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Miniscrew implant placement grids – A review

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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 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 compiles and summarizes the existing mini implant techniques and showing their possible clinical effectiveness.

Keywords – Anchorage, mini implant, guiding template, retention, stability.

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. Ronerts22 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 Miniscrew

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 Miniscrew

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]. In case of minor damage to root tissue on

placing mini-implant; periodontal ligament heals 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 center 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].

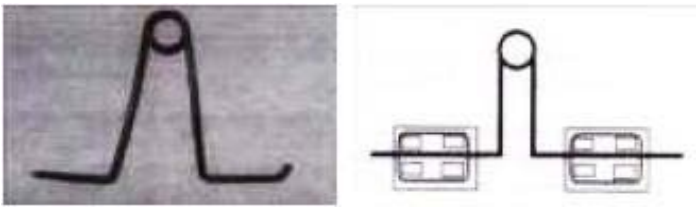

Fig. 1: Simple wire guide

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].

Fig. 2: Radiographic Template

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,

1. 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.

2. 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.

3. Placement guide – It has a vertical round wire, has cylinder on the end, which works as a guide to place mini-implant.

4. 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].

Stereo lithographic Surgical Template: Stereo lithographic 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].

Fig. 3: Stereo lithographic Surgical Template

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].

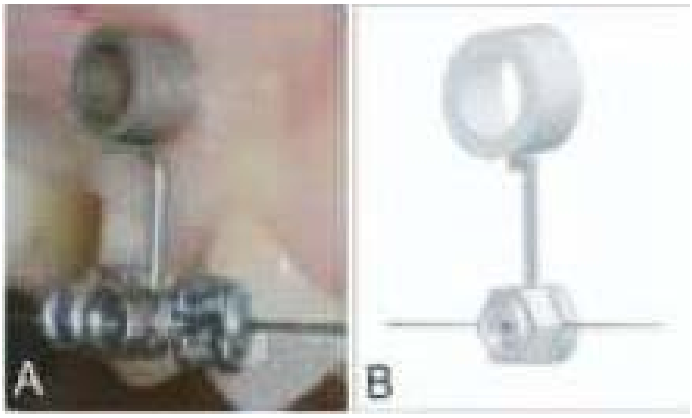

Fig.4: Suzuki 3D Guide

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].

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].

Fig. 5: Cone Beam Computed Tomography Guide

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 1.5mm2. 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].

Fig. 6: Universal Wire Grid

K.S. Micro-Implant Placement Guide

The wire guide is fabricated using round 0.018 or 0.020 (A.J. Wilcock) or 17 × 25 or 19 × 25 stainless steel wire. A helix of 2–3 mm diameter is made at the center of the wire. The appropriate length is determined by the desired mini-screw insertion point (generally 5–6 mm apical to the alveolar crest). After vertical height is determined,

continues vertical loop made until measured length and one or two horizontal bends are the place at the level of the adjacent brackets [59].

Fig. 7: K.S. Micro-Implant Placement Guide

A 3D jig for accurate mini implant placement

A mini implant 3D jig is fabricated by using 0.019x0.025 ss wire, a 0.022 slot weldable double molar tube and a crimpable hook. The wire is cut into two pieces, one piece is used to fabricate eyelet or helix approximately 2mmin diameter which is inserted into the main tube and other piece is bent to form L and inserted into auxillary tub. The other end of this arm is bent to formthe angulation guide arm [60].

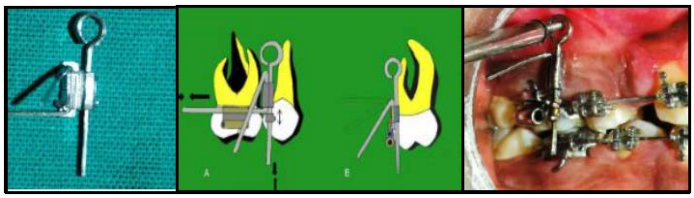

Fig. 8: A 3D jig for accurate mini implant placement

A Simplified Stent for Anterior Miniscrew Insertion

1. Clinically locate the roots adjacent to the miniscrew insertion site by firmly pressing the long end of a periodontal probe against the buccal tissue.

2. Securely tie two L-shaped rectangular wires, facing each other, into the bracket slots adjacent to the miniscrew site. These wires should extend vertically well beyond the mucogingival junction, following the outer surfaces of the roots, and horizontally past the outer edges of the brackets. Using rectangular instead of round wire prevents the stent from rolling away from the gingiva when the patient closes over the film holder.

3. Take a periapical radiograph to confirm the proper positioning of the stent. If necessary, slide the archwires within the bracket slots until they accurately follow the outlines of the roots [61].

