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Case Study

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STATIC NAVIGATION IN IMPLANT DENTISTRY: NEW LEARNING CURVE CASE REPORTS

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ABSTRACT

The minimal invasive surgery in implant dentistry uses advancements experienced in diagnostic techniques & specific surgical instruments to perform surgical procedure with less damage to soft & hard tissue. Minimal invasive surgery has lead to an increase in the degree of patient satisfaction and it has been suggested as an option for improvement of soft and hard tissue outcome. These case reports present implant placements using minimal invasive surgery with static navigation showing optimum result and minimal discomfort to patient.

KEYWORDS: static navigation, crestal bone loss; dental implants; flapless surgery.

INTRODUCTION

Replacing missing teeth with dental implants is highly predictable. However, achieving implant esthetics remains a challenge with respect to recreating a naturally appearing gingival margin and papilla.[1] Endosseous dental implants have become a dependable and predictable method of replacing missing teeth to enhance patients quality of life. Clinicians are striving to further improve the patient implant journey through minimizing the post surgical discomfort, maximizing aesthetics and improving the long term success of the implants.[2]

Over the past decade flap design for implant surgery has undergone number of changes, and the concept of implant placement without flap elevation and exposure of the bony tissues was introduced. The flapless surgical approach was introduced in the late 1970s by Ledermann to overcome the bone resorption process. Flapless implant surgery is one of these alterations that is quickly rising in popularity.[3]

According to the findings of various studies conducted on both people and animals, flapless implant surgery is regarded as a stable procedure that provides positive outcome.[3] The flapless technique uses rotary burs or a tissue punch to gain access to the bone without flap elevation so the vascular supply and surrounding soft tissue are well preserved. Advantage of this type of procedure includes less surgical trauma, shortened operative time, rapid post surgical healing, less damage to soft and hard tissue & high patient acceptance.[4]

The flapless implant placement using static navigation i.e. computer assisted virtual treatment planning and navigated placement can ensure appropriate implant angulation and depth for esthetic situations. A static system uses CT-generated computer – aided design and computer aided manufacturing to create stents, with metal tubes, and a surgical system that uses coordinated instrumentation to place implants using the guide stents. The implant position is dependent on the stent without the ability to change the implant position.[5]

These Case reports present with implant placement with a flapless surgical procedure using static navigation with minimal discomfort to the patient and a good esthetic outcome.

CASE REPORTS

Case 1: Guided immediate implant placement

A 42 year old male patient reported to the department of Periodontics and oral implantology of Pandit Deendayal Upadhyay Dental College and Hospital, Solapur with a chief complaint of discolored & fractured tooth in the upper front region of the jaw since 2 years and wanted its replacement. There was no relevant medical history. Intra oral examination revealed ellis class III fracture and discoloration with 21 (Fig.1). Radiographic examination revealed non healing periapical lesion with 21. Upon endodontic consultation, the tooth had poor prognosis and was advised for extraction.

Treatment options of either immediate implant placement or delayed implant placement, or fixed partial denture were explained to the patient along with advantages and

disadvantages of each. The patient decided to go with immediate implant placement.

Primary impression was made with irreversible hydrocolloid impression material and diagnostic cast was poured with Type III dental stone (Gyprock India Pvt. Ltd). Preoperative CBCT (Cone Beam Computed Tomography) scans were examined and it showed sufficient width (7.10mm) and height (19.10mm) (fig. 2), using static navigation (Irays software) virtual tooth planning was created (Seven internal hex D4.2 L13.0 SP) (Fig. 3), and it was decided to place a standard sized diameter root form implant (4.2*10mm, MIS Dental implant system Ltd, Israel). The surgical guide was planned using parameters that coincided with the MIS guided kit drills. The surgical guide was fabricated using stereolithography (3D layering/ printing) (Fig.4).

