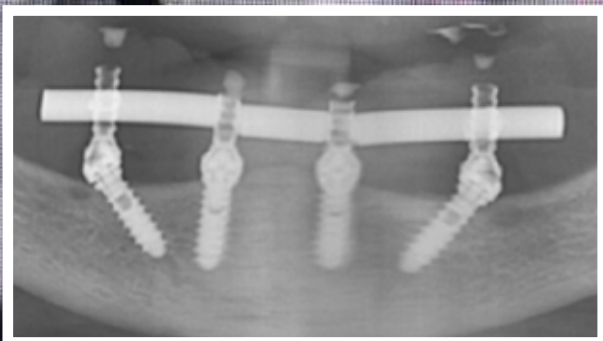


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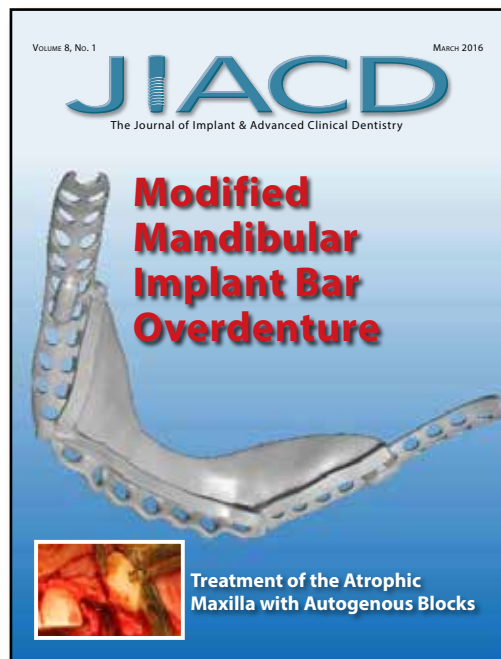
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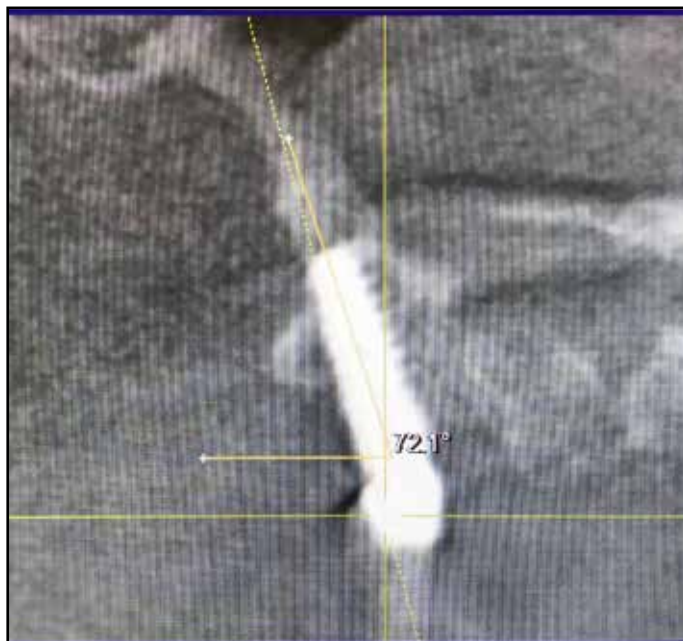
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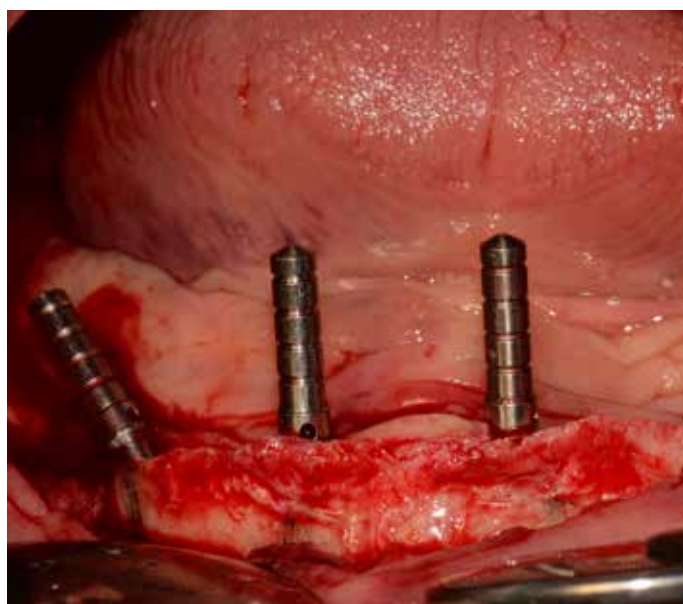
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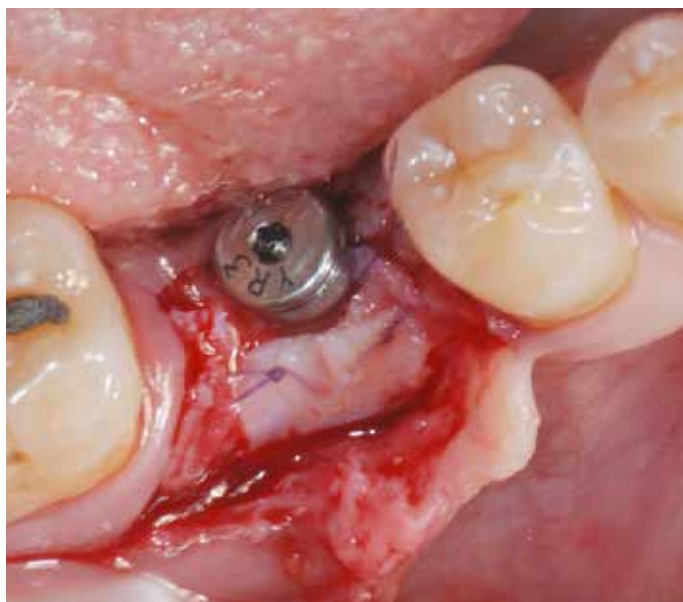


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# Pterygoid Fixated Arch Stabilization Technique (PFAST): A Retrospective Study of Pterygoid Dental Implants used for Immediately Loaded Full Arch Prosthetics

Dan Holtzclaw, DDS, MS<sup>1</sup> • Roger Telles, MBA<sup>2</sup>

## Abstract

**Introduction:** The pterygomaxillary complex is a known anchorage location for dental implants that is typically reserved for use in compromised situations. The dense bone in this area provides excellent insertion torque for dental implants and has been associated with high survival rates in delayed loading scenarios. To date, no known studies have specifically evaluated pterygoid anchored dental implants for immediately loaded full arch restorations. As such, the goal of this paper is to evaluate the Pterygoid Fixated Arch Stabilization Technique (PFAST) protocol for implant insertion characteristics and success when pterygoid implants are used for immediately loaded full arch scenarios.

**Methods:** A retrospective chart review was performed for all patients that were treated with the Pterygoid Full Arch Stabilization Technique (PFAST) protocol. There were no exclusion criteria. Implant insertion torque, mesiodistal angulation, and survival rates were evaluated.

**Results:** A total of 25 dental implants placed in 16 patients were identified as meeting the cri-

teria set for this study. A total of 13 females and 3 males were treated with an average age of  $59.87 \pm 6.88$  years (range 48-72). Pterygoid dental implants used in the current study had 100% survival rates with follow-up times ranging from 6-40 months. Average insertion torque value for the pterygoid dental implants was  $44.52 \pm 11.89$ Ncm. Average mesiodistal insertion angle for the pterygoid dental implants was  $70.08 \pm 7.41^\circ$ . Prosthetic survival rates with 6-40 months of follow-up were 100%.

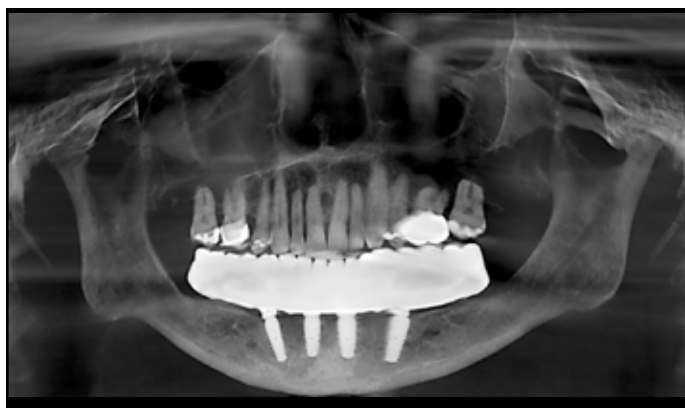
**Conclusions:** The PFAST technique provides a means to attain high insertion torque values for dental implants and serves as an adjunct for All-On-4 dental implant treatment during certain compromised situations. When properly applied, pterygoid implants have demonstrated high survival rates in delayed loading situations and the current study shows that they may be successfully applied with immediately loaded full arch situations as well. Additional studies are warranted to confirm these findings.

**KEY WORDS:** Pterygoid, dental implants, All-On-4, immediate load, maxilla

1. Private practice, Austin and San Antonio, Texas

2. San Antonio, Texas





**Figure 1:** Mandibular All-On-4™ style dental implant procedure with distal implants angled to avoid neural structures.



**Figure 2:** Maxillary All-On-4™ style dental implant procedure with distal implants angled to avoid penetration of the maxillary sinus.

## INTRODUCTION

The “All-on-4™” treatment concept involves restoring an arch with at least 4 dental implants, the distal of which are tilted up to 45 degrees, and immediately loading the transitional prosthesis.<sup>1</sup> Biomechanically, tilting the posterior dental implants offers a number of benefits over axially inclined implants including increased anterior-posterior spread, reduction of prosthetic cantilever length, and increased bone-to-implant contact.<sup>3</sup> Anatomically, benefits of tilted implants include avoidance of nerves,<sup>4</sup> (Figure 1) elimination of the need for maxillary sinus augmentation,<sup>5</sup> (Figure 2) elimination of bone grafting procedures,<sup>6</sup> and improved implant anchorage in dense anterior alveolar bone.<sup>6,7</sup> The All-On-4™ dental implant concept was originally documented over 15 years ago as an immediately loaded treatment option for resorbed mandibles that could not be treated in the traditional manner.<sup>2</sup> In 2005, Malo et al.<sup>5</sup> published one of the first reports of this treatment concept being used in the maxillary arch. Utilization of the All-On-4™ dental implant technique for maxillary rehabilitation entails unique chal-

lenges not seen in the mandible including lower bone densities<sup>8,9</sup> and pneumatization of the maxillary sinus.<sup>10</sup> Many prominent authors recommend a composite implant insertion torque of at least 120Ncm for immediate loading of full arch prosthetics.<sup>11</sup> On occasion, the lower bone density of the maxilla coupled with limited bone availability may result in composite insertion torques that fail to meet the requirement for immediate loading.<sup>12</sup> On other occasions, composite insertion torque may be adequate, but extensive pneumatization of the maxillary sinus migrates the anterior sinus wall so far mesially that inadequate anterior-posterior implant spread (AP-spread) results in distal extension cantilevers of excessive length.<sup>12</sup> Encountering such scenarios during maxillary All-On-4™ surgery is distressing and often cannot be predicted even with the most careful pre-operative planning.<sup>12</sup> For the inexperienced surgeon, options at this point are limited and undesirable with one choice being the delivery of a traditional denture in lieu of a fixed prosthesis and the other being delivery of an extremely short fixed prosthesis that results in a truncated arch. For the expe-

rienced surgeon, the pterygoid dental implant often affords an alternative to these unsavory outcomes. Although the pterygoid process has been used for dental implant treatments dating as far back as the early 1970's,<sup>59-63</sup> it has received little attention in dental literature for immediate loading. To date, there are no known studies that have specifically evaluated the utilization of pterygoid dental implants for immediately loaded full arch dental implant treatment protocols. As such, the goal of the current paper is to present data on the Pterygoid Fixated Arch Stabilization Technique (PFAST) which the author has used in his private practice to immediately load full arch prosthetics aided by implant anchorage in the pterygoid.

