REVIEW ARTICLE

Guide For Orthodontic Mini Implant Insertion - A Review.

Arun Kumar Chauhan[1], Kanchan Das[2], Sayantan Choudhury[2], Arunavo Nandy[2]

Abstract:

Success or failure of the orthodontic treatment largely depends on the vital role played by anchorage. Anchorage control in conventional way is very challenging and has various limitations. Thus mini screws are used to augment anchorage. These are 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. Removal is done usually after treatment. But insertion of mini implants requires pinpointing their optimal position to prevent any damage to the adjacent anatomical structure. Since its' introduction in 1980s guiding templates are being used for placing mini-implants. They help to assist the orientation of osteotomy preparation and thus aid in correct fixture placement. This article compiles and summarizes the existing guiding templates used for mini implant placement and shows their possible clinical effectiveness.

Keywords – Anchorage, mini implant, guiding template, stainless steel (SS).

Introduction :

Orthodontic treatment is largely dependent on the vital role played by anchorage. Orthodontic anchorage is defined as the resistance to undesired tooth movement[1]. Anchorage conservation in totality has been a common problem for all orthodontists. Conventional means of supporting anchorage rely on either intraoral sites or extra-oral means. Both of these have their own limitations. Poor anchorage control during therapy may increase treatment time and lead to an unfavorable result[2]. Mini implants have gained wide popularity for its promising results in clinical orthodontics as absolute anchorage[3-9].

These orthodontic implants made up of titanium have broadened the use of skeletal anchorage by virtue of their easy placement and multiple suitable intraoral sites[10-14]. Miniscrew type of anchorage is widely used because of its smaller size, ease of insertion and removal, low cost than implants, onplants and miniplates, short or no waiting period before loading, no need for laboratory work and improved treatment outcome[1,15].

1. *Professor*
Department Of Orthodontics & Dentofacial Orthopaedics, Kothiwal Dental College & Research Centre
2. *Post Graduate Student*

Correspondence Address:
Dr. Kanchan Das
Post Graduate Student
Department of Orthodontics & Dentofacial Orthopedics,
Email id: kanchandas35751@gmail.com

Phone no - 9862088948

Widespread use of mini-implants has led to a need for precise placement and better retention. But accurate placement of mini implant is of utmost importance for safety and absolute anchorage.

Sites for mini-screw placement: Very commonly mini-implants are placed in inter-radicular spaces of maxillary and mandibular arches[16]. Inter-radicular areas especially of posterior maxilla and mandible are considered as preferred sites of implant insertion to prevent root damage to increase the horizontal component of applied force[4, 17-18]. Baumgartel and Hans found a buccal cortical bone thinnest in the anterior sextants of both jaws and a progressive increase toward the posterior region, except distal to the maxillary second molars, where the buccal cortex average was thin[19]. 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[18]. In maxilla screws are inserted at 30°- 40° angle facilitating longer screw insertion. In mandible, safe zone for implant placement is between 1st and 2nd molars and between 1st and 2nd premolars.

Complications of improper placement

Required tooth movement may be hindered thus limiting the effectiveness of the skeletal anchorage due to improper positioning[10]. Vertical/sagittal placements and proximity to a root are among several factors that might influence the stability and failure rates of mini-implants[20-21]. Insertion techniques should maximize the available bone volume while avoiding adjacent anatomical structures, such as dental roots, naso-maxillary cavities, and neurovascular tissues[22]. Various complications, arising due to inappropriate placement of mini-implants, include: fracture of alveolar bone, root hypersensitivity/fracture, maxillary sinus perforation, damage to inferior alveolar nerve. Mini-

implants in contact with roots are considered to be at a greater risk of failure[21]. Wu et al reported that screw placement without an accurate surgical guide results in 20% of injuries during positioning[23]. Accidental impingement of mini-implants into the dental root and periodontium causes the stoppage of tooth movement for 3-4 months. Hence, accurate placement of an implant is necessary for its success. To overcome all these "Implant guides" are used.

Types of guiding templates: They can be divided into three categories:

A. Metallic guides - practical radiopaque marker formed from a brass or SS wire
B. surgical templates, and
C. other devices and methods.

