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CLINICAL TIP

Fabrication of a Surgical Guide with Help of a Milling Machine by Ridge Mapping Method

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Abstract Optimizing the prosthetic result by customization of a surgical guide should be a major consideration in the implant placement. The design of the surgical guide must account for several factors, including position of the implant, the tissue present, and the anticipated prosthesis. The objective of this article is to present a technique for fabrication and customization of surgical guide with the help of ridge mapping procedure and a milling machine. This technique is helpful for the beginners in implant dentistry and for the dentists who cannot avail the CBCT/medical CT facilities.

Keywords Surgical guide · Milling machine · Ridge mapping

Introduction

Long term success of a dental implant has significant correlation to its ideal positioning for function. Diagnostic wax-up, assist in the fabrication of a surgical guide for placement of dental implants. It dictates drilling position, depth and angulation. If constructed properly, surgical guides can be helpful in selecting the precise site for surgical implant placement. Proper angulation is one of the important factors for success of implant treatment.

The following section is a simple, step-by-step illustrated technique description for a surgical guide fabrication. The technique uses a milling machine and readily available inexpensive materials.

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Technique for a Surgical Guide Fabrication

Step 1

Thickness of the mucosa of the proposed implant site (maxillary right central incisor) was measured by *ridge mapping method*. After completion of diagnostic wax-up (Fig. 1) a layer of *modeling wax* was applied over the adjacent teeth on both the sides of the planned site (to provide space for the acrylic resin guide) and a *putty index* (Fig. 2) was prepared using addition silicon putty (Express, 3M ESPE, St Paul, MN USA).

Step 2

Four *die pins* (Cross Pins, Nordin, Sweden) were fixed in the base of the cast, two on either side of the proposed implant site. Petrolatum gel was applied and a base was poured with the help of base former. Ideal implant location was marked using a marker and the cast was sectioned at that point with a mechanical saw (Averon, St Ekaterinburg, Russia). One half of the sectioned cast was removed, and the readings obtained by *ridge mapping were transferred* to the cross section of the other half of the cast with a marker (Fig. 3). This helped to assess the width and the angulations of the available bone. The ideal *bucco-lingual angulation* of the implant was determined and was marked on the sectioned cast (Fig. 3).

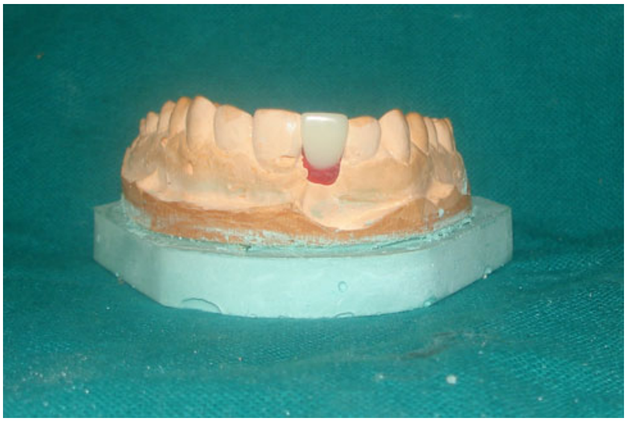

Fig. 1 Diagnostic wax up

Fig. 2 Putty index with addition silicone

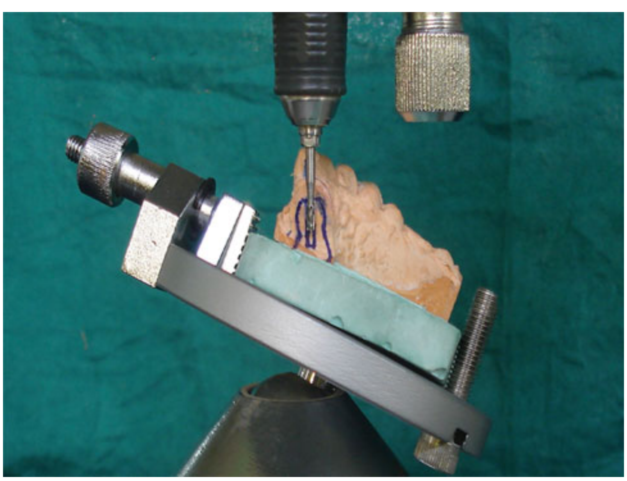

Fig. 3 The sectioned cast was mounted on the cast holder which was oriented in such a way that the proposed path of implant placement would be parallel with a straight fissure bur

Step 3

The sectioned cast was mounted on the cast holder of a milling machine (Confident, Bangalore, India). *The cast holder was oriented in such a way that the proposed path of implant placement would be parallel with a straight fissure bur attached to the milling machine*. The cast position was locked in the cast holder (Fig. 3).

Step 4

The sectioned cast was assembled and alignment was checked. *Care was taken not to disturb the position of cast with respect to the cast holder*. A hole of 5 mm depth was drilled in the cast with a 2.2 mm diameter straight fissure bur (DFS, Germany) in the predetermined angulations at the proposed site (Fig. 4).

