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Guiding Templates for Mini-Implants in Orthodontics: A Systematic Review.

K Niranjani*.

Saveetha Dental College, Saveetha University, Chennai-77, Tamil Nadu, India.

Review Article

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*For Correspondence

Saveetha Dental College,
Saveetha University, Chennai-77, Tamil Nadu, India.
Mobile: +91 8220335988

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ABSTRACT

Anchorage plays a vital role in orthodontic treatment. Miniscrews are used to augment anchorage and are defined as temporary components fixed to the bone for improving the orthodontic anchorage; either by supporting the teeth of the reactive unit or obviating the need for the reactive unit. It is subsequently removed after treatment. It has gained wide use for absolute anchorage in orthodontics. Guiding templates have been used always, for placing mini-implants since 1980s. They help to assist the orientation of osteotomy preparation and thus aid in correct fixture placement. This article throws light on some of the widely used templates for mini-implant placement.

INTRODUCTION

Orthodontic anchorage is the resistance to undesired tooth movement [1], and is the most important factor for success and failure of orthodontic treatment [2]. Anchorage is the fundamental aspect of orthodontic treatment; poor anchorage control during therapy may increase treatment time and lead to an unfavourable result [3]. Moderate anchorage provides reciprocal space closure; maximum anchorage means most of the space closed by retraction of incisors; minimum anchorage means most of the space closed by protraction of buccal segments [1].

The use of mini-implants to obtain absolute anchorage has recently become very popular in clinical orthodontics for promising results [4,5,6,7,8,9,10]. Mechanical retention plays a role in stability of mini-implants and it can be placed in any site in oral cavity [11,12,13,14,15,16,17]. In 1945, Gainsforth and Higley [18] used vitallium screws in mongrel dogs to create absolute anchorage for tooth movement. Linkow [19, 20] suggested implants for anchorage purposes and described the use of an endosseous blade implant for retraction of anterior teeth in 1969. In 1983, Creekmore and Eklund [21] performed maxillary incisor intrusion with the help of a titanium osteosynthesis screw. Ronerts[22] et al reported on applying these principles for molar movement in an adult patient.

With the invention of the onplant in 1995, Block and Hoffman [23] introduced the palate as an anchorage device location. Dental implants, miniplates and miniscrews have been used as orthodontic anchorage; But miniscrew type of anchorage is widely used because of its smaller size, ease of insertion and removal, low cost than implants, onplants and miniplates, no waiting period before loading, no need for laboratory work and improved treatment outcome [1].

Indication for Miniscrews

Mini-implants are excellent alternative to conventional orthodontic anchorage systems such as intraoral dental anchoring units and extra-oral headgear devices [24]. Mini- implants are indicated for correcting class II malocclusion and severe overjet by extracting first and second premolars, retraction of maxillary anterior teeth. Patient with anterior open bite can be corrected by intrusion of molar segments and deep bite can be corrected by extruding maxillary molar segments [1].

Contraindication for Miniscrews

Mini-implants are contraindicated in patients suffering from metabolic bone disease, circulatory disturbances, acute infections, recurring diseases of oral mucosa, patients receiving immune suppressive therapy, chronic steroid, bisphosphonate medication [25].

Sites for Miniscrew Placement

Kanomi [26] and costa [27] et al implanted mini-screws into the basal bone between roots of the teeth to prevent root damage [28]. If implanted miniscrews are positioned at a higher level; applied force for vertical sectors will be limited. Park et al [29, 30] implanted microscrews between the roots of posteriors to increase the horizontal component of applied force [8]. Mini-implants are placed in interroot spaces of maxillary and mandibular arches [31].

Insertion of mini-implants in alveolar process is a critical procedure [32,33]. Single osteointegrated implant between the roots of 2nd premolar and 1st molar in the upper arch and between the roots of 1st molar root and 2nd molar in the lower arch provide sufficient stability to reduce the number of mini-implants and need for posterior bands and brackets [34]. Insertion of miniscrews in maxillary posterior region above 8-11mm from gingival margin is not recommended to avoid damage to the sinus and in the tuberosity region due to the presence of limited bone and wisdom teeth. Palatal site is usually recommended for implant placement than the buccal side but it has to be carefully evaluated [28].