Different Guiding Templates

1. Surgical Stent[25]:

Morea and colleagues introduced this in 2005. 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 does not allow the drill to be clearly seen. Local anesthesia is administered in the desired site, stent is placed temporarily to check the mucosa with probe. Circular section of mucosa is removed using 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.
Advantage – It allows precise implant location.
Disadvantage – Fabrication is cumbersome & extra appointment is required.

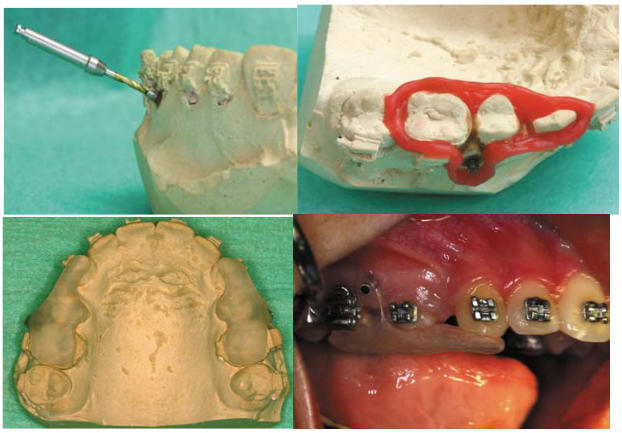

Fig. 1 Surgical stent

2. Radiographic and surgical template[26] :
It was introduced by Jian-chao Wu and associates in 2006. It is fabricated from plaster cast of the patient. 5mm thick bite block is fabricated using auto-polymerising acrylic resin and three 0.018 inch SS 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 inter-septal bone of two adjacent teeth. 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 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 micro-implant placement.

Fig.2 Radiographic template

3. Simplified Stent for Anterior Miniscrew Insertion[27] :

- Roots adjacent to the insertion site are located by firmly pressing the long end of a periodontal probe against the buccal tissue.
- Two L-shaped rectangular wires are then engaged into the bracket slots adjacent to the mini-screw site. Vertical extension of the wire is beyond the muco-gingival junction and horizontally past the outer edges of the brackets. 0.016"x0.022" SS rectangular wire used.
- IOPA is taken for confirmed positioning. Sliding of the arch-wire is possible.

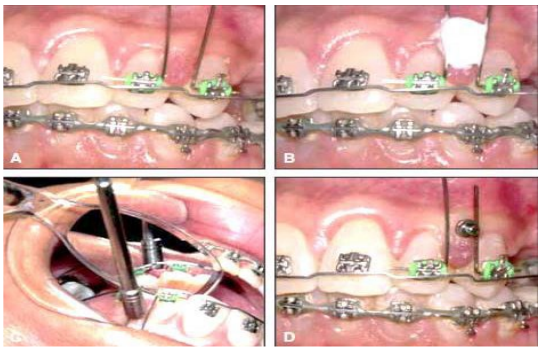

Fig.3 Simplified Stent for Anterior Miniscrew Insertion

Advantage –
1. Can be used for both anterior & posterior region
2. Fabrication is simple and quick

4. Cone Beam Computed Tomography and 3D Prototyping[28] :

CBCT guide was introduced by Kim et al in 2007. CBCT derived 3-D images are used to obtain additional information about the anatomic structures. Pre-surgical 3D model of patient's teeth and underlying alveolar bone is 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 stereo lithographic apparatus. The site and length of mini-implant is determined in axial and 3D view of CBCT.

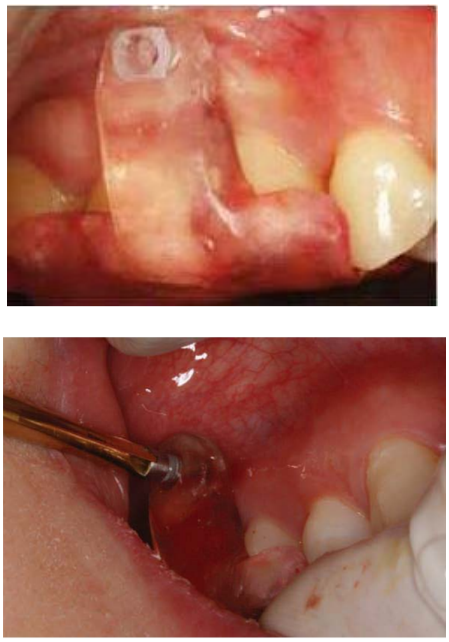

Fig.4 Cone Beam Computed Tomography Guide

Advantage –
1. More reliable and safe
2. It is much more precise

Disadvantage –
1. More radiation exposure than IOPA x-ray.
2. High fabrication cost