## MATERIALS AND METHODS

A retrospective chart review was performed for all patients that were treated with the PFAST protocol. With the PFAST protocol, dental implants are placed in the pterygoid region for additional anchorage in immediately loaded full arch All-On-4 style procedures. All PFAST procedures were performed in the same private practice and by the same single provider (DH) between the years 2015 and 2018. Implant success was defined according to the criteria of Albrektsson et al.<sup>13</sup> Patient charts were reviewed for dental implant length, dental implant diameter, insertion torque, prosthetic survival and any complications reported by the doctor or patient. Cone beam computed tomography images and viewing software (Galileos, Dentsply Sirona, York, Pennsylvania, USA) were utilized to measure the mesiodistal inclination of the dental implants relative to the occlusal plane. As this was a retrospective review, there were no exclusion criteria for patients in this study.

## RESULTS

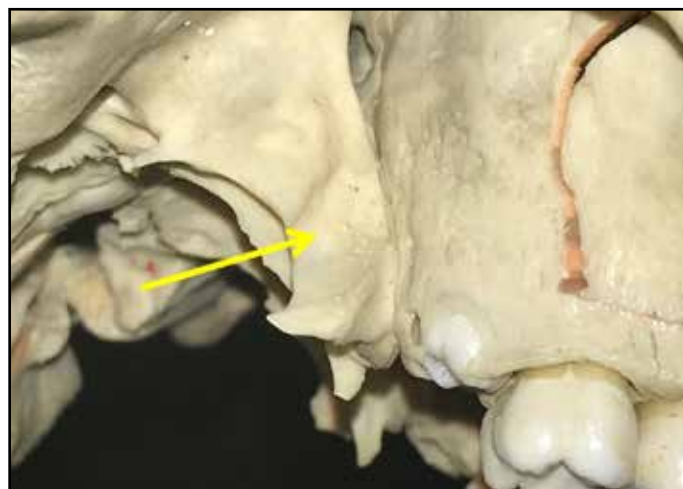
A total of 25 dental implants placed in 16 patients were identified as meeting the criteria set for this study. A total of 13 females and 3 males were treated with an average age of  $59.87 \pm 6.88$  years (range 48-72). Eighteen of the 25 dental implants were placed in a bilateral fashion to support both sides of an All-On-4™ style dental prosthesis while 7 of dental implants were placed in a unilateral fashion. Nineteen of the dental implants were 3.5mm in diameter while 6 of the implants were 4.3mm in diameter. Eight of the dental implants were 11.5mm in length while seventeen of the dental implants were 13mm in length. The mean mesiodistal angle of the dental implants relative to the occlusal plane was  $70.08 \pm 7.41^\circ$  degrees. Average insertion torque values for the dental implants placed in this retrospective review were  $44.52 \pm 11.89$ Ncm. All fixtures identified in this retrospective chart review were Neodent CM Drive dental implants (Neodent, Andover, Massachusetts, USA) and all were loaded with screw retained prostheses within 3 hours of placement. After a minimum follow-up period of 6 months and a maximum follow-up period of 40 months, 100% of the dental implants were still successfully in function. One patient noted a transient episode of trismus after her surgical procedure that subsided within one month.

## DISCUSSION

The All-On-4™ style procedure has become a predictable method for immediately loaded full arch dental implant rehabilitation with multiple studies confirming long term success rates of 98-100%.<sup>1-7,11,12,14-29</sup> One of the consistently cited criteria for success in these immediate loading studies is adequate dental implant insertion torque.<sup>11,12,30-34</sup>



**Figure 3:** Pterygoid based dental implant with 60Ncm insertion torque.



**Figure 4:** Pterygoid process (arrow). Site for anchorage of pterygoid dental implant.



**Figure 5:** Measurement of mesiodistal angulation relative to the occlusal plane of a pterygoid based dental implant evaluated in this study.

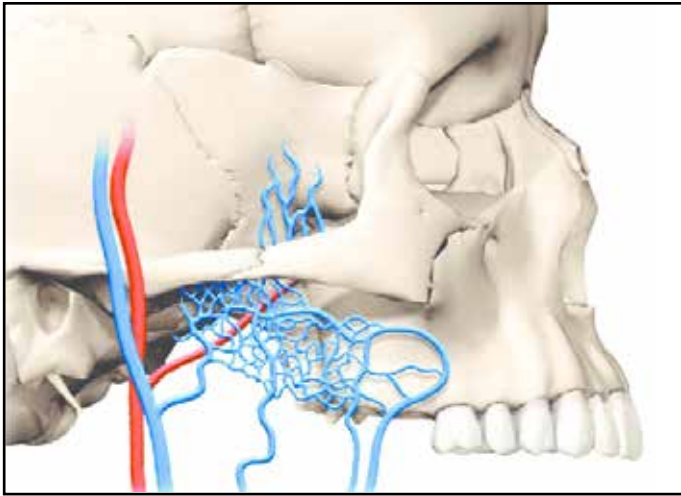


**Figure 6:** The significantly distal location of pterygoid based dental implant can create access difficulties.

For individual dental implants placed in this style of treatment, insertion torque values of 30-35Ncm are generally recommended for immediate loading.<sup>23,28,29,35-37</sup> When insertion torque values for all dental implants placed in a single arch are combined, the term “composite torque value” (CTV) is applied and recommendations of 120Ncm CTV have been cited as a prerequisite for full

arch immediate loading.<sup>11</sup> Insertion torque and primary implant stability have proven to be substantially dependent on bone density with denser bone producing more favorable situation.<sup>38</sup> Multiple studies have consistently found lower bone densities in the maxilla<sup>39-43</sup> and concluded that “achieving primary stability in the maxilla may be challenging.”<sup>44</sup> Accordingly, it is not uncommon





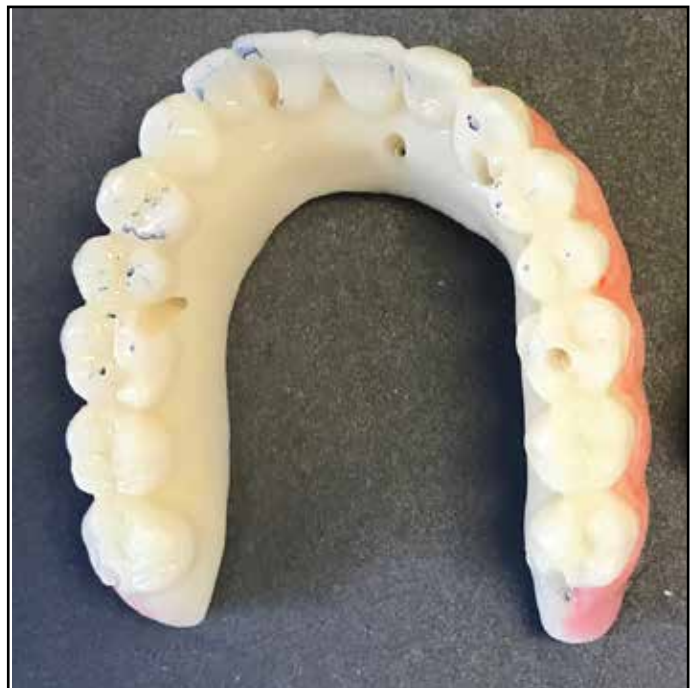
**Figure 7:** Pterygoid venous plexus has potential for hemorrhage complications if damaged during placement of pterygoid based dental implants.<sup>79</sup>



**Figure 8:** Immediately loaded full arch restoration treated with the PFAST protocol.



**Figure 9:** Example of pterygoid based dental implants placed with PFAST protocol to enlarge A-P spread.



**Figure 10:** Transitional restoration for patient treated with PFAST protocol to enlarge A-P spread. The placement of pterygoid based dental implant allowed for 16 total teeth in the maxillary arch.





**Figure 11:** Example of pterygoid based dental implant placed due to soft bone in the maxillary left premolar region. Soft bone in this area prevented the placement of a dental implant with adequate insertion torque for immediate loading. A maxillary sinus lift was performed in case of need for placement of a future dental implant in this sextant.



**Figure 12:** Final restoration of patient treated with PFAST protocol. Pterygoid based dental implant on right side was placed to increase composite torque value due to low bone density and poor insertion torque values in the maxillary arch.

mon for CTV's in the maxilla to achieve values less than 120Ncm.<sup>69</sup> In such situations, utilization of the pterygoid dental implant may provide additional insertion torque that can cumulatively increase the CTV to exceed 120Ncm. The average insertion torque for dental implants in this study was 44.52Ncm (Figure 3). This value alone for one single dental implant exceeds one-third of the required CTV for full arch immediate loading.