For safe insertion of the miniscrews, axis and screw shape become critical. In maxilla screws should be inserted in an oblique angle (30-40degrees), which allows longer screw insertion. In mandible, safe zone for implant placement is between 1st and 2nd molars and between 1st and 2nd premolars. Safe insertion is over 8mm from the alveolar crest. For placing mini-implants several factors are recommended; includes type and direction of the applied force, the loading period, bone, quality and quantity of the insertion site [28].

Complications of Improper Placement

Inappropriate placement of mini-implants results in various complications which includes hypersentivity of root, root fracture, alveolar bone fracture, perforation of maxillary sinus, damage to inferior alveolar nerve [35,36,37,38]. Incase of minor damage to root tissue on placing mini-implant; periodontal ligament heal normally on removal. In contrast, heavily injured tissue will not heal completely; but leave a bony ankylosed area on the root surface, which can have a negative impact on orthodontic tooth movement. Mini-implants in contact with roots are considered to be at a greater risk of failure [39]. Success rate of mini- implants varies from 37% to 94%. It differs because (1) difference in duration of use, age of the patient, level, direction of applied force and placement site. (ii) Although the prosthetic implants sustain multidirectional and heavy occlusal force; the orthodontic mini-implants bears the smaller force with more regular direction (iii) several products from different manufactures [40,41,42,43,44,45,46,47].

Different Guiding Templates

Simple Wire Guide

Simple wire guide is invented by Suma T et al in the year of 2010. It is fabricated using stainless steel wire (0.018 in diameter); helix is made with the diameter of 3mm in the centre of wire. Length of mini-screw insertion is determined (generally 5-6mm from alveolar crest. Wire guide is secured to the adjacent brackets using ligature wire or 'O'ring. After determining the vertical height, two horizontal bends are placed at the level of adjacent brackets. Position of the helix is confirmed using periapical radiograph for Miniscrew placement. Wire guide is removed after 3/4th of the Miniscrew is driven in and then Miniscrew is completely inserted. Placement is reconfirmed with radiograph [48].

Multiloop Wire Guide

Multiloop wire guide was introduced by Hemanth et al in the year of 2012. It is inexpensive and easy to use; formed from brass or stainless steel may be used to determine the position of the mini-implant. It contains 3 to 5 loops depends on the vestibular depth. Wire guide should be placed in the interradicular space and secured with elastomeric ligature in mesial tooth bracket and position is determined using radiograph, mini-implant is placed on the selected loop. The multiloop wire guide minimizes the failure rate of implants and also significantly reduces the risk of root injury [49].

Radiographic Template

Radiographic template was introduced by Freudenthaler and associates. It is fabricated from plaster cast of the patient. Flat bite block of 5mm thick is fabricated using autopolymerising acrylic resin and three 0.018 inch stainless steel wires placed parallel to the occlusal plane. Before polymerization wires are placed on to the flat surface of bite block. Middle wire should be superimposed over the imaginary line through the center of the interseptal bone of 2 adjacent teeth. This serves as a radiographic template. A simple film holder is fabricated to obtain intra oral radiographs. This can align the x-ray source, teeth and film in a straight line and it will guide the central x-ray perpendicular to the radiographic film. Resultant radiograph has to be clipped on the buccal side of the

template. Middle wire is bent occlusally at 30 to 40 degrees for maxilla and 10 to 20 degree for mandible, this serves as a guide for directing the microimplant placement [50].

3D Placement Guide: Aleppo University Surgical Orthodontic Miniscrew

AUSOM 3D placement guide is introduced by Mahmoud Al-Sueiman et al in the year of 2011

It consists of four parts,

- Vertical part – It is a round stainless steel wire, used to locate the position of mini-implants in vertical direction and it has a lock which is fixed to the orthodontic wire connected to fixed appliance.
- Horizontal part – It is a round stainless steel wire, used to locate the position of mini-implants in horizontal direction and it has a lock, movable in vertical direction. Once desired height is reached, lock can be closed. It also holds the placement guide.
- Placement guide – It has a vertical round wire, has cylinder on the end, which works as a guide to place mini-implant.
- Film holding part – It is a wire extends from the film holding part of the molar band and inserts into the periapical radiograph holder [2].