After the sterilization process, the surgical field was prepared and disinfected by asking patient to gargle with Betadine mouthwash (Povidine iodine solution I.P. Abbott health care Pvt. Ltd) The area was anesthetized using 2% lidocaine hydrochloride with epinephrine (1:2,00,000). A minimally traumatic extraction of the tooth was performed without flap elevation (fig. 5). The extraction socket was debrided and irrigated with metronidazole, the surgical guide was placed at the operating site and checked for its stability (Fig. 6) Osteotomy preparation was done with sequence of drills to the required diameter to receive the appropriate implant. After that 4.2*13mm size implant was placed into the osteotomy site (fig. 7) and radiograph taken immediately after implant placement (fig. 8), Gingival former was placed on the same day of surgery (fig. 9) and radiograph taken after gingival former placement (fig. 10) Suturing was not required.

Postsurgical instructions were explained to patient and antibiotics and analgesics prescribed for 5 days along with 0.12% chlorhexidine mouth rinse for 1 week to maintain good oral hygiene. The patient was recalled after 1 week for follow up to check for any sort of discomfort, and There was no pain, swelling and discomfort experienced, wound healing was checked using wound healing index by Huang et.al.[6]

After healing period of 12 weeks follow up was taken. Soft tissue changes showed good architecture around gingival former and on removing the gingival former a smooth healthy gingival cuff was found to have formed around it.(fig. 11). The impression post was placed and a definitive impression was taken with Polyvinyl Siloxane Impression material (Zhermack zetaplus, India Pvt. Ltd.) using open tray technique. The final cement retained prosthesis was delivered within 1 week with good esthetic and functional results (fig. 12).

Fig. 1: (Pre operative clinical view).

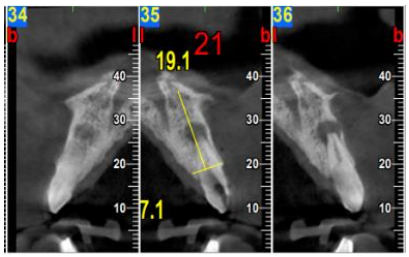

Fig. 2: (Pre Operative CBCT).

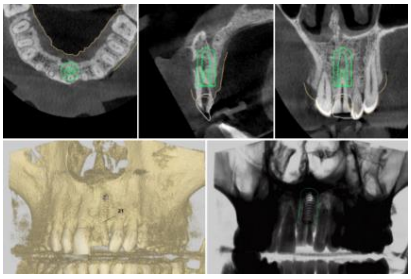

Fig. 3: (Virtual implant planning).

Fig. 4: (Surgical guide).

Fig. 5: (Atraumatic extraction with respect to 21).

Fig. 6: (Checked fitting and stability of surgical guide).

Fig. 7: (4.2*13mm Implant placement).

Fig. 8: (Radiograph after implant placement).

Fig. 9: (Gingival former placement).

Fig. 10: (Radiograph after gingival former placement).

Fig. 11: (Gingival cuff).

Fig. 12: (Cement retained Prosthesis with respect to 21).

Case 2: Guided flapless implant placement

A 31year old female patient reported to the department of Periodontics and oral implantology of Pandit Deendayal Upadhyay Dental College and Hospital, Solapur with a chief complaint of missing tooth in the lower right back region of the jaw since 2 years and wanted to get it replacement. There was no relevant medical history. Intra oral examination revealed missing tooth (46) which was extracted 2 years back due to caries.(Fig.13).

Treatment options of delayed implant placement, or fixed partial denture were explained to the patient along with advantages and disadvantages of each treatment option. The patient decided to go with delayed implant placement as this was more predictable and conservative to the teeth.

Primary impression was made with irreversible hydrocolloid impression material and diagnostic cast was poured with Type III dental stone (Gyprock India Pvt. Ltd). Preoperative CBCT scans were examined and it showed sufficient width (7.00mm) and height (11.09mm) (fig. 14), using static navigation (Irays software) virtual tooth replacing the missing tooth was created (Seven internal hex D4.2 L10.0 SP) (Fig. 15), and it was decided to place a standard sized diameter root form implant (4.2*10mm, MIS Dental implant system Ltd, Israel). The surgical guide was planned using parameters that coincided with the MIS guided kit drills. The surgical guide was fabricated using stereolithography (3D layering/ printing) (Fig.16).

