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Implant Guide X - An Extraoral Guide for Optimal Implant Placement in Orthodontics

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Abstract:- Orthodontic mini-screws provide absolute skeletal anchorage and can be placed in various sites according to needs. The advantage of these implants is their ease of insertion and removal, as well as the ability to immediately withstand forces. Placing mini-screws too close to the root surface can result in insufficient bone remodeling due to occlusal forces transmitted through the teeth to the implant, leading to implant failure. The conventional method of placing interradicular implants often led to incorrect positioning, causing perforation of the dental root and subsequent loss of vitality, osteosclerosis, and dentoalveolar ankylosis. To address these issues, numerous intra-oral implant placement guides have been developed. In our study, we developed a prototype of an extra-oral detachable metal mesh grid that can be attached to the parallelogram x-ray positioner (RIN XCP). This prototype promises increased accuracy and utility in implant placement.

Keywords:- *Mini-Implants, Skeletal Anchorage, RIN XCP, Radiopaque Grid, Implant Placement Guide.*

I. INTRODUCTION

Anchorage preservation poses a significant challenge in orthodontics. Traditional methods of reinforcing anchorage using intra-oral or extra-oral means have their own limitations, whereas mini-implants have shown to offer absolute skeletal anchorage[1]. Mini-implants also have several additional advantages, including ease of insertion and removal, allowing immediate force loading, and promoting rapid healing. These benefits make mini-implants a preferred choice for orthodontic treatment, providing orthodontists with greater control and efficiency in achieving desired tooth movements[2]. However, one of the major drawbacks with mini-implants is the risk of root injury, periodontal ligament damage, perforation of the maxillary sinus, and damage to the inferior alveolar nerve during implant placement. It is said that periodontal structures can heal after mild injury caused by temporary anchorage devices, but it is important to carefully select insertion sites by evaluating the clinical and radiographic areas for their anatomical details.

A. Aim:

To develop a prototype of detachable metal mesh grid that can be attached to parallelogram x-ray positioner (RIN XCP).

B. Objectives:

To create a standardized radiopaque grid that can be easily attached and adjusted to parallelogram x-ray positioning device.

C. Material:

Implant guide X consists of following parts:

- Detachable 2x3mm metal grid (Figure 1)
- X-ray positioning device (paralleling cone technique) (Figure 1)

This helps obtain a standardized radiopaque grid which can guide the implant placement.

II. METHODOLOGY

A detachable 2x3mm metal grid was attached to the X-ray positioning device (paralleling cone technique) and a pre-operative X- ray was obtained which contained grids to help determine the accurate position of the interradicular implant. Before the placement of the implant an IOPA is taken using parallelogram technique with the help of RIN XCP device to which the metal grid was attached. Using this IOPA on which the grids are present, calculation of how many millimeters in horizontal and vertical direction the implant placement would be safe is assessed using crown as a reference point. This point is then transferred onto the patient's mouth using clinical crown as a reference point and Implant placement is done using this point that is obtained (Figure 2).

A. Advantages of Our Prototype

- The radiograph is taken using the parallelogram technique. In this technique, the film is parallel to the long axis of the tooth, and the x-ray beam is projected perpendicular to both the teeth and the film. This provides an image of almost the same size as the tooth itself or slightly larger (i.e., a 1:1 ratio of the actual tooth to the radiographic image), resulting in a more accurate depiction of the relationship between the teeth and surrounding structures.

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- The device is extraoral in nature, so it does not disturb the existing appliance system, nor does it encounter limitations of the sulcus.
- The design is simplistic.
- It does not require customization; once fabricated, it can be universally used for all patients.
- Minimal equipment is required for fabrication.
- It facilitates precise implant placement and reduces the risk of root injury.

III. DISCUSSION

Anchorage refers to the resistance against undesired tooth movement. Loss of anchorage during orthodontic treatment can lead to unfavorable treatment outcomes. Therefore, preserving anchorage is crucial for achieving the best possible results. In orthodontics, the preferred sites for implant placement are the interradicular spaces in the posterior and anterior regions of the maxilla and mandible. However, these areas pose a high risk of root injury and periodontal ligament damage due to incorrect evaluation of the quantity of interproximal bone and the inclination and proximity of the roots.