The pterygomaxillary region is composed of 3 distinct bony structures: the low density maxillary tuberosity, the high density pyramidal process of the palatine bone, and the high density pterygoid process of the sphenoid bone (Figure 4).<sup>45</sup> When placing "pterygoid dental implants" the fixture may engage all three of these anatomical regions with apical engagement into the pyramidal process of the palatine bone and pterygoid

process of the sphenoid bone producing crucial initial implant stability.<sup>46-50</sup> Cone beam computed tomography analysis found that bone densities in the pterygoid region are 139.2% higher than in the tuberosity area.<sup>50</sup> To properly engage the pterygoid process, angulations that closely approximate the bone are required. While early studies suggested placing pterygoid implants at a 45° mesiodistally relative to the occlusal or Frankfort horizontal plane,<sup>51,52</sup> more recent CBCT analytical studies have advocated mesiodistal angulations of 70.4-74.19°.<sup>48-50</sup> In the present study, mean mesiodistal implant angulation relative to the occlusal plane was 70.08 ± 7.41° (Figure 5) which places these implants in the range recommended by prior studies. It is important to note that all of the dental implants placed in this study were non-guided and placed freehand

by the author (DH). When placing the dental implants in this study, the author commonly encountered extreme low density bone in the tuberosity region of the posterior maxilla making initial placement challenging. This low-density bone often allowed for migration of the initial dental implant drills and it wasn't until the drills engaged the higher densities of the palatine and sphenoid bones that stability was achieved. While computer guided surgery and stents may have helped stabilize the initial drilling and angulation for these dental implants, they are not a panacea and have occasionally resulted in significant complications with pterygoid dental implant surgery. In addition to limited access due to the thickness of the surgical stent combined with the anatomical limitations of the pterygoid surgical site, guided surgery of pterygoid dental implants have resulted in implant displacement into the infratemporal fossa.<sup>78</sup>

Multiple studies have noted that pterygoid dental implants have a high learning curve and are technically challenging due to difficult surgical access (Figure 6) and close proximity to vital anatomic structures.<sup>53-56</sup> Vascularity such as the pterygoid venous plexus (Figure 7)<sup>79</sup> and descending palatine artery are in propinquity to the pterygomaxillary fissure and pose a risk for excessive hemorrhage should they be damaged during implant placement.<sup>56,57</sup> In a 2017 Japanese cadaveric study of pterygomaxillary anatomy for implant placement, Uchida et al.<sup>57</sup> examined 78 hemi-heads with atrophic posterior maxillae. CBCT scans and physical dissection of the heads revealed that the average distance between the lowest point of the maxillary tuberosity and the descending palatine artery was  $19.2 \pm 4.5\text{mm}$  in males and  $19.8$

$\pm 3.1\text{mm}$  in females.<sup>57</sup> It must be noted, however, that the minimum distances seen between these same anatomic structures was as low as  $12.7\text{mm}$ . This finding led Uchida et al.<sup>57</sup> to the conclusion of "a potential danger in the placement of a pterygomaxillary implant of  $>15\text{mm}$ , depending on the case." These conclusions differ, however, from many other published papers regarding pterygoid dental implants. A series of studies published by Rodriguez et al.<sup>48-50</sup> evaluated CBCT scans of actual and virtual pterygoid implant placements with respect to implant diameter, length, and angulation in relation to adjacent anatomical structures. The conclusions and recommendations of these studies were that implants of  $3.75\text{mm}$  diameter and  $15\text{-}18\text{mm}$  in length could be safely utilized in the pterygoid region.<sup>48-50</sup> In a retrospective evaluation of 992 dental implants placed into the pterygoid region over a 28 year period, Balshi et al.<sup>46</sup> utilized only  $4\text{mm}$  diameter implants with  $93.2\%$  of implants being  $15\text{-}18\text{mm}$  versus  $6.8\%$  of the implants being  $7\text{-}13\text{mm}$ . Of these implants, the  $15\text{-}18\text{mm}$  group had cumulative survival rates of  $93.75\%$  while the  $7\text{-}13\text{mm}$  group had  $88.06\%$  survival.<sup>46</sup> This led Balshi et al.<sup>46</sup> to conclude that "...the anatomy of the pterygomaxillary region favors a longer implant" and "...longer implants, which are better able to fully engage the cortical plates found in the pterygomaxillary region, may play a role in increased survival rates...". Balshi et al.<sup>46</sup> reported no surgical complications in using implants as long as  $18\text{mm}$  in the pterygomaxillary region. In a recent 2017 case report in which pterygoid implants were used to treat an extremely atrophic maxilla, Cucchi et al.<sup>47</sup> utilized  $4.1\text{mm}$  diameter implants with lengths of

15mm. While the Uchida et al.<sup>57</sup> study found a minimum distance to vascular structures of 12.7mm in Japanese males, the average distance exceeded 19mm. This average distance seems to be confirmed by other published literature in which 15-18mm dental implants were routinely used without complication.<sup>46-50</sup> In the present study, the majority of dental implants placed were 3.5mm in diameter with lengths ranging from 11.5-13mm. The implants used in the current study were shorter, on average, than implants used in previously published studies. All cases in the present study were treated in the All-On-4 style immediately loaded protocol. With this protocol, vertical bone reduction is performed to achieve a maxillary "All-On-4 Shelf".<sup>58</sup> According to Jensen et al.<sup>58</sup> alveolar ridge modification for the creation of this shelf "enables optimal surgical prosthetic management of implant placement for the fixed hybrid prosthesis." Reduction of vertical ridge height in the posterior maxilla shortens the residual ridge height and thus reduces the distance from the tuberosity to the vascular structures of the pterygoid area. Considering this, the author chose to utilize implants slightly shorter than those used in previously published studies which were not employing immediately loaded All-On-4 style protocols. Although implants less than 15mm in length were used in this study, average insertion torque of 44.52Ncm indicates that the implants were engaged in the high-density pyramidal process of the palatine bone and the high-density pterygoid process of the sphenoid bone. Radiographic assessment of the dental implants confirmed these findings.

While Linkow and colleagues<sup>59-63</sup> extensively documented use of the pterygoid region with

subperiosteal dental implants as far back as the early 1970's, the first reports of root form pterygoid dental implants are generally attributed to Tulasne.<sup>47,54-56,65</sup> Early use of root form implants in the pterygoid region during the 1990's reported success rates ranging from 83.7%<sup>51</sup> to 93%.<sup>66</sup> These earlier pterygoid root form dental implant studies utilized a delayed approach and attempted to reduce non-axial loading. More recent studies performed within the past 10 years have shown improved success rates for root form pterygoid dental implants ranging from 93.75 – 100%.<sup>46-48, 66-68</sup> The improvements in success rates for pterygoid dental implants over the past 25 years may be due to improvements in implant surface technology,<sup>64</sup> the availability of specialty components such as angulated multi-unit abutments, and an improved understanding of the technique. The current study found success rates, albeit in the short-term in comparison to some studies,<sup>46,48,67</sup> that are similar to previous published contemporary dental literature.<sup>46-48, 66-68</sup> One significant difference between the current study and those previously published is that all implants in the current study were immediately loaded (Figure 8). While a small number of previously published studies have employed early loading protocols, the majority of pterygoid implant studies use delayed loading protocols and none reported exclusive use of an immediately loaded protocol.<sup>56</sup> Full arch dental implant studies have extensively and consistently shown that dental implants may be immediately loaded successfully in both axial and off-axial directions so long as the implants achieve certain individual and cumulative torque values and are stabilized in a cross-arch, fixed manner.<sup>1-7,11,12,14-29</sup> Nearly

all pterygoid implant studies report excellent primary fixture stability due to the implants being anchored in the dense cortical bone of the pyramidal process of the palatine bone and pterygoid process of the sphenoid bone.<sup>46-53,56,64-67</sup> and the current study corroborated such findings with average implant insertion torque values of 44.52Ncm. Utilizing the PFAST protocol, all 16 patients in this study received immediately loaded screw retained restorations within 3 hours of implant insertion. Consistent with previously published All-On-4 full arch literature, the PFAST protocol employed in this study resulted in immediate prosthetic function, high implant survival rates, high prosthetic survival rates, and minimal complications.

The PFAST technique was employed by the author as an adjunct for standard All-On-4 style dental implant treatment. During the course of performing more than 1,500 All-On-4 style dental implant procedures, the author has run into many situations that had the potential to compromise the outcome of the procedure. In some instances, severely pneumatized sinuses restricted the A-P spread between implants. Such cases could still be completed, but would result in truncated restorations that would limit the available chewing surface for the patient. Furthermore, in certain patients with very wide and high smiles, a truncated restoration would also result in unaesthetic black spaces at the distal extent of the buccal corridors. By employing the PFAST technique to engage the dense cortical bone of the pyramidal process of the palatine bone and pterygoid process of the sphenoid bone, the author was able to dramatically increase the A-P implant spread (Figures 9, 10) for these patients, thus

ensuring a restoration that has an adequate distal extent for chewing capacity and buccal corridor aesthetics. Severely pneumatized maxillary sinuses are relatively easy to diagnose and plan for with standard CBCT pre-surgical evaluation and rarely come as a surprise during the surgical procedure. Low bone density and its influence on All-On-4™ surgery planning, on the other hand, may be a bit more challenging to diagnose pre-surgically. Multiple studies have confirmed that CBCT scans are a useful diagnostic tool for assessing bone density with Hounsfield unit analysis.<sup>70-72</sup> Furthermore, many of these studies have shown that pre-surgical analysis of cortical bone thickness and Hounsfield units for bone density have a positive correlation with dental implant insertion torque and ISQ values.<sup>72-75</sup> When performing All-On-4™ style dental implant procedures, a few items must be accounted for when evaluating CBCT scans for bone density and pre-surgical planning of potential implant placement locations. First and foremost, it must be remembered that alveolar bone reduction is required in most All-On-4™ style surgeries prior to the placement of dental implants.<sup>58</sup> In most cases following such bone reduction, the crestal cortical bone will be removed leaving less dense trabecular bone as the recipient site for dental implants. In most patients, the threads of the dental implants are able to engage dense cortical bone of the buccal and lingual walls of these surgical sites. In some patients with exceptionally wide ridges, however, removal of the crestal cortical bone leaves a situation where the implant diameter is not wide enough for the threads to engage buccal or palatal cortical bone. Furthermore, in some cases there is



minimal to no cortical bone to engage apically in the maxilla. Adding another obstacle to the mix is infected bone at the potential sites of dental implant placement. It is well documented that infected bone secondary to periodontal disease or acute/chronic apical periodontitis has lower bone density than healthy bone.<sup>76,77</sup> When performing All-On-4™ style dental implant surgery, teeth affected by such conditions are often encountered and the residual apical bone in these areas may be of inadequate density to provide sufficient insertion torque values for immediate loading. In cases with widespread affliction of such conditions, it may be difficult to find satisfactory insertion torque or composite insertion torque values that favor immediate loading, especially when one remembers that the crestal cortical bone will be removed during the bone reduction phase of the surgery. As such, when these situations are encountered, utilization of pterygoid implants can provide much needed additional support for immediately loaded full arch restorations (Figures 11, 12).

## CONCLUSION

The PFAST technique provides a means to attain high insertion torque values for dental implants and serves as an adjunct for All-On-4™ style dental implant treatment during certain compromised situations. By engaging the dense cortical bone of the pyramidal process of the palatine bone and pterygoid process of the sphenoid bone, the additional insertion torque can be added to full arch cumulative torque values which increases the chances for immediate loading. Furthermore, the location of the pterygoid implants dramatically increases A-P spread, allowing for significantly

longer full arch restorations with more chewing surface and improved aesthetics for certain patients with wide smiles. When properly applied, pterygoid implants have demonstrated high survival rates in delayed loading situations and the current study shows that they may be successfully applied with immediately loaded full arch situations as well. The findings of this study warrant larger studies to confirm the success rates of immediately loaded pterygoid implants when used in full arch restorations. ●

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## Disclosure

The author reports no conflicts of interest with anything in this article.

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# All on 4 Immediate Loading Technique Using Laser Narrow Made Implants in Severely Reabsorbed Jaws: A 3 Year Prospective Study

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## Abstract

**Objective:** The objective of the present prospective study was to observe the behavior of an immediate loading protocol on 4 narrow laser made implants distributed polygonally in severely reabsorbed edentulous mandibles.

**Material and methods:** We observed 8 individuals, 2 men and 6 women with a mean age of 60.5 years, total mandibular edentulous teeth with hybrid assisted implant prosthesis with a welded titanium rod of circular section of 2 mm thickness installed at 48 hours after the insertion of the implants, which at 3 months was changed by a definitive prosthesis. During the observation period, the success rate of implantation, biological and mechanical complications for a period of 3 years was evaluated.