After the sterilization process, the surgical field was prepared and disinfected by asking patient to gargle with Betadine mouthwash (Povidine iodine solution I.P. Abbott health care Pvt. Ltd) The area was anesthetized using 2% lidocaine hydrochloride with epinephrine (1:2,00,000). The surgical guide was placed at the operating site and checked for its stability (fig. 17). Surgical guide was placed at the operating site, soft tissue was removed with the help of tissue punch through the surgical guide to facilitate the access for osteotomy preparation (fig. 18). Osteotomy preparation was done with sequence of drills to the required diameter to receive the appropriate implant. After that the 4.2*10mm size implant was placed into the osteotomy site (fig. 19) and Gingival former was placed on the same day of surgery (fig. 20) and radiograph taken (fig. 21). Suturing was not required. Postsurgical instructions were explained to patient and antibiotics and analgesics prescribed for 5 days along with 0.12% chlorhexidine

mouth rinse for 1 week to maintain good oral hygiene. The patient was recalled after 1 week for follow up to examine the soft tissue (fig. 22) and to check any sort of discomfort, and there was no pain, swelling and discomfort experienced, wound healing was checked using wound healing index by Huang et.al.[6] Post operative CBCT taken after 1 week to check hard tissue changes (fig. 23).

After healing period of 12 weeks repeat follow up was taken to evaluate the soft tissue (fig. 24) and CBCT to evaluate hard tissue changes(fig. 25). There was good soft tissue healing around the gingival former and no bone loss around the implant, On removing the gingival former a smooth healthy gingival cuff was found to have formed around it(fig. 26). The impression post was placed and a definitive impression was taken with Polyvinyl Siloxane Impression material (Zhermack zetaplus, India Pvt. Ltd.) using open tray technique. The final cement retained prosthesis was delivered within 1 week with good esthetic and functional results (fig. 27).

Fig. 13: Pre Operative.

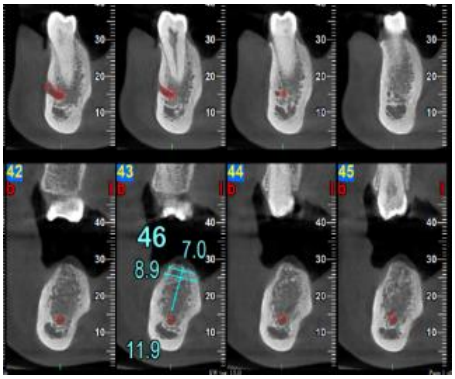

Fig. 14: Pre Operative CBCT.

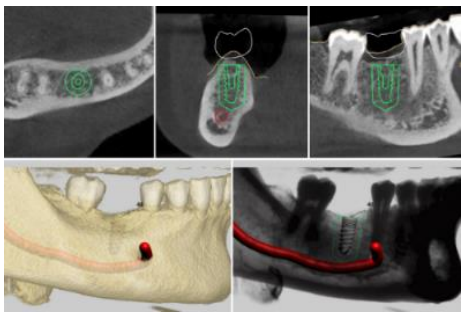

Fig. 15: Virtual implant placement planning.

Fig. 16: Surgical Guide.

Fig. 17: Checked fitting and stability of surgical guide.

Fig. 18: soft tissue was removal with the help of tissue punch.

Fig. 19: 4.2*10mm size implant placement.

Fig. 20: Gingival former placement.

Fig. 21: Radiograph taken after gingival former placement.

Fig. 22: Follow up after 1 week.

