Patients with poor oral hygiene;
- Patients who have not completed skeletal growth.

Success and Failure

The main factors of failure of the TADS are classified into:

1. GENERAL:

- impairment of general health of the patient;
- Heavy smokers who cannot provide an adequate plaque control and therefore could face loss of implant and bone loss around the implant;
- Patient Age: normally TADS are not able to affect bone growth, but being of small devices if they are inserted in palate of complications may occur, in view of what you prefer the insertion of devices in median region of the palate when patient has reached the age of majority or otherwise as median suture of the palate is completely calcified;

2. LOCAL:

- Patients with periodontitis who should be motivated to good oral hygiene prior to insertion of TADS, inflammation being one of the main risk factors related to treatment failure;
- Degree of opening of mouth and quality of bone-density: patients with high mandibular plane angle generally have reduced thickness of the vestibular cortical bone;
- Diameter of TADS;
- Inflammation of peri-implant;

The main success factors related:

- type of device chosen for treatment;
- diameter;
- length of the mini-screw;
- selection of suitable site;
- density and thickness of the cortical bone in the different skeletal types;
- model of skeletal growth;
- At the correct input mode;
- Correct position of the implant so that it does not interfere with the desired tooth movement;
- oral hygiene of the patient and not least the skill of the operator;
- Lack of mobility, pain, infection, sensation of foreign body;

Conclusion(s)

Temporary anchorage devices (TADS) represent new addition to dental armamentarium and can be used to replace traditional extra-oral orthodontic appliances. Review of the literature shows that usage of (TADS) is an orthodontic technique reliable, secure and high success rates. Temporary Anchorage Devices have great potential because they have ability to meet some basic requirements both orthodontist and patient: In fact these devices allow an absolute anchorage-independent and methodical cooperation of patient, also give the opportunity to make quick treatment , aesthetic and economic. The most serious complications (injury to nerves, root canal , maxillary sinus and nasal cavity) are reported in literature as potential complications and are still avoidable by careful pre-operative assessment. The most common complications, such as loosening of the device and the local inflammation, are rather minor inconveniences and still easily manageable by the clinician. Clinical success depends on site of insertion, surgical technique , by optimal ratio between diameter of the device and diameter of the pilot drill, local inflammation and management of orthodontic load.

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