**Results:** A total of 32 narrow implants distributed in 16 distal tilted implants and 16 medial axial implants with an average torque of 49.52 Ncm were installed, presenting a success rate of 100%, minor biological complications related to mucositis and mechanical complications due to loosening of the prosthetic screw and fracture of aesthetic elements.

**Conclusions:** Preliminary data suggest that the immediate loading through a rigid prosthetic structure associated with narrow posterior tilted implants in combination with narrow medial axial implants could be considered as a viable modality treatment and present a good clinical outcome in the severely reabsorbed mandible.

**KEY WORDS:** Immediate Dental Implant Loading, Mandible/surgery, Dental Implants, Jaw, Edentulous/rehabilitation, Dental Prosthesis, Implant-Supported

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## INTRODUCTION

The rehabilitation of edentulous jaws with osseointegrated implants has proven to be a highly predictable treatment. However, rehabilitation of severely resorbed edentulous jaws has anatomical limitations due to reduced bone volume, particularly in the region of premolars and molars. Prosthetically, they are designs of dental prosthesis with distal extensions up to 15mm, where greater length has shown a lower success rate.<sup>1</sup> Another method is the installation of short implants, which could be an alternative, but this requires a minimum amount of 7 mm of vertical bone height and in many of these patients is not that option.<sup>2,3</sup> Reconstructive surgery through onlay contour bone grafts in severely resorbed jaws is a treatment option<sup>4,5</sup> but patient compliance to these procedures could be low due to the invasive nature of the surgical procedure associated with an increased risk of morbidity and high costs. The option of using extra-oral anchors, as introduced by Branemark,<sup>6</sup> zygomatic implants and implant installation in the anatomical region of the tuberosity or pterygoid region<sup>7-10</sup> represent other treatment options to restore edentulous jaws, however, in severely resorbed mandibles there are no such resources as are remote anchorages. From the anatomical point of view, the efficient positioning of implants in severely resorbed jaw is subject to the location of mental foramen and the shape of the mandibular arch. Based on this analysis, Branemark proposed using 5 or 6 parallel implants between the mental foramina designing classic ad modum Branemark prosthesis.<sup>11</sup> Conventionally, implants are machined by a lathe from a titanium rod, obtaining a screw which in its

macrostructure describes its shape and respective threads of insertion. Then, these machined screws receive a second process, the surface treatment, thereby configuring a micro surface anatomy with micro roughness ranging on average 20-micron depth, which improve and optimize the osseointegration process. Laser made is a completely different way to build the macrostructure of an implant that also creates the microstructure of an implant in one step, which features micro roughness ranging from 200 to 300 microns in depth, facilitating its osseointegration. The laser process also made possible to obtain highly resistant narrow implants, with an elasticity module that accompanies elastic deformation of the bone.

The option to install tilted implants, avoiding the maxillary sinus pneumatization or the presence of mental nerves in severe resorption of the jaws, raised by Krekmanov<sup>12-14</sup> and Malo, increases the possibility of installing longer implants, improves the polygonal distribution of prosthetic bearing and reduces the number of implants, without the need for a bone graft filler of the maxillary sinus.<sup>12-20</sup> This option of tilting implants can also be a surgical resource in severely reabsorbed jaws, placing implants in the area between the mental foramina, providing a viable and predictable alternative, reducing the number of implants, achieving a polygonal efficient distribution capable of supporting 10 to 12 prosthetic teeth, and choosing for immediate prosthetic function mode, improving the acceptance of treatment by patients seeking replacement of their conventional prosthesis. The aim of this study was to observe the behavior of an immediate loading protocol on 4 narrow laser made implants distributed polygonally in severely reabsorbed edentulous mandibles.



**Figure 1:** Opening flap and delimitation implants path by drawing in pencil.



**Figure 2:** Initial drilling.

## MATERIALS AND METHODS

The study was performed with 8 selected patients who consulted freely. Patients were instructed regarding the conditions of the study and all subjects who know the inclusion criteria were enrolled, prior information of type, mode and time of treatment, by signing an informed consent.

### Inclusion Criteria

- Full mandibular edentulous patients with healed bone.
- Men and women over 18 years.
- Absence of systemic disease that contraindicated treatment implant assisted prosthesis.

### Exclusion Criteria

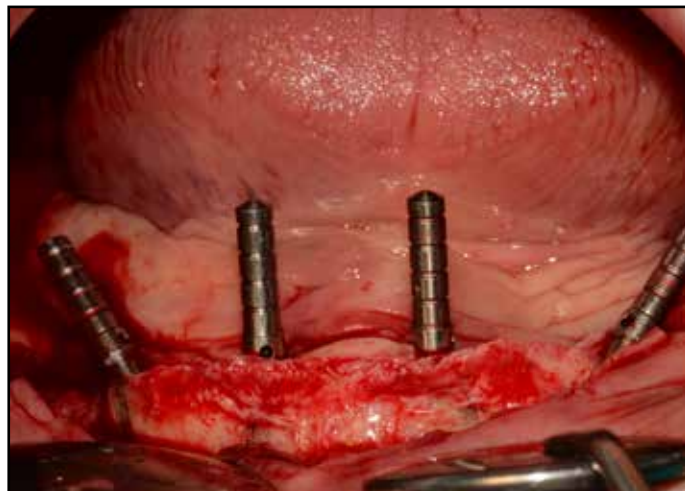
- Patients irradiated in the head and neck within 12 months before surgery.
- Pregnancy.
- Presence of smoking.
- Presence of untreated periodontal disease.
- The type of opposing dentition was not a limiting condition in this study.

### Surgical Phase

The patient went under surgery with intravenous sedation administered by an anesthetist and medicated before surgery with antibiotic therapy with amoxicillin 1 g. every 12 hours for 7 days and anti-inflammatory painkillers (Actron 400mg every 6-8 hrs. and Xumadol 1 g. every 6-8 hrs. for 3 days). The surgical procedure started with local anesthetic infiltration raising one full thickness flap by a supra crestal incision and two vestibular discharge side to the height of the 1st molar lower in order to identify the mental foramen, marking its position and projecting on the flange with a graphite pencil with sterile define the path of the implants drawing on the buccal aspect of the mandibular bone (Figure 1). If required we proceed to a bone plateau with carbide burs under copious irrigation with saline to reach a bone thickness for the insertion of implants and body diameter 3.3 and platform diameter 4.1 (Figure 2). Shaping the implant site, began with spear drill, then drill to 2.0mm in diameter to length



**Figure 3:** Laser made titanium narrow implant.



**Figure 4:** Bone-drilling completed and verification of implants positions.



**Figure 5:** Insertion of anterior parallel implants.

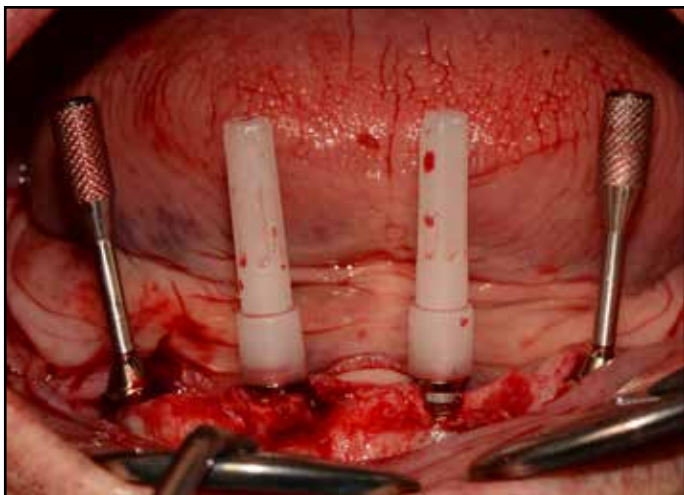


**Figure 6:** Insertion of all implants in all on 4 technique.

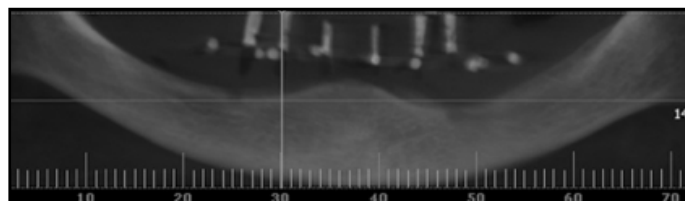
and proceeds to verify by depth gauge, then to 2.5 mm diameter partially or completely to length, this it is performed in order to obtain higher torque values surgical insertion to 35 N. After the milling, the implant (Figure 3) is inserted without irrigation verifying compliance with the milling direction guided by the drawings of the trajectories of implants and determining the final insertion torque with surgical motor (NSK surgical Xt) (Figures 1-6).

### Immediate Load Prosthetic Phase

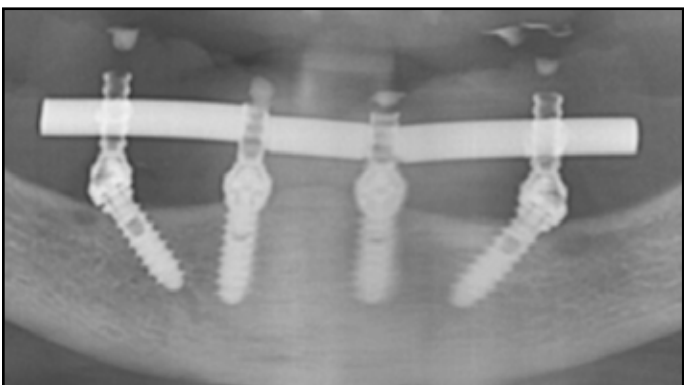
The prosthetic procedure begins with the minimum definition of progressive surgical torque greater than 35 N in the four implants, if one of them does not achieve torque the immediate loading procedure is suspended and the implants are submerged. Once the torques were defined during the surgical phase, the multiunit 30° and 0° pillars were installed in order to parallelize the four implants and thus suture the flap (Figure 7).



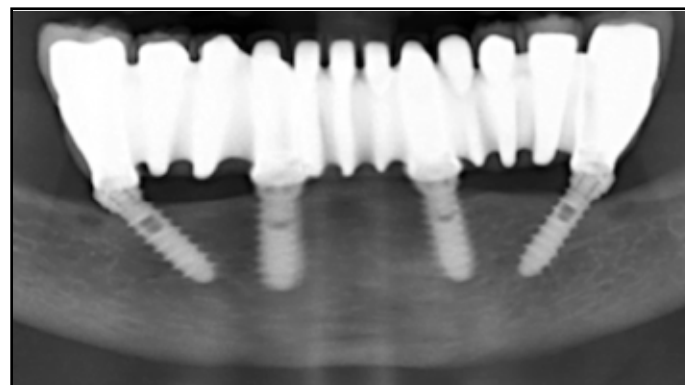
**Figure 7:** Insertion of the multi-unit abutment (straight in anterior and 30° in posterior) and X-Ray control of the hybrid structure.