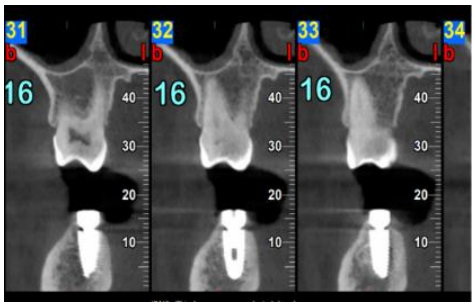

Fig. 23: Post Operative CBCT after 1 week.

Fig. 24: Follow up after 12 week.

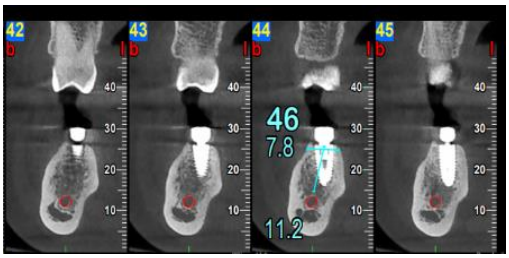

Fig. 25: Post Operative CBCT after 12 week.

Fig. 26: Gingival Cuff.

Fig. 27: Cement retained prosthesis with respect to 46.

Case 3: Surgically guided open flap implant placement

A 22 year old male patient reported to the department of Periodontics and oral implantology of Pandit Deendayal Upadhyay Dental College and Hospital, Solapur with a chief complaint of missing tooth in the lower right back region of the jaw since 3 year and wanted to get it replacement. There was no relevant medical history. Intra oral examination revealed missing tooth.[46] which was extracted 3 years back due to caries (fig.28).

Treatment options of delayed implant placement, or fixed partial denture were explained to the patient along with advantages and disadvantages of each treatment option. The patient decided to go with delayed implant placement as this was more predictable and conservative to the teeth.

Primary impression was made with irreversible hydrocolloid impression material and diagnostic cast was poured with Type III dental stone (Gyprock India Pvt. Ltd). Preoperative CBCT scans were examined and it showed sufficient width (4.60mm) and height (16.00mm) (fig. 29), using static navigation (Irays software) virtual tooth replacing the missing tooth was created (Seven internal hex D3.75 L10.0 SP) (Fig. 30), and it was decided to place a standard sized diameter root form implant (3.75*10mm, MIS Dental implant system Ltd, Israel). The surgical guide was planned using parameters that coincided with the MIS guided kit drills. The surgical guide was fabricated using stereolithography (3D layering/ printing) (Fig. 31).

After the sterilization process, the surgical field was prepared and disinfected by asking patient to gargle with Betadine mouthwash (Povidine iodine solution I.P. Abbott health care Pvt. Ltd) The area was anesthetized

using 2% lidocaine hydrochloride with epinephrine (1:2,00,000). Mid crestal incision was given and full thickness flap reflected (fig. 32). The surgical guide was placed at the operating site and checked for its stability (fig. 33). Surgical guide was placed at the operating site and osteotomy preparation was done with sequence of drills to the required diameter to receive the appropriate implant. After that the 3.75*10mm size implant was placed into the osteotomy site and Gingival former was placed on the same day of surgery and radiograph taken (fig. 34). Flap was reapproximated and suturing was done using 4-0 silk suture. Postsurgical instructions were explained to patient and an antibiotics and analgesics prescribed for 5 days along with 0.12% chlorhexidine mouth rinse for 1 week to maintain good oral hygine. The patient was recalled after 1 week for follow up (fig. 35) to check any sort of discomfort. There was uneventful healing of the soft tissue, wound healing was checked using wound healing index by Huang et.al.[6] Post operative CBCT after 1 week was taken to check the hard tissue changes (fig. 36).

After healing period of 12 weeks repeat follow up taken to evaluate soft changes(fig. 37) and CBCT to evaluate hard tissue changes (fig. 38), there was good soft tissue healing around gingival former and minimal bone loss around the implant, on removing the gingival former a smooth healthy gingival cuff was found to have formed around it(fig. 39). The impression post was placed and a definitive impression was taken with Polyvinyl Siloxane Impression material (Zhermack zetaplus, India Pvt. Ltd.) using open tray technique. The final cement retained prosthesis was delivered within 1 week with good esthetic and functional results (fig. 40).