Stereolithographic Surgical Template

Stereolithographic guide was introduced by Seong-Hun Kim et al in the year of 2008. This template has been used in dentistry since early 1980s for fabrication of subperiosteal dental implants using stereolithiography [51]. The surgical guide was designed using rapid prototyping (RP) machine which uses stereolithography, and rapid prototyping process based on photopolymer liquid resins that solidify when exposed to UV light. The RP machine read angulations and diameter of implant, simultaneously polymerizes the resin around the implant site, and forms the cylindrical guide on the replica corresponding to each implant. Then the supporting resin is removed and cylindrical guide is used to insert surgical grade stainless steel tubing which serves as a guide tube [52,53,55]. The surgical template would transfer the planned three dimensional implant positions to the surgical site [55]. It was designed to determine not only the best insertion site but also accurate placement of the head of the screw. Surgical guide can be adjusted before surgery using the radiograph [55]. Template can be disinfected using gluteraldehyde before surgery [56].

Suzuki 3D Guide

Suzuki consists of vertical arm. One end is connected to the orthodontic archwire with gurin lock. Other end is connected to stainless steel tube which determines optimal site for implant placement. Using bitewing radiograph implant site is predetermined for drilling pilot hole and mini-implant placement [2].

3D Radiographic Surgical Guide

This consists of two items, vertical arm which has round telescopic stainless steel tube soldered on one end of the wire; other end is connected to the horizontal arm using gurin lock. Both are made of stainless steel wire which is connected to the fixed orthodontic appliance. Using radiograph, mini-implant position is determined [2].

Cone Beam Computed Tomography and 3D Prototyping

CBCT guide was introduced by Ken Miyazawa et al in the year of 2010. CBCT is a safe, accurate, and simple procedure for determining mini-implant position. This helps to proceed in complex surgical procedures using preoperative plan based on CT to minimize risks and optimize clinical results. Three dimensional images acquired from CBCT used to obtain additional information about the anatomic structures. Presurgical 3D model of patient's teeth and underlying alveolar bone was created; this helps to place mini-implants in predetermined position. A CBCT record is transformed into 3D images. A replica model of the cast is fabricated using stereolithography apparatus. Mini-implant site and Length of the mini-implant is determined in axial and 3D view of CBCT [57].

Surgical Stent

Morea and colleagues introduced surgical stent. A guide channel for pilot drill may be fabricated from acrylic or metal tubing supported by acrylic. Metal channel provides smooth surface for pilot drill, but doesn't allow the drill to be clearly seen. Acrylic channel will contaminate the surgical site with acrylic debris. Local anesthesia should be administered in the desired site, stent is placed temporarily to check the mucosa with probe or round bur. Circular section of mucosa is removed using circular punch. Stent is replaced by a drill to create an appropriate implant drill. Stent is removed and Miniscrew placed with the manual screw driver or slow handpiece. Implant position is verified using radiograph [55].

Universal Wire Grid

Universal wire grid was introduced by Narendra S Sharma et al in the year of 2013. It consists of positioning grid and guide base. Positioning grid is fabricated by cutting stainless steel wire in 1 inch length and welded to form a column grid, each cell should measure about 1.5mm^2. Column grid is welded to round 'U' frame support arm of the positioning grid. Stent base is fabricated by bending 18 gauze wire forming one end to support the grid and the other end embedding in the occlusal surface of acrylic resin. Grid should be adjusted in vertical direction and it can be placed 5-6mm from the alveolar crest. Softened wax is added to the acrylic base and pressed towards the occlusal surface. IOPA is taken to determine the position of stent in relation to the roots. Once the appropriate cell of the grid is selected, pilot drilling is performed with the grid in place followed by mini-implant placement. Occlusal mirror is used to visualize the occlusal surface to guide the implant driver. Final position is verified using radiographs [58].

DISCUSSION

Anchorage control is the important for successful orthodontic treatment. In order to overcome compromised esthetics and patients inco-operation mini-implants are developed. Mini-implants are placed any site in the oral cavity with the help of guiding templates. Miniscrews placed without using guiding templates must have various complications. Guiding templates have been used in dentistry since 1980s. Each template have its own advantages and disadvantages, on comparing the above mentioned templates 3D guiding templates helps to plan the Miniscrew position in the appropriate site and it has best clinical outcome compared to others. On using guiding templates various complications acquired using improper placement can be minimized.

CONCLUSION

After discussing about guiding templates, it is always safer to use guiding templates for placing mini-implants to reduce the risk of failure and complications. An accurate method has to be followed for determining the mini-implant placement site, using cone beam computed tomography, panoramic radiograph, intra oral radiograph.

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