**Figure 8:** Panoramic view of pre-surgical scanner.



**Figure 9:** Panoramic view of immediate loading.



**Figure 10:** Panoramic view of 3 years.

After the surgery, titanium abutments and the multifunctional tray are inserted and cut at the clinic over the multiunit pillars to allow its passage and settlement without contact between the pillars, allowing a bite position in MIC, then drilled by vestibular at the height of the pillars in order to make 4 windows that allow vision and set the multipurpose tray with acrylic self-curing. Finally, silicone is injected into the open spaces between the mucosa and multifunctional bucket and takes a record MIC bite on the fixed structure. The

lab makes a hybrid structure with a titanium rod welded 2mm circular wrapped in acrylic, which is installed within 48 hours (Figures 8, 9) Evaluating their passivity insertion and prosthetic adjustment radiographic settlement. The implants installed with their dentures should be checked to complete the 3 years of observation (Figure 3). To optimize the recording of data obtained during the follow-up phases implants were numbered in their positions based on the dental international nomenclature, which divides the mouth



**Table 1: Implant Length**

<b>Length</b>	<b>Implant Inclined Distal Quadrant 3</b>	<b>Vertical Implant Medial Quadrant 3</b>	<b>Implant Vertical Medial Quadrant 4</b>	<b>Implant Inclined Distal Quadrant 4</b>
<b>13</b>	<b>8</b>	<b>1</b>	<b>—</b>	<b>9</b>
<b>11.5</b>	<b>4</b>	<b>4</b>	<b>2</b>	<b>2</b>
<b>10</b>	<b>—</b>	<b>1</b>	<b>1</b>	<b>—</b>
<b>Total Implants</b>				<b>32</b>

**Table 2: Average Insertion Torque**

	<b>Implant Inclined Distal Quadrant 3</b>	<b>Vertical Implant Medial Quadrant 3</b>	<b>Implant Vertical Medial Quadrant 4</b>	<b>Implant Inclined Distal Quadrant 4</b>
<b>Torque Torque (N/cm2)</b>	<b>51.9</b>	<b>45.2</b>	<b>49.7</b>	<b>51.3</b>
<b>General Average</b>				<b>49.52</b>

into quadrants listed in the direction of clockwise, defining the position and number as follows:

- Implant No1: Implant in position tilted distal Quadrant 3.
- Implant No2: medial axial position implant in Quadrant 3.
- Implant No3: medial axial position implant in Quadrant 4.
- Implant No4: Implant in position tilted distal Quadrant 4.

### Evaluation Criteria

*Implant Success Criteria:* 1) Absence of spontaneous pain and the longitudinal and oblique percussion; 2) bone level consistent with formation of biological width; 3) absence of peri-implant radiolucency; 4) lack of obvious mobility; 5) sound dull to percussion.

*Biological Success Criteria:* 1) During the clinical observation it was assessed; 2) no signs or symptoms of gingival tissue inflammatory peri-

Table 3: Implant Success Rate of 36 Months

	Implant Success Criteria	Biological Criteria of Success		Prosthetic Success Criteria			
Control Month	%	Signs and periimplant Inflammatory Symptoms	Perimplant Exudates	Screw Prosthetic Loosening	Pilar Screw Loosening	Aesthetic Element Fracture	Bar Fracture
1	100%	—	—	—	—	1	—
2	100%	—	—	—	1	1	—
3	100%	1	—	1	—	—	—
6	100%	1	—	—	—	—	—
12	100%	—	—	—	—	—	—
18	100%	—	—	—	1	—	—
24	100%	—	—	1	—	—	—
30	100%	1	—	—	—	—	—
36	100%	—	—	—	—	—	—
	100%	90.62%	100%	93.75%	93.75%	93.75%	100%

implant; 3) absence of peri-implant exudates.

*Prosthetic Success Criteria:* 1) No loosening screws in 30° angled abutment; 2) No loosening of the prosthetic screws; 3) No fracture of the prosthetic pillar; 4) No breaking of the bar; 5) No breaking of the aesthetic element.

## RESULTS

The observed patients were divided into 2 men and 6 women, with an average age of 60.5 years, who received an implant prosthetic treatment assisted hybrid temporary, with a circu-

lar section rod 2mm titanium welded by laser and coated bonding acrylic thermosetting at 48 hours of performed surgery, which was changed to the 3 months ended osseointegration process by a final ceramic hybrid metal prosthesis. A total of 32 implants made narrow laser threaded connection external diameter 3.3 and 4.1 platform (TIXOS LEADER ITALIA) were installed (Table 1), showing average insertion torque of 49.52 N (Table 2). Implant success rate at 36 months was 100% for all implants. Three (3) biological complications of mucositis occurred deficiency hygiene

in the area asking patients improve the cleaning area without taking a major complication and six (6) mechanical complications represented by two (2) screw loosening of the prosthetic pillar, two (2) loosening of abutment screw and two (2) aesthetic element fracture of the dental acrylic phase immediately loaded (Table 3).

## DISCUSSION

The clinical outcome of this prospective study in edentulous jaws for the prosthetic implant assisted treatment immediately loaded with narrow implants, presents a highly predictable outcome, which is closely compared to the results published by Malo et al.<sup>17,18</sup> under his technical “all on 4”. Along with the above data reported by Krekmanov<sup>13</sup> and Aparicio<sup>14</sup> in the use of parallel and inclined implants are also compared, but we must mention that the implants of the study are implants of small diameter due to the anatomical conditions reabsorption jaw unlike those reported in previous studies. Torque values obtained with narrow implants are related to torque values presented in immediate loading protocols reported in the literature showing no damage to the structure of the implant product of its condition of small diameter.

In vitro studies analyzing the distribution of the burden of implants connected to inclined columns have unfavorable results, however, it should be noted that the results were reported for single-tooth implants<sup>19</sup> and not for implants splinted in the form of rigid arch.<sup>12,13</sup> In relation to the inclination of implants versus axially install option has not been reported differences in the transmission of the tension to the prosthetic abutment and the implant platform.<sup>12,13</sup>

No doubt the indication in using inclined

implants allows patients to obtain a highly efficient and predictable treatment, in the form of immediate prosthetic function implants, but certainly we can also provide other clinical advantages including first the possibility of placement longer implants which increase the area of contact of the implant with the bone, and increasing the primary stability of the implant due to the interlocking generated by contact with the lingual and vestibular cortical and increase the distance between the implants, reducing cantilever and increasing the polygonal distribution of implants using less implants to support the prosthesis and the possibility of applying a protocol of immediate prosthetic function along with reducing overall treatment costs.

But surely that our work not only makes a contribution in the traditional structural concept but rather in new capacity have implants trabecular metal, which have a difference to the traditional for implants, and this difference was the ability to produce a bone ingrowth into the implantable to increase the contact area implant bone increasing its closest surface to 800% and on the other hand the resilience of a sintered metal to receive loads, which showed that its elasticity module is very similar to bone and behavior under load accompanies the elastic movement of the bone, together with the increased absorption load having a higher resistance under the same stimulus compared to machining implant.

## CONCLUSION

Preliminary data suggest that an immediate loading protocol using a hybrid screwed prosthesis with a rigid bar of titanium and wrapped in acrylic, and a ceramic defini-

tive prosthesis metal associated with inclined and axial narrow implants could be considered a form of viable treatment for the atrophic mandible presenting no clinical differences with axial and conventional implants. ●

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### Disclosure

The authors report no conflicts of interest with anything in this article.

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# Dental Abscess Affecting Facial Skin: A Case Series

Amir Khalid Hassan, BDS MDS<sup>1</sup>

## Abstract



**D**ental abscesses are frequently found in the oral cavity and are often related to badly decayed teeth and poor oral hygiene. Dental caries and pulpal necrosis often end in extending infections to alveolar bone and sometimes involving the outer layer of the face. The origins of these facial sinus orifices cannot be distinguished easily, often confusing the medical team attempting diagnosis. A fistula

is an abnormal pathway between two anatomic spaces or a pathway that leads from an internal cavity or organ to the surface of the body. A sinus tract is an abnormal channel that originates or ends in one opening. An orofacial fistula is a pathologic communication between the cutaneous surface of the face and the oral cavity. The following case series documents treatment of dental abscesses that affected facial skin.

**KEY WORDS:** Dental abscess, infection, fistula, oral pathology

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## INTRODUCTION

Dental abscesses are frequently found in the oral cavity<sup>1</sup> and are often related to badly decayed teeth and poor oral hygiene. Dental caries and pulpal necrosis often end in extending infections to alveolar bone and sometimes involving the outer layer of the face.<sup>1-9</sup> The origins of these facial sinus orifices cannot be distinguished easily, often confusing the medical team attempting diagnosis.<sup>2-10</sup> A fistula is an abnormal pathway between two anatomic spaces or a pathway that leads from an internal cavity or organ to the surface of the body. A sinus tract is an abnormal channel that originates or ends in one opening. An orofacial fistula is a pathologic communication between the cutaneous surface of the face and the oral cavity. In the literature, the terms fistulas and sinuses are often used interchangeably. *Stedman's Medical Dictionary* defines a sinus as a fistula or tract leading to a suppurating cavity. Orofacial fistulas are not common, but intraoral sinus tracts due to dental infections are common. When infection or neoplasia is involved, immediate treatment is necessary. Dental infections, salivary gland lesions, neoplasms, and developmental lesions cause oral cutaneous fistulas, fistulas of the neck, and intraoral fistulas.<sup>2,3,5</sup> Chronic dental periapical infections cause most intraoral and extraoral fistulas. These dental periapical infections might cause chronic osteomyelitis, cellulitis, and occasionally facial abscesses. Infection can spread to the skin when it is the path of least resistance causing cutaneous fistulas. One case report<sup>2</sup> reviewed this occurrence from a periapical infection from the right central mandibular incisor, which drained to the patient's chin. Because the tooth could not be restored, it was extracted, which resolved the lesion. Another

case with cutaneous manifestations involved a 44-year-old woman with a draining lesion to the skin just lateral to the nasofacial sulcus. Oral antibiotics did not help in treating the lesion. The patient had bad oral hygiene and two periapical radiolucencies of the maxillary right lateral incisor and canine were observed. The teeth were extracted, which resolved the lesion. Sheehan et al.<sup>3</sup> emphasized on the importance of a dental examination and radiographs to rule out infection of dental origin to the cutaneous face or neck. This article is a case series of three cases in which dental abscesses extended to the facial skin with documentation of their treatment and resolution.