5. Stereo lithographic Surgical Template[29]:

It is designed using RP machine and rapid prototyping process, introduced by Seong-Hun Kim et al in 2008. Confirmation is done by radiograph. It is based on stereolithographic process and uses photopolymer liquid resin. 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.

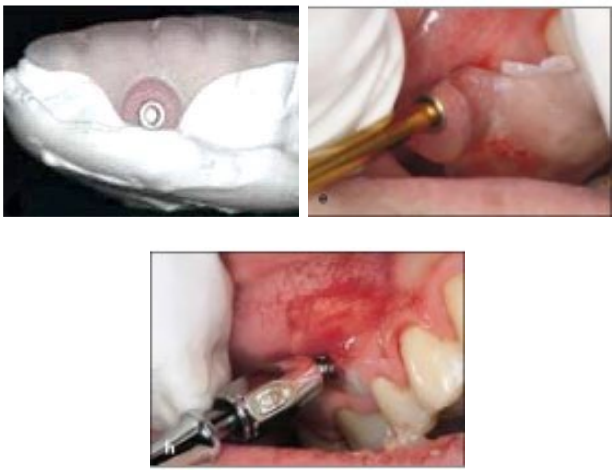

Fig.5 Stereo lithographic Surgical Template

Disadvantage -
1. Fabrication is time-consuming
2. Requires extensive advance preparation in the laboratory

6. Suzuki 3D Surgical Guide[30]:

It was fabricated by Suzuki & Suzuki in 2008. The 3D surgical guide consists of a 5, 7, or 9 mm long vertical arm connected at one end to the main orthodontic wire to provide rigid, stable anchorage by means of Gurin locks. At the opposite end of the adjustable arm is the surgical guide, a stainless steel tube 5 mm long and 3 mm in diameter. The surgical guide tube is used to map the optimum implant site during the radiographic diagnostic procedures, orient the drilling of the pilot hole, and subsequently place the implant. Bitewing radiograph is used for this purpose.

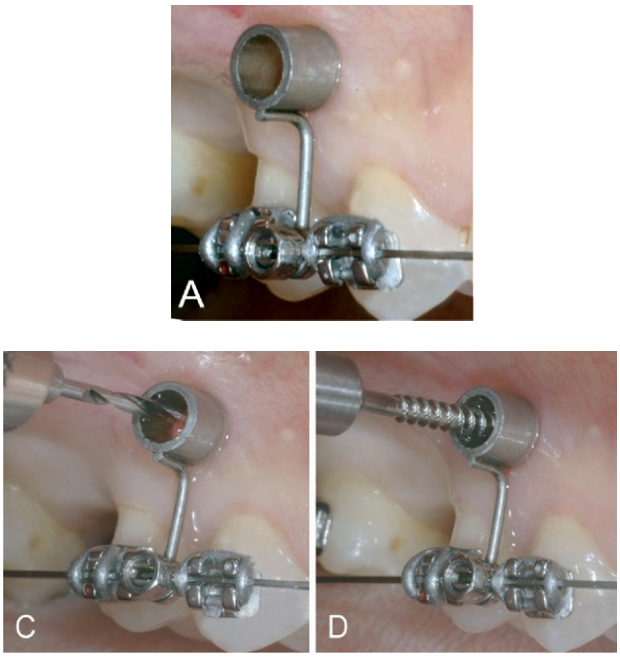

Fig.6 Suzuki 3D Guide

Advantage -
1. It provides a precise method.
2. Minimizes the risk of root injury.
3. Design is simple, quick and easy.
4. Preoperative radiographic information can be transferred to the surgical site.