Step 5

A cycle spoke (Vedant enterprises, Pune, India) with sleeve of 2.2 mm in diameter was selected. The spoke was placed in the prepared hole and the *height was adjusted till the incisal edge*. The position of spoke was fixed with *cyno-acrylate resin* (Feviquick, Mumbai, India) the metal sleeve was placed over the spoke which simulated the ideal implant location and angulations (Fig. 5). All *undercuts*, including the areas of the cast where it was sectioned, and on the incisal aspect of the sleeve were blocked out with wax (DPI, Mumbai, India).

Step 6

Separating media (DPI, Mumbai, India) was applied and a surgical guide was fabricated in clear autopolymerized

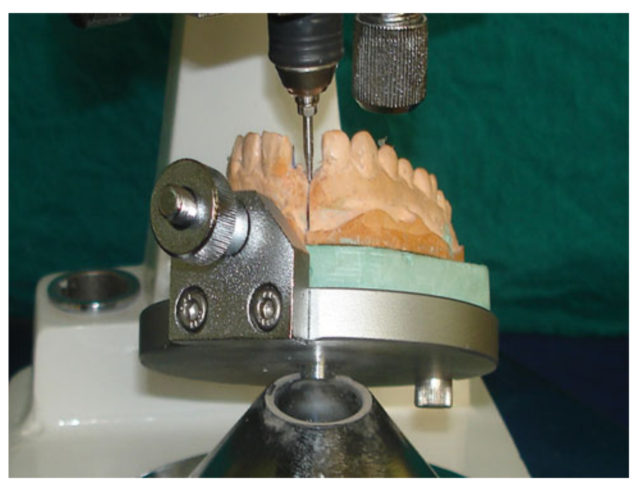

Fig. 4 The sectioned cast was assembled and a hole was drilled at the proposed angulation

Fig. 5 Metal sleeve placed over the cycle spoke which simulated the ideal implant location and angulation

resin (DPI, Mumbai, India) by adopting putty index. After curing, the spoke was removed, the surgical guide was trimmed and its fit was verified on the model.

The surgical guide helped in positioning of the pilot drill (Fig. 6). After the implant (Noble replace tapered select) placement IOPA X-ray (Fig. 7) and CT (Fig. 8) was taken to verify the preciseness of this method and it was found to be acceptable.

Discussion

Diagnostic casts, panoramic radiographs do not provide three-dimensional information required for correct positioning and orientation of the implant [1]. Optimal restoration is facilitated by ideal implant placement. Three factors considered when inserting implants, are *position, depth and angulations*. It has

Fig. 6 Surgical guide helped in positioning of the pilot drill

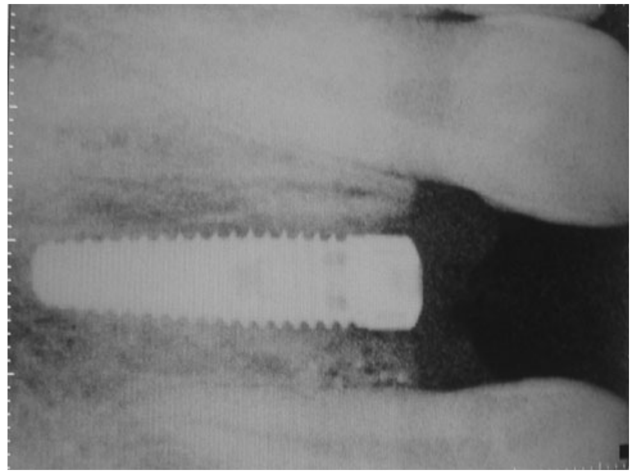

Fig. 7 Iopa X ray of the post implant placement

been well documented in literature that the implants placed using stents are more accurately positioned than those without the stent [2, 3]. The surgical guide should accurately translate diagnostic information from pre-surgical diagnostic wax up to direct implant placement in three dimensions position, depth and angulation [4, 5]. Some clinicians advocate provision of guidance hole through the *incisal edge* in the correct angulations [5–7], while others prefer surgical guide with *palatal or cingulum* approach [2, 8, 9]. Stents are fabricated in conventional methods by clear vacuum form and a hole [10], vacuum form with metal sleeves [11], self cure acrylic stent with guide channel [12, 13] self cure acrylic stent with holes [14, 15] acrylic with wire [16] self cure acrylic with metal sleeves [17]. Recently, novel CAD/CAM techniques such as stereolithographic rapid prototyping have been developed to build surgical guides in an attempt to improve precision of implant placement [18–21].

The earlier stent designs in the 90's were either diagnostic or surgical purpose and were focused on determining the correlation of implant site with surrounding vital structures [22]. Later stents were developed to position implants in proper mesio-distal and bucco-lingual position [13, 23, 24]. The stents which have been reported to have accurate implant angulation placement need a CT image [25–27]. We could not found any article describing accurate angulation without a CT image.