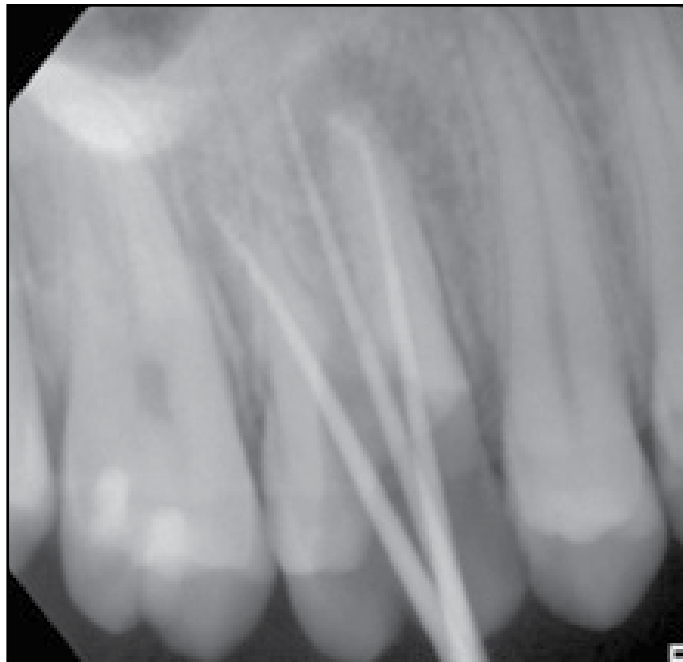
## CASE SERIES

### Case 1

A 20-year-old Yemeni patient presented with an abscess that involved her face. Drainage and curettage had been performed by General Physicians as well as laser cauterization by a Dermatologist, but the lesion remained unresolved. Ultimately, it was suspected that the abscess might be of dental origin. Endodontic treatment on the maxillary right first molar was initially performed in 2010 but was not completed. Due to the incomplete treatment, the patient suffered from chronic periapical abscesses that were subsequently treated with intrapulpal drainage and antibiotics. During our examination, it was noticed that the abscess extended to the face and was drained through infraorbital skin area (figure 1). Radiographic examination was done by orthopantomogram and periapical parallel technique inserting gutta percha inside the facial orifice of the sinus and tracking the origin. This revealed the presence of this abscess and its relation to the suspected tooth. Our findings were discussed with



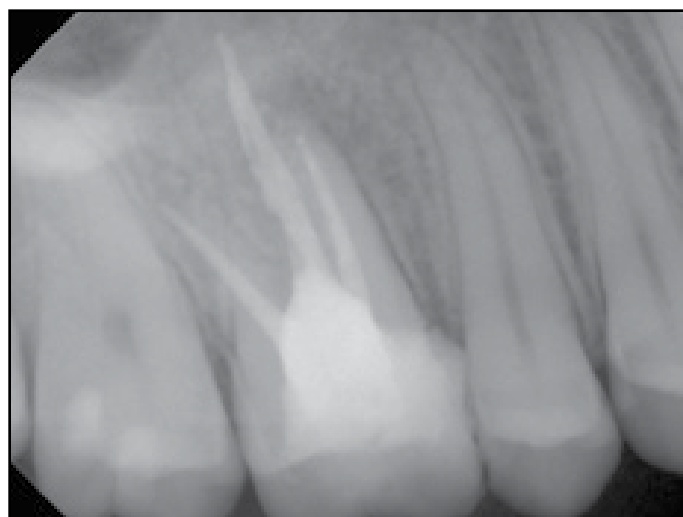
**Figure 1:** Pre-operative view of facial fistula.



**Figure 2:** Gutta percha insertion during endodontic treatment of tooth 16 (FDI tooth numbering system).

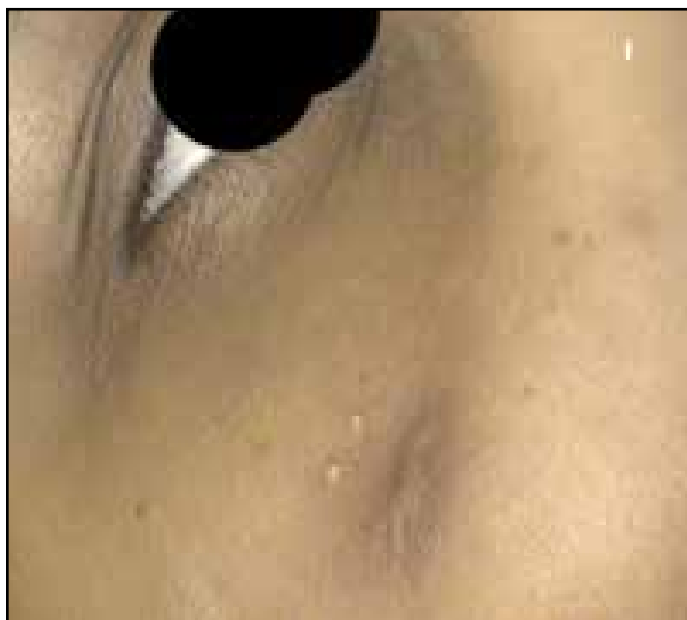


**Figure 3:** Facial fistula at 3 months healing.

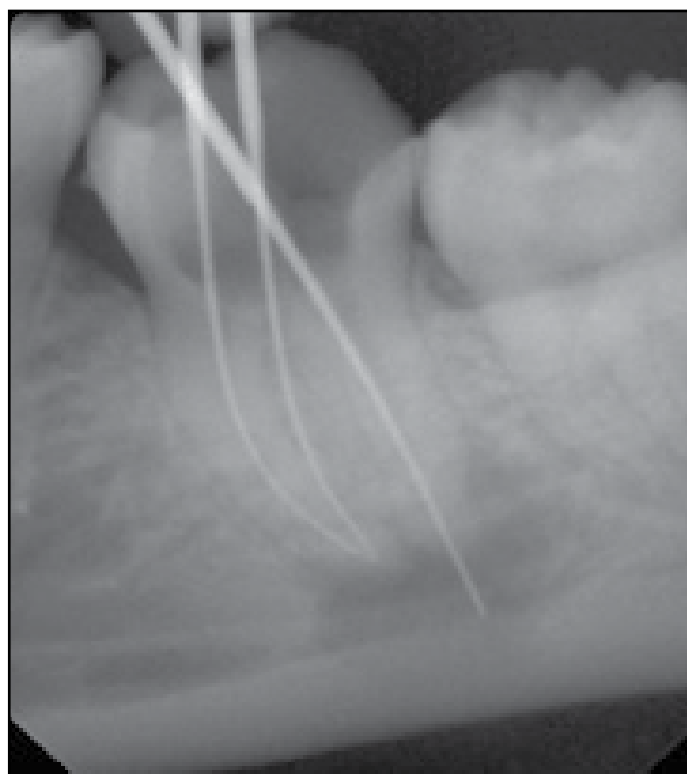


**Figure 4:** Endodontically treated tooth 16 at 3 months healing.





**Figure 5:** Facial fistula at 6 months healing.



**Figure 6:** Gutta percha insertion during endodontic treatment of tooth 36.

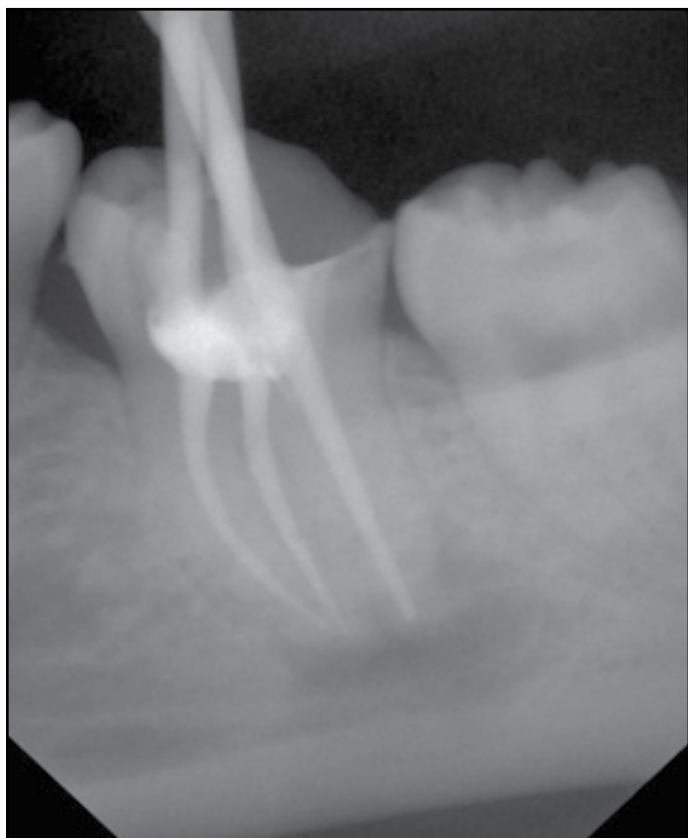


**Figure 6:** Pre-surgical radiographic view of affected tooth 36.

the patient. Endodontic preparation and obturation using rotary instrumentation was accomplished over three visits of 10 days intervals under antibiotic coverage of Doxycycline capsule 150 mg twice a day. The same antibiotic tablets (3 tabs) were crashed into a chlorohexidine mouthwash and used as irrigant for the root canals along the procedures (figure 2). The case was observed for three months (figures 3 and 4) six months (figure 5) and one year without any complaints. The tooth was finally restored with a ceramic crown. The outer scar of the sinus tract was treated by laser and improved in appearance.

## Case 2

A 22-year-old Pakistani female patient presented to our clinic with a chief complaint of recurrent excised skin infection at the neck with purulent discharge from the corner of the mandible. She had previously been treated by medical physicians but the lesion failed to resolve. The patient attended the facility of Qatar Armed Forces where she was referred to Dental Department for consultation. A complete oral examination was performed. Radiographic examination (figure 6) was done by orthopantomogram and peri-



**Figure 8:** Gutta percha insertion during endodontic treatment of tooth 36.



**Figure 9:** Facial fistula at 1 month healing.



**Figure 10:** Facial fistula at 3 months healing.



**Figure 11:** Facial fistula at 6 months healing.



**Figure 12:** Facial fistula at 12 months healing.



**Figure 13:** Facial fistula at 12 months healing.

apical parallel technique inserting gutta percha inside the facial orifice of the sinus and tracking the origin. This revealed the presence of this abscess and its relation to the suspected tooth. The same method of treatment in Case 1 was followed including endodontic treatment (figures 7, 8). Follow-up evaluations were performed at 1, 3, 6 and 12 months (figures 9-13). The patient refused to receive laser treatment to remove the scar as lesion at the former site of the fistula.

### Case 3

A 62 year old Pakistani female patient was referred from a dermatology clinic suffering from a discharging nodule on the right lower nasolabial fold lasting more than two months duration. She took many courses of antibiotics and surface lozenges with no benefits. The patient's

medical history was positive for hypertension and diabetes which were well controlled medically. Oral, dental, and radiographic examinations were performed (figure 14). A gutta percha point inserted inside the facial skin nodule indicated relation to the apical abscess tooth #12 (FDI tooth numbering system). The tooth was treated endodontically (figure 15) in an attempt to resolve the lesion. During irrigation of the endodontic procedure, irrigant solution was observed to discharge out of the nodule sinus (figures 16, 17). Post-operatively, the patient irrigated the facial sinus tract with Doxycycline capsule dissolved in 500 ml of saline. After 3 weeks, the facial sinus completely closed. The patient was followed for an additional 3 months and had significantly improved healing of the facial fistula (figures 18, 19).