7. Simple Wire Guide[31]:

It was invented by Suma T and Alle R S in 2010.Used 0.018 inch SS wire and has a helix of diameter 3 mm in the centre of the wire.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. Helix position is confirmed using IOPA radiograph.Wire guide is removed after 3/4th of the mini-screw is driven in and then mini-screw is completely inserted.

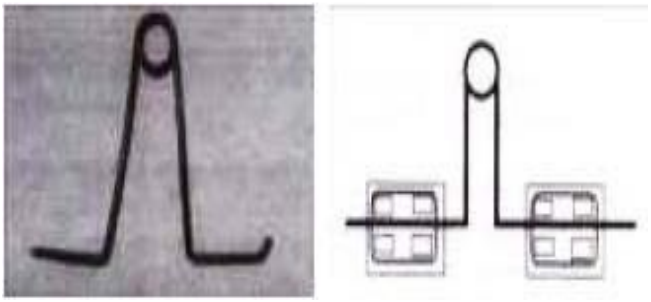

Fig.7 Simple wire guide

8. Aleppo University Surgical Orthodontic Mini-screw (AUSOM)guide[32] :

It was introduced by Al-Suleiman et al in 2011. It consists of four parts,

1. Vertical part –Uses round SS wire to locate the position of mini-implants in vertical direction, has a lock, fixed to the orthodontic wire connected to fixed appliance.

2. Horizontal part –Round SS wire used to locate the position of mini-implants in horizontal direction, has a lock, movable in vertical direction. After reaching desired height, lock is closed.

3. Placement guide – It has a vertical round wire, 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.

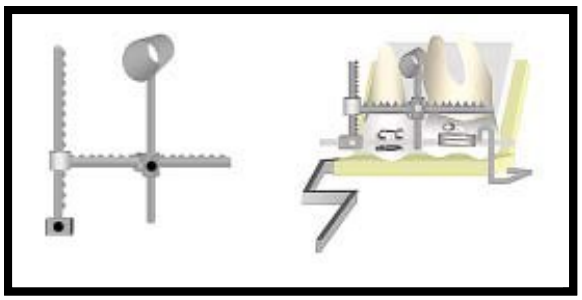

Fig.8 AUSOM 3D placement guide

9. Jiffy Jig - A quick chair side micro implant guide[33] :

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.

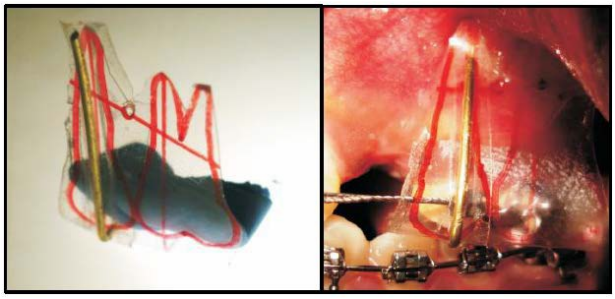

Fig. 9 Jiffy Jig

Advantage - Implant placement site is clearly visible unlike radiographic template of Jian Chao
Disadvantage - Accuracy may be in question as the jig is not stable.

10. Multi-loop Wire Guide[34]:

Introduced by Hemanth et al in 2012, inexpensive & easy to use; formed from brass or SS wire. It contains 3-5 loops depending on the vestibular depth. Wire guide should be placed in the inter-radicular space and secured with elastomeric ligature in mesial tooth bracket and position is determined using radiograph, mini-implant is placed on the selected loop.

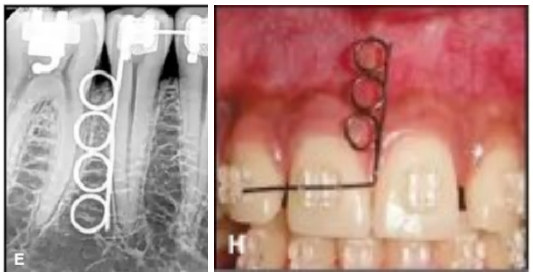

Fig.10 Multi loop wire guide

11. Universal Wire Grid[35] :

It was introduced by Narendra S Sharma et al in 2013. It consists of positioning grid and guide base. It is fabricated by cutting SS wire in 1 inch length and welded to form a column grid, each cell should measure about 1.5mm. 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 alveolar crest. Softened wax is added to the acrylic base and pressed towards occlusal surface. IOPA is taken for positional confirmation. Once the appropriate cell of the grid is selected, pilot drilling is performed with the grid in place followed by mini-implant placement. Final position is verified using radiographs.