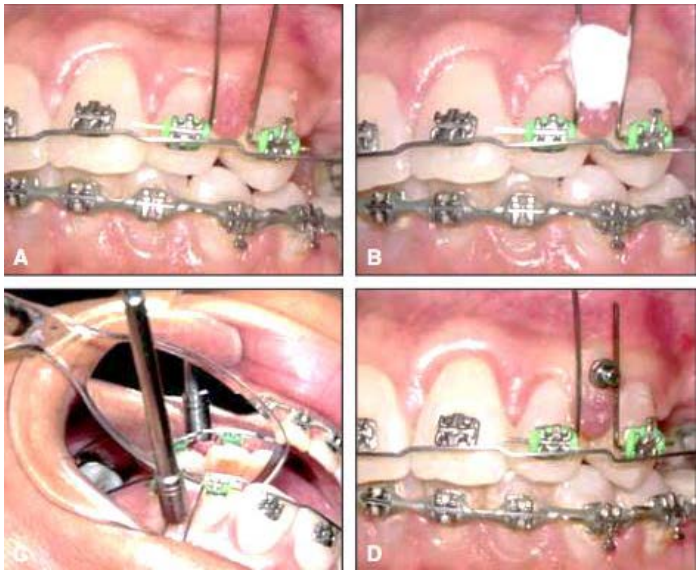

Fig. 9: A Simplified Stent for Anterior Miniscrew Insertion

Jiffy Jig - A quick chair side micro implant guide

The IOPA radiograph of the area of implant placement is taken using parallax technique. The IOPA radiograph is traced onto an OHP sheet of same size as of IOPA radiograph film with increased length for occlusal extension. The point of implant placement is decided on IOPA radiograph following the guidelines for implant placement. The point is transferred to the traced OHP sheet and a hole is punched in the OHP sheet Attach one brass wire piece to OHP sheet which acts as guide for long axis. The OHP sheet is cut into the shape of teeth with a part extending occlusally to stabilize the sheet intra-orally and this makes the “JIFFY JIG” ready [62]

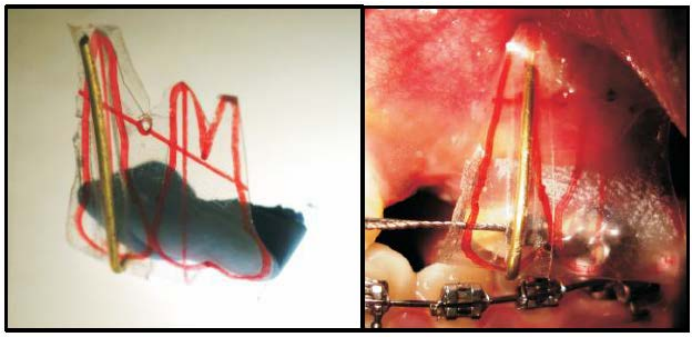

Fig. 10: Jiffy Jig

Simploguide - A Simplified Guiding Template for Miniscrew Implant Placement.

The wire guide was fabricated using 0.014-inch A. J. Wilcock wire. Three helices of 2mm in diameter were made by using bird beak plier and placed at a distance of 4mm, 6mm and 8mm respectively from base arch wire (0.019 × 0.025 stainless steel). The template was first welded and then cold soldered to the base arch wire and later finished by using finishing burs. As a stiffer base arch wire is used chances of sliding of wire and shifting of template was minimized [63].

Fig. 11: Simploguide - A Simplified Guiding Template for Miniscrew Implant Placement

Mini - Implant Punch (MIP)

A 0.018" A. J. Wilcock stainless steel wire made straight and center of the wire was marked with glass marking pencil.At the marking point, a helix of diameter 3mm was incorporated. Then, point was marked 4mm on either side of helix and bent 90 degrees. Buccal arm was taken 7-8mm long and lingual arm of 4-5mm length. Buccal arm is again bent 90 degrees for 3mm.

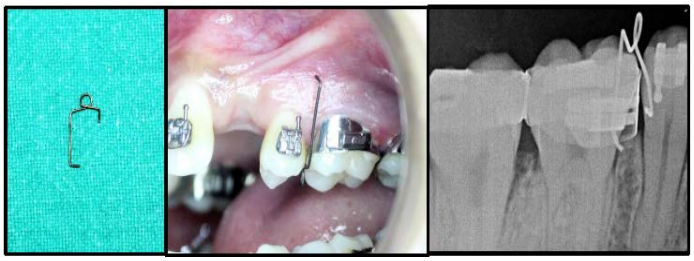

Fig. 12: Mini - Implant Punch (MIP)

Conclusion

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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