Various intra-oral guides have been developed to facilitate the safe placement of interradicular mini-implants. This includes the surgical stent introduced by Morea et al in 2005, which was fabricated using acrylic and metal tubing. A disadvantage of this technique is that it requires one additional appointment for fabrication and insertion[3]. The surgical template introduced by Jian-chao Wu et al in 2006 consists of an occlusal acrylic block that incorporates wire extensions to hold the x-ray film. This allows the radiation to fall perpendicular to the film, minimizing errors, and the wires act as a guide for placing the mini-implants. Disadvantage of this technique is that fabrication is cumbersome[4]. An 'L'-shaped rectangular stainless-steel wire, whose position can be adjusted, was attached to the premolar and canine brackets introduced by Kravitz in 2007[5]. Kim et al in 2007 gave a 3D printed guide derived from CBCT images; however, the disadvantage was the cost factor[6]. Suzuki et al. introduced a 3D surgical guide in 2008 consisting of 5, 7, and 9mm long vertical arms with a metal loop as a guide for placing the mini-implant. However, this could not be used in patients with shallow vestibular sulci[8]. Suma et al in 2010 used a vertical loop with a helix as a guide for implant placement[12]. AUSOM (Aleppo University surgical orthodontic Mini-screw) Guide introduced by Al-Suleiman et al in 2011 was an adjustable 3D implant placement guide that can be used for all patients, but fabrication was technique-sensitive[13]. Jiffy Jig introduced by Nanda Kumar et al can be fabricated chairside, but the accuracy was questionable because of the instability of the jig[14]. Hemanth et al. introduced a multi-loop rectangular stainless steel wire guide in 2012. This guide consists of 3-5 loops depending on the vestibular depth. It is placed between the two tooth roots and secured to the bracket using an o-ring. On the radiograph, a safe loop was recognized and used for implant placement[15]. The Universal Wire Grid introduced by Narendra Sharma et al in 2013 involved creating a grid about 1.5mm in dimension by soldering the wire segments, and this was attached to an acrylic block that is perpendicular to the grid. The patient is asked to bite over the acrylic to stabilize the grid, and a radiograph is obtained. The radio-opaque lines will help in choosing the region for mini-implant placement[16]. Waseem Khan et al also introduced a device similar to the previous one, but here there was a wire extension that was inserted into the headgear tube to stabilize the mesh[8]. The K.S. Micro-Implant Placement guide by Sharma K and Sangwan A, as well as the Simploguide by Ambekar et al., includes a multi-looped wire segment that extends towards the vestibule. A radiograph is taken with the loop in place, and a safe point is marked on the radiograph. The implant is then placed through that loop for safe placement of the implant[2,10].

The drawbacks of these appliances include, reduced efficacy because of anatomic limitations like shallow vestibule, tori, as these are intraoral devices. Most of these techniques use bisecting angle technique to obtain IOPARs, their relative positions may be inconsistent in different radiographic views which hampers the accuracy. The need for intraoral attachments to place the device needed skills to make it customized for every patient. And need for stringent sterilization if they have to be reused as it is used intraoral.

Thus, to overcome these limitations in our prototype we have used an extra-oral implant guiding device and also, we have used parallelogram technique to take radiographs which will minimize the magnification errors. And thus, help us for precise placement of mini-implants.

These techniques aim to minimize the risk of complications associated with implant placement and optimize the success of orthodontic treatment.

IV. CONCLUSIONS

Implant guide X prototype development provides a simple, extraoral, standardized and an objective radiopaque grid that guides the clinician to place the implants accurately by reducing iatrogenic risks and magnification errors. Use in regular orthodontic practice will enhance the accuracy and quality of the treatment.

A. Figures

Fig 1 – Implant Guide X

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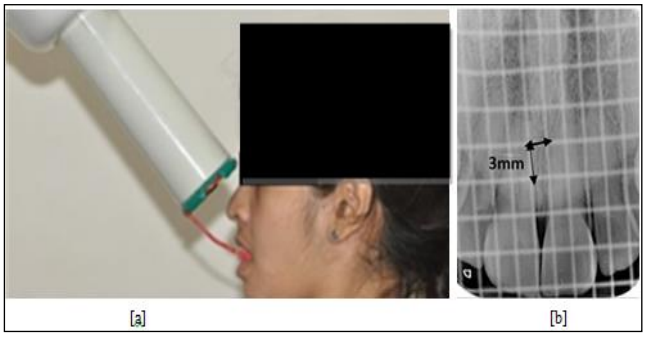

Fig 2 – a) Using Implant Guide X in Maxillary Anterior Region; b) Radiograph Obtained

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