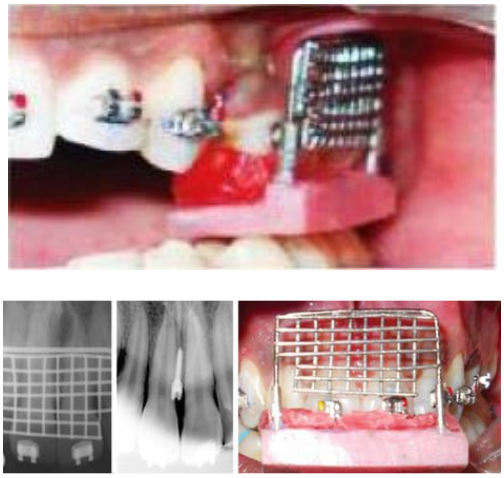

Fig.11 Universal Wire Grid

Advantage –
Better accuracy of implant position than the single wire stents.
Disadvantage –
Fabrication is time consuming

12. Simple 3D wire stent[36] :
It was introduced by Sumathi A Felicita in 2013. The stent is made of 0.018"× 0.025" SS arch-wire which consists of a 'u loop' angulated at 20°, a vertical limb, a horizontal limb and a stop. The angulation of the 'u' helps in the placement of the mini-implant at 70° to the long axis of the tooth. The vertical height is determined such that the mini-implant is placed at the mucogingival junction. The mini-implant is placed with the aid of the stent, and its angulation and proximity to the adjacent roots are checked with a cone beam computed tomography image. It is simple, cost-effective, and provides ease of insertion/removal, and 3D orientation of the mini-implant.

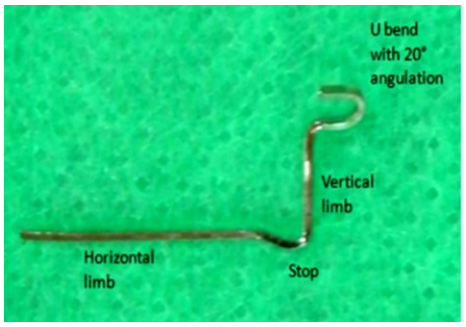

Fig.12 Simple 3D wire stent

13. Chair side simple wire stent[37] :
Bhagchandani et al in 2013 proposed this easy and simple stent.
Fabrication steps:

I. Overlap IOPA radiograph on working model
II. Superimpose roots of the teeth, between which the implant is to be placed (determining height of the stent).
III. Mini-screw insertion site is located by firmly pressing the long end of a periodontal probe against the buccal side of gingival tissue.
IV. A 19'' × 25'' SS wire used for fabrication of the stent with a loop of 4 mm diameter and length of the two vertical legs extending incisally was 6 mm.
V. Total length was 9 mm (from the bracket position), head of the stent lies near the middle third of the roots of the second premolar and first molar. The horizontal components of the legs inserted inside the 2nd premolar bracket and molar tube.
VI. Vertical extension is below the mucogingival junction.
VII. An IOPA is taken for confirmation of position. Process is repeated until accurate positioning achieved.

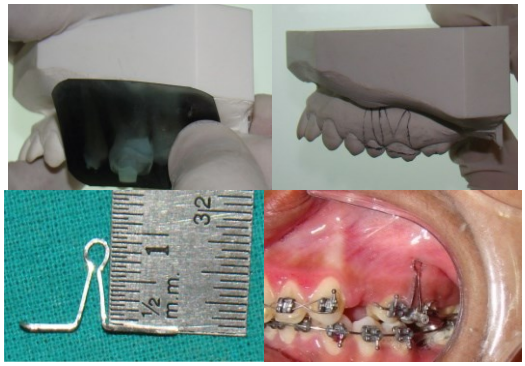

Fig.13 Simple chair side stent

14. 3D jig for accurate mini implant placement[38] :
It was 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 2mm in diameter which is inserted into the main tube and other piece is bent to form L and inserted into auxiliary tube. The other end of this arm is bent to form the angulation guide arm. It was introduced by Amit Revankar et al in 2013.