**Figure 14:** Pre-surgical radiographic view of affected tooth 12.



**Figure 15:** Gutta percha insertion during endodontic treatment of tooth 12.



**Figure 16:** Pre-operative view of facial fistula.



**Figure 17:** Endodontic irrigant solution expressing from facial fistula of Case 3.





**Figure 18:** Facial fistula at 1 month healing.



**Figure 19:** Facial fistula at 3 months healing.

## CONCLUSION

Skin lesions of dental origin may occasionally prove to be a conundrum for medical providers not accustomed to seeing the origins of such lesions. Teamwork treatment is essential for the diagnosis and treatment of such lesions. ●

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### Disclosure

The authors report no conflicts of interest with anything in this article.

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# Immediate Healing Abutment Placement Associated with Connective Tissue Graft and Coronally Positioned Flap on Laser-Microgrooved Implants to Improve Peri-Implant Soft Tissue Conditions: A Case Report

Alessandro Bermonds, DDS<sup>1</sup> • Luca Savio, DDS<sup>2</sup> • Renzo Guarnieri, MD, DDS<sup>3</sup>

## Abstract

**Background:** Soft tissue recession is one of the most important problems of implants, when thin buccal bone thickness, and inadequate width and thickness of keratinized gingiva are presents. To prevent such defects and to increase width and thickness of keratinized tissue around implants, connective tissue graft (CTG) is one of the most used surgical techniques.

**Case presentation:** This paper describes a surgical technique at the implant insertion stage, with an immediate CTG, a coronally positioned

flap, and immediate healing abutment placement, aimed to obtain peri-implant soft tissue conditions around laser-microtextured implants.

**Conclusions:** in case of an inadequate vestibular bone thickness ( $< 1.5/2\text{mm}$ ), additional bone grafting is not needed around a laser-microtextured implant/abutment, if an adequate soft tissue width and thickness is obtained with an immediate CTG, a coronally positioned flap, and immediate healing abutment placement.

**KEY WORDS:** Dental implants, connective tissue, mucogingival graft, coronally positioned flap, laser

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## INTRODUCTION

The potential role of an adequate width and thickness of keratinized/attached mucosa (KM) on long-term dental implant clinical stability is still a matter of debate, and controversy exists in literature with respect to the question whether or not there is a need to augment the keratinized tissue around dental implants in cases with a lack of or reduced width and thickness.<sup>1-10</sup> Some human and animals studies<sup>6,8</sup> reported no correlation between implant success and the presence of KM, while other studies have shown that implant sites without an adequate band of KM exhibit an increased susceptibility to inflammation and adverse peri-implant soft and hard tissue reactions.<sup>7,11</sup> However, more recent reports indicate that an inadequate width and thickness of peri-implant KM may lead to increased soft tissue recession,<sup>11-13</sup> higher risk of clinical attachment loss,<sup>13</sup> and peri-implant alveolar bone loss.<sup>14</sup> Based on these results some authors<sup>11,15</sup> have highlighted the importance of the presence of KM around dental implants of at least 2mm in width, dimensions similar to the zone of keratinized gingiva recommended to be adequate around teeth.<sup>16</sup> Moreover, according to long-term clinical studies by Grunder et al.,<sup>17-19</sup> in addition to an appropriate soft tissue volume, the thickness of the bone on the buccal side of an implant should be at least 2mm.

The connective tissue graft (CTG) is one of the most often used surgical techniques to increase soft tissue volume, width, and thickness of keratinized tissue around natural teeth.<sup>20</sup> This technique has also been proposed around dental implants and its predictability has recently been analyzed by some literature reviews.<sup>21-23</sup> It can be performed at different surgical stages of the treatment:

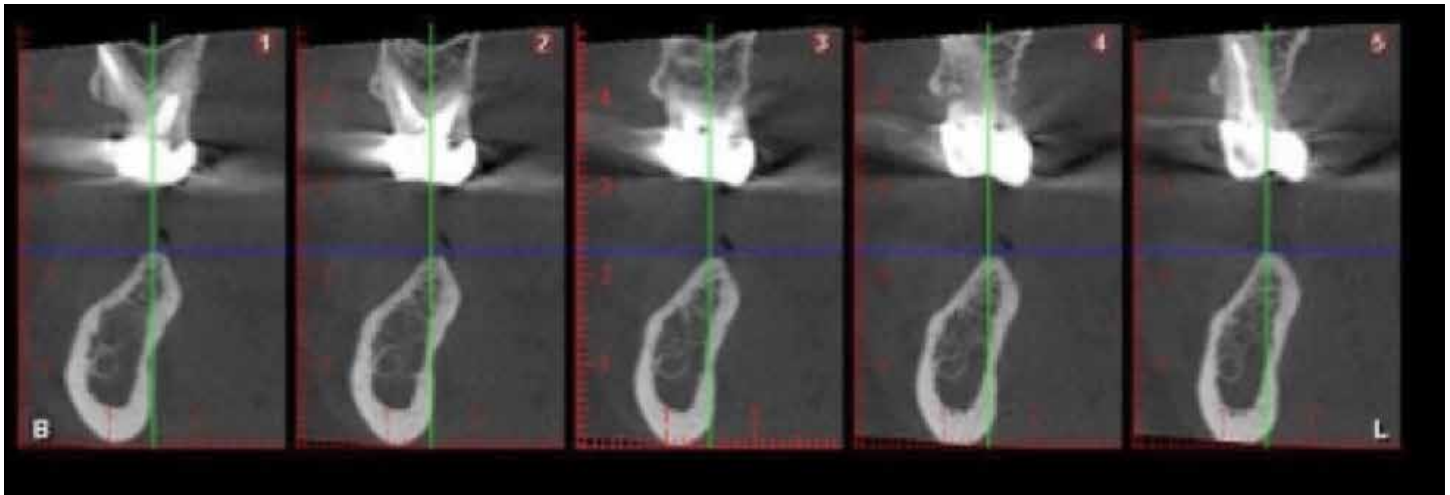


**Figure 1:** Clinical situation before implant placement with adequate width and thickness of keratinized mucosa.

before the implant placement, during the implant placement, during the second-stage surgery (re-entry), or after the implant is osseointegrated, uncovered, and eventually, already loaded.<sup>21-23</sup>

It is known that the histological aspect of CTG healing around a natural tooth depends on several factors, among which are flap positioning at the end of surgery<sup>24,25</sup> and the root surface preparation.<sup>26-28</sup> The epithelium and connective tissue of the pedicle flap are not subjected to major changes because of the preservation of the blood supply. In addition, the connective tissue graft acts as a biological barrier that prevents the early contact of the oral epithelium with the root surface, hence delaying epithelial apical migration. It has been well documented that only the healthy, deep cementum layer on the root surface, following light mechanical instrumentation, obtains a new connective attachment, while the treated surface of dentin apparently lacks such inductive activity.<sup>27</sup>

Epithelial and connective tissue attachment on a conventional smooth/machined surface titanium-implant/abutment differs from that of the periodontium of a tooth. Hemidesmosomes and the implant internal basement laminae are formed



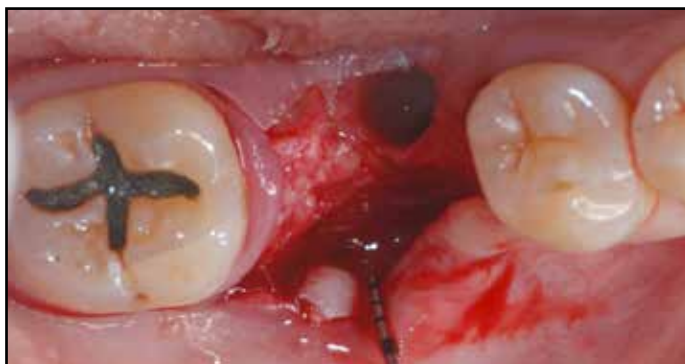
**Figure 2:** CBCT scans of the implant site.

only in the lower region of the peri-implant epithelium interface, in contrast to natural teeth where the hemidesmosomes and internal basement laminae are evident throughout the junctional epithelium-tooth interface.<sup>29</sup> Moreover, a natural tooth demonstrates an attachment apparatus with Sharpey fibers embedded into the cementum and covering the root surface at an oblique angle,<sup>30</sup> whereas implants have shown firm bundles of connective tissue fibers which run parallel to the implant surface.<sup>31</sup> Consequently, it can be hypothesized that the weakness of the epithelial attachment, and the lack of connective tissue fibers insertion in traditional smooth-machined implant surface/abutments, could limit soft tissue adhesion to their surface.<sup>32</sup>

Cell culture experiments,<sup>33</sup> have illustrated the potential of a laser-microgrooved surface with 8° in pitch, to interact with fibroblastic cells, influencing their behavior and growth. Observed under an electron microscope, fibroblastic cells grown on the laser-microgrooved surface, had an elongated morphology with many pseudopods, strongly attached to the surface.<sup>34</sup> Moreover, laser-micro-

grooves with 8° in pitch inhibit the epithelial cell migration.<sup>33</sup> Subsequent histological studies<sup>35-37</sup> on this specific surface of implant retrieved in humans, documented a connective tissue integration, indicating that this type of surface unequivocally allows the establishment a unique soft tissue morphology during healing. This leads to an improved and stable soft tissue implant/abutment interface. Based on these considerations, it is possible to speculate that the “biomimetic” features of laser-microtextured surface on implant collar, allows a simpler approach to soft tissue volume augmentation around dental implants. Therefore, the hypothesis to be tested in the present prospective study was to determine if, in sites with limited width and thickness of KM and thin vestibular bone thickness, an immediate CTG, and a coronally positioned flap, at the implant insertion stage, associated with the immediate healing abutment placement, could improve peri-implant soft tissue conditions around laser-microtextured implant/abutments. This paper reports preliminary data of an ongoing prospective study and describes the proposed technique.





**Figure 3:** Buccal bone thickness <2mm is detected in the implant site.



**Figure 4:** A connective tissue graft is placed on the microgrooved implant collar, and sutured to the alveolar crest.



**Figure 5:** An immediate healing abutment is screwed on the implant.



**Figure 6:** The coronally positioned flap is adapted to the healing abutment.

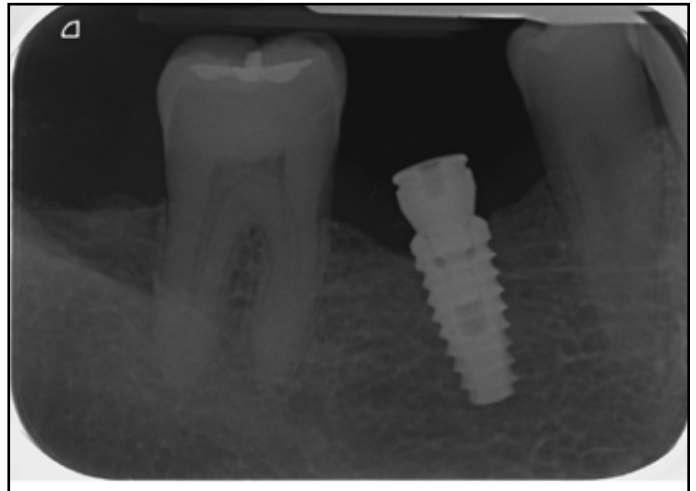
## CASE PRESENTATION

A 57 year-old male patient, presented an edentulous site in position 46. At clinical evaluation a KTW < 2 mm measuring from the mid crestal position to the buccal side and a KTT < 2mm were present. The KTW was determined by using a periodontal probe on the mid-buccal side from the mucogingival junction to the most coronal part of gingiva of the implant site (Figure 1). The patient received an antibiotic treatment with 875mg penicillin and 125 Clavulanic Acid twice a day for 6 days starting the day prior to surgery. Following local anaesthesia, the KTT was measured, by means of no. 30 K-file

inserted through the soft tissue until touching the bony crest at the center of the future implant site. A CBCT scan of the implant site (Figure 2) revealed no more than 5 mm of horizontal bone thickness for the implant insertion. Following local anesthesia, a mid-crestal incision was carried out with a 12D blade trying to split the keratinized mucosa equally on the lingual and buccal sides. This helps during the suturing since a tighter and more resistant tissue is present on both sides. The flap was elevated full thickness in the implant insertion area. The papillae dissection of the adjacent teeth was carried with split thickness to provide a bed for



Removal of sutures at 10 days.