Studies have shown that implants can be placed in more predictable way, if stents are fabricated by using surveyor [11, 13, 23, 24, 28] and by ridge mapping procedures [29, 30]. Surveyor has been used for proper mesio-distal and bucco-lingual positioning, paralleling in multiple implant placement and ridge mapping aids in evaluating proper angulation. Ridge mapping can be done by Wilson bone caliper [29], and the Spoerlein caliper [31]. This technique is unique in *amalgamating the advantages of both the surveyor and ridge mapping*.

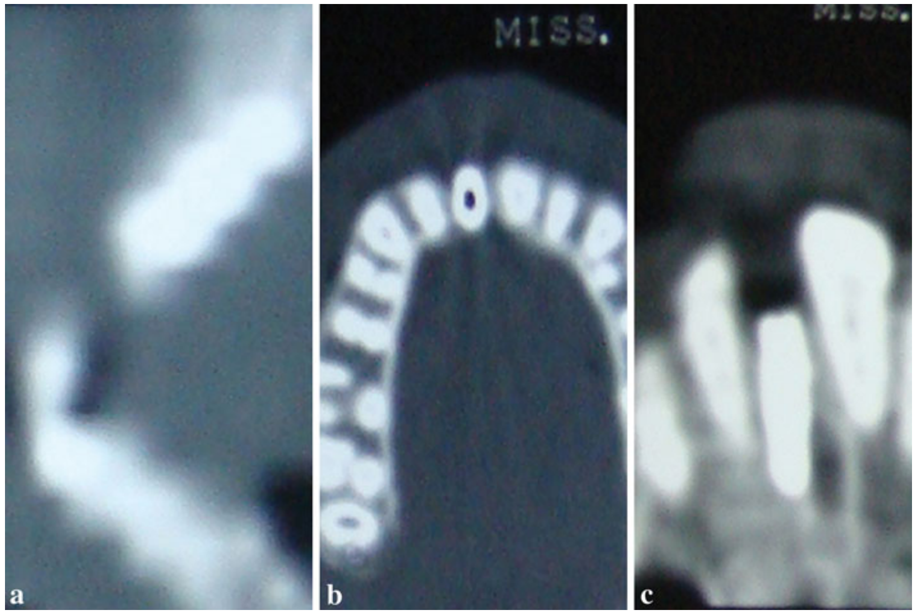

Fig. 8 Post implant placement, **a** Sagital view, **b** Horizontal view, **c** Coronal view

The *advantages* of this method are, this is an *useful and easy procedure* for the beginners to understand and guide angulations of the drill during implant placement and the surgical phase of the implant procedure becomes *quicker and more precise*. This can be used for *dual purpose*, as both radiographic and as a surgical stent. It is especially useful in the upper anterior region to determine the width and angulations of the available bone. The materials and equipments used are easily available so it is a *simple and cost-effective* method to fabricate. Channel length has been proved to be the primary controlling factor in minimizing deviated angulations, and found that length of around 9 mm is more predictable [32]. In this method the length of the metal sleeve is almost equal to the height of the crown, so 9–10 mm length can be achieved. So the pilot drill can be placed in only *one specific path*. The stent was fabricated with acrylic and metal sleeve as this is *more stable and more accurate* than compared to stents fabricated with other conventional methods [22]. Computed aided splints are accurate are expensive and require extensive laboratory set up for their fabrication [18–20]. This stent can be fabricated *without a CT and expensive lab*. Ridge mapping procedure has been proved to be *reliable* when the labial aspect of the anterior ridge is not markedly concave [33].

Caution has to be taken in the following steps

1. During drilling hole in the cast the cast and the cast holder should be in stable position.
2. The spoke should be firmly fixed and the height of the spoke and the metal sleeve should not be higher than the incisal edge of the adjacent teeth otherwise the putty index cannot be seated properly.

One study found similar results between ultrasound measurements and ridge mapping method [31]. There is *contradictory results* comparing accuracies between ridge mapping and CT, One study found the ridge mapping to be better [34], while others are in favor of CT image [33, 35]. However with advances of technologies the accuracies of CT will be definitely better. So this technique is not useful when the *width* of the bone is *insufficient* or when there is a *bony defect* in the ridge. The *limitations* of this method are that it takes *more time* than the conventional methods, difficult to fabricate in *multiple implant* placements, the stent cannot be used when the clinical situation needs a *change in angulations*. Anterior maxilla with questionable bone support is often a clinical challenge, and the use of computed tomography is crucial.

Criteria for implant success were defined by Albrektson and Zarb [36]. Later *esthetic factor* has been added. Etiology of *prosthetic complication* related to implant placement can be attributed to lack of attention to detail when developing the treatment plan and *failure to use a surgical guide* while placing implants [37]. The most precise imaging modality available to dentists today is Cone Beam CT (Cone Beam Computed Tomography). One of the *limitations* of this expensive equipment is *availability*. *Extra time* spent in fabricating this useful surgical guide will help in placing implants in esthetic zone especially in upper anterior. *This technique is helpful for the beginners in implant dentistry and for the dentists who can not avail the CBCT/Medical CT facilities*.

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