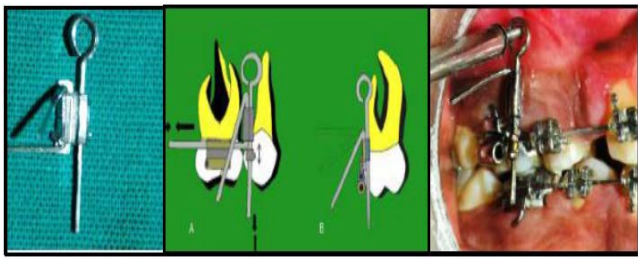

Fig. 14 3D jig for accurate mini implant placement

Advantage –
1. Positional accuracy is better as it involves angulation guide
2. Simple and efficient fabrication with chairside materials
3. Precise placement of miniimplant with 3D control
4. Main archwire removal not required, as the jig is secured on to the auxiliary tube. So the existing orthodontic appliance is not displaced.

Disadvantage –
1. Welding is unaviodable

15. K.S. Micro-Implant Placement Guide[39] :
Wire used: 0.018/0.020 (A.J. Wilcock) or 17 × 25 or 19 × 25 SS 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, continuous vertical loop made until measured length and one or two horizontal bends are at the level of the adjacent brackets. It was introduced in 2014 by Sharma K & Sangwan A.

Fig. 15 K.S. Micro-Implant Placement Guide

Advantage –
1. Simple and easy chairside fabrication
2. Easily available armamentarium

16. Simploguide - Simplified Guiding Template for Miniscrew Implant Placement[40] :

It was proposed by Ambekar and colleagues in 2018. 0.014"A. J. Wilcock wire was used to fabricate the guide with 3 helices of 2mm diameter and placed at a distance of 4mm, 6mm and 8mm respectively from base arch wire (0.019 × 0.025 SS). The template was first welded and then cold soldered to the base arch wire and later finished by using finishing burs. Sliding of wire and shifting of template was minimized by using stiffer base arch wire.

Fig. 16 Simploguide

Advantage –
Simple and quick chairside fabrication

Disadvantage –
1. Multiple IOPA x-rays are necessary for confirmation of the implant position
2. Vertical adjustments are difficult as the guide is soldered with the base arch wire

17. Mini - Implant Punch (MIP)[41] :

Very recently (2021) it has been proposed by Ambekar & colleagues. It is known for its very simple design. 0.018" A. J. Wilcock SS 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 at 90°. Buccal and lingual arms were 7-8 mm and 4-5 mm long respectively. Buccal arm is again bent 90° for 3mm.

Fig. 17 Mini - Implant Punch (MIP)

Advantage –

1. Easy and simple chairside wire bending with minimum armamentarium
2. Placement confirmation done with IOPA/RVG
3. MIP placement does not require removal of base arch wire
4. Comfortable and can be used for any side

Disadvantages –

1. Requires practice to be skilled

Conclusion

One of the various factors of orthodontic mini implant success is its precise location and accurate insertion. So it is always safer to use guiding templates for placing mini-implants to reduce the risk of failure and complications as these guides can indicate implant inclination and facilitate precise location which should be confirmed by using intra oral radiographs, panoramic radiograph or more recently cone beam computed tomography (CBCT). Although individual techniques have their own pros & cones, each of them are particularly valuable when a self-drilling miniscrew implant is inserted by an orthodontist not highly experienced in implant techniques. Wire guide, although inexpensive, simple to fabricate, and easy to use; but it provides limited, two-dimensional information on the implant site. Because relative positions may be inconsistent in different radiographic views, the wire and metallic guides are not always accurate. Furthermore, because guides do not prevent deviation of the pilot drill, they do not eliminate the risk of root damage. Surgical stents, guides, and templates can transfer a radiographically planned, 3D implant position to the surgical site more accurately than wire or metallic guides. The stent allows access for both visual monitoring and saline irrigation, but this takes time and effort for the laboratory work, and fine adjustments cannot be made.

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