**Figure 8:** Radiograph taken after the implant placement.

the connective graft to be sutured in place. Once enough buccal bony crest was exposed to obtain good access for fixture insertion, the flap was dissected with a split thickness technique in order to give enough mobility for it to be repositioned coronally without tension. Though the implant site presented a buccal bone thickness  $< 2$  mm (Figure 3), the implant with an internal hex connection and laser microgrooved collar surface  $8^\circ$  in pitch was placed (Biohorizon, Birmingham, Alabama, USA) with a single stage approach without applying bone regeneration techniques. Following the CTG harvesting and de-epithelialization, the graft was sutured to the buccal bony crest using the split thickness bases of the dissected papillae as anchorage for stabilizing the graft by means of a 7-0 resorbable suture and a reverse cutting 8 needle which size allows to anchor the suture in very small fibers without traumatizing the dissected tissue. A 3mm in height and 3 mm in diameter healing abutment was immediately placed (Figure 5) and the flap was adapted over it (Figure 6). Since the residual bony crest buccal to the implant was less than 1 mm, a thin healing abutment allows leaving

a higher healing volume /area for the CTG and soft tissue healing in the 3 months following surgery. Suture removal was planned at 2 weeks (Figure 7). An anti-inflammatory drug (600mg Ibuprofen) was prescribed twice a day for three days following surgery and only if necessary afterward. The patient was recommended to apply extra-oral ice packs to the site for 10 min at hourly intervals on the first day following surgery and instructed not to brush the treated area for the following 4 weeks. A 0.12% chlorhexidine mouthwash was given to rinse three times a day for the entire healing period which comprised of the 2 weeks prior to suture removal and the 2 following weeks. For the second month following surgery the patient was instructed to use an extra soft toothbrush in the treated area with a roll technique in order not to traumatize the healing tissues. Intra-oral radiographs were taken on the day of surgery and at 2, 4, and 6 month intervals.

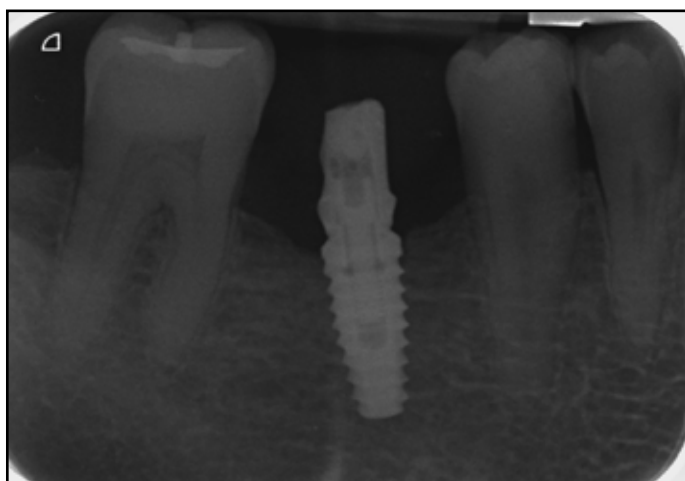
The implant was loaded in the 3rd month where a complete and healthy healing of the peri-implant soft tissues was noted (Figure 8). An open tray impression was taken of the implant in order for the technician to design and construct



**Figure 9:** Clinical situation at 3 months post-op.



**Figure 10:** A prosthetic abutment is screwed on the implants.



**Figure 11:** Radiograph of crown abutment.



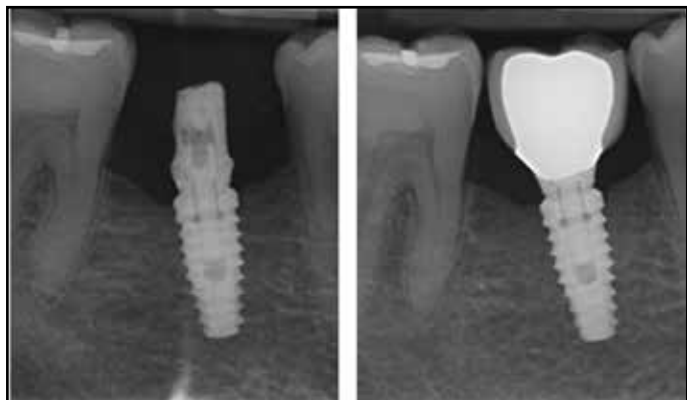
**Figure 12:** Occlusal view of the definitive crown.

a custom made milled titanium abutment with a correct emergence profile for a first molar and a provisional resin crown to be delivered for the following 3 months of implant loading (Figures 10, 11). At this stage the technician prepared the metal framework for the final crown, which was placed 3 months following loading. In order to start the molding of the peri-implant tissues of a molar tooth, a wider screw cap was then placed, so that at the loading appointment a wider transmucosal implant area of the healed soft tissue was available. At 3 months following loading,

an impression of the metal framework previously constructed was taken in order for the technician to finalize the ceramic work for the crown (Figure 12). The implant was then checked at 6 months intervals during the patient's recall visit, and radiographs were taken every year.

## RADIOGRAPHIC EXAMINATIONS

Radiographs were taken using a film holder by means of long cone technique. For the radiograph procedure, an individualized acrylic resin



**Figure 13:** Comparative radiographic results at the delivery of provisional crown and at 3-years follow-up.

device was fixed to the residual dentition and a radiograph holder was constructed. This technique ensured that the same position of the radiograph film could be reproduced at each visit and the angle of the radiograph would not deviate. A comparison between the initial post-surgical radiograph and the 3-year follow-up radiograph (Figure 13), showed that no marginal bone loss was present even if the initial bony crest width was  $< 2$  mm. In addition, especially on the mesial and distal aspects of the fixture a vertical radiographic bone growth at the implant collar in the 3 years radiograph was detected.

## DISCUSSION

The role of an adequate soft tissue volume around dental implants is still controversially discussed in the literature. Although some studies indicated that the amount of soft tissue volume can influence the success rate, the esthetic outcome, and may even in part compensate for missing bone on the buccal side of dental implants,<sup>38,39</sup> to date, the critical soft tis-

sue dimension in a three-dimensional way has not been evaluated, as a single parameter in any a long-term clinical study.<sup>40</sup> Some authors suggested that an adequate peri-implant bone volume is necessary to provide a stable base for the overlying soft tissue, to ensure satisfactory long-term aesthetics and functional outcomes.<sup>41,42</sup> Particular attention needs to be given to the buccal bone because of its extensive remodeling ability,<sup>43</sup> as well as its role in supporting the aesthetic buccal mucosa. In this context, it is important to take into consideration that a certain amount of bone resorption, not only in a vertical but also in a horizontal direction, occurs around implants as soon as the implant is in contact with the oral environment.<sup>44</sup> Accordingly, it has been suggested that a minimum buccal bone thickness of 1.5/2mm is required for maintaining a proper soft-tissue support on implant, and long-term aesthetics and functional outcomes.<sup>19,45</sup> An adequate peri-implant bone and soft tissue width/thickness appear to have an impact on the long-term



predictability of an implant therapy over time, since sites with an adequate peri-implant tissue volume seem to be less prone to brushing discomfort, plaque accumulation, peri-implant soft tissue inflammation,<sup>46</sup> impaired immunological reaction,<sup>47</sup> and to peri-implantitis.<sup>48</sup> A recent literature review, analyzing results of peri-implant tissue augmentation techniques, provided a decision tree, which served as a guide for clinicians to choose the most suitable treatment modality for various clinical situations.<sup>49</sup> In presence of an adequate thickness and height of KM: 1) If the vestibular bone thickness is  $>2$  mm, an implant may be placed; 2) If the bone is  $< 2$  mm, and: a) the bone defect is mild to moderate, implant placement and bone augmentation have to be done simultaneously; b) the bone defect is severe, bone augmentation is performed first, then, when optimal bone quantity and quality has been achieved, an implant is inserted. In presence of an inadequate thickness and height of KM, soft tissue augmentation must be done first, at the implant placement, or with the second-stage implant surgery, based on personal preference and professional experience. Moreover, if an inadequate thickness and height of KM are associated with a vestibular bone thickness  $< 2$  mm, a bone augmentation must always be carried out with soft tissue augmentation, before or during the implant placement surgery, based on personal preference and professional experience.

In the present report, in absence of an adequate thickness and height of KM, a simultaneous surgical approach at the implant placement time is proposed for peri-implant soft tissue augmentation, even though the vestibular bone thickness was  $< 2$  mm, without GBR. The ratio-

nale of this simultaneous approach without GBR is connected to the “biomimetic” features of the laser-microtextured surface, which provides an implant/abutment area for a physical connective tissue attachment and for and the epithelial downgrowth inhibition.<sup>35-37</sup> It is possible speculate that the coronal positioning and adaptation of the flap on the immediate healing abutment, beside allowing the preservation of the blood supply, might allow an early contact between the soft tissue and the laser-microtextured surface, and that the donor connective tissue might act as a biological barrier that prevents the apical migration of epithelial tissue. As is the case of natural teeth, in which collagen bundles insert into the root cementum, the laser-microtextured surface, while not analogous to the cemental surface of the natural teeth, might act by promoting the formation of a physical connective tissue attachment that restricts the downgrowth of epithelium. The preliminary radiographic results of the present study showed after 3 years of function, a stable marginal bone level around laser-microtextured implants treated with the surgical proposed approach, even in case of vestibular bone thickness  $< 1.5/2$  mm. These data seem to indicate that also in case of an inadequate vestibular bone thickness, additional bone grafting is not needed around a laser-microtextured implant/abutment, if an adequate soft tissue width and thickness is obtained. The present paper reported only a preliminary results of a ongoing study and described the surgical technique. For these reasons, final confirmation of findings and of related suggestions put forward in this paper will require longer periods of observation with an increased number of implants.

## CONCLUSIONS

Preliminary results of the present study suggested that, also in case of an inadequate vestibular bone thickness ( $< 1.5/2\text{mm}$ ), additional bone grafting is not needed around a laser-microtextured implant/abutment, if an adequate soft tissue width and thickness is obtained. ●

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### Disclosure

The authors report no conflicts of interest with anything in this article.

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