Fig. 28: Preoperative image.

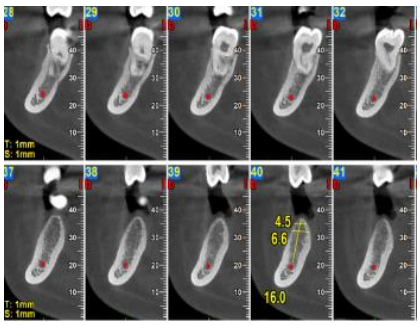

Fig. 29: Preoperative CBCT.

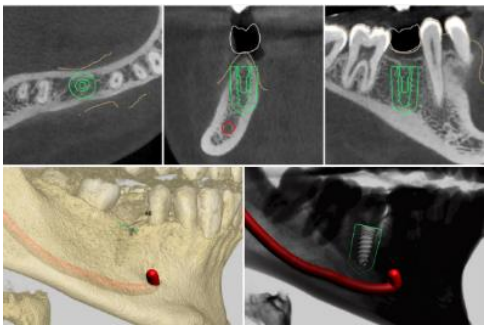

Fig. 30: Virtual implant placement planning.

Fig. 31: Surgical guide.

Fig. 32: Flap reflection.

Fig. 33: Checked fitting and stability of surgical guide.

Fig. 34: Radiograph of gingival former & implant placement.

Fig. 35: Follow up after 1 week.

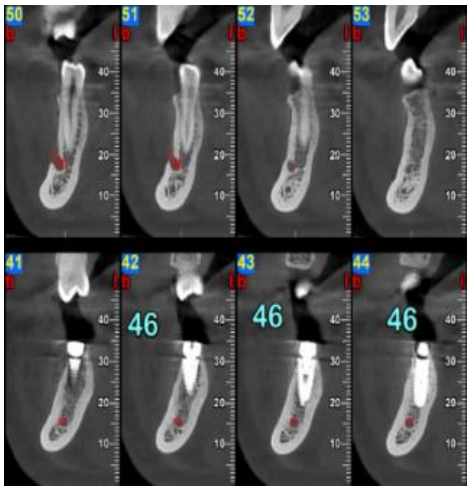

Fig. 36: Post Operative CBCT after 1 week.

Fig. 37: Follow up after 12 week.

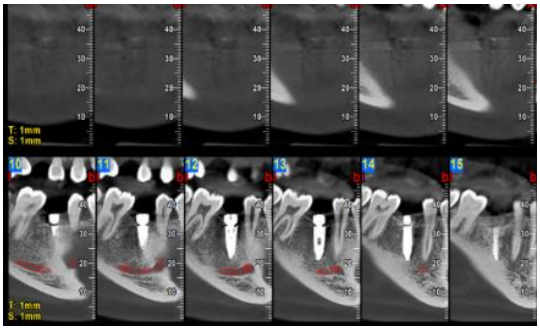

Fig. 38: Post Operative CBCT after 12 week.

Fig. 39: Gingival Cuff.

Fig. 40: Cement retained prosthesis with respect to 46.

DISCUSSION

The advantage and increasing popularity of guided flapless implantation resulted in a considerable number of clinical studies which mainly investigated clinical and radiographic parameters. The purpose of the present case report was to evaluate the efficacy and accuracy of static navigation in various cases.

Digital dental workflows can optimize the process, providing valuable diagnostic information and facilitating backward planning to improve safety and efficiency, which contribute to a more predictable outcome. Several systematic reviews have reported that static surgical guides reproduce the digitally planned position of the implant with adequate levels of accuracy.[7]

The use of CT imaging enhances the correlation between implant planning and actual implant placement compared to conventional radiographic methods.[8] The introduction of computer -aided manufacturing (CAM) of anatomic

models and surgical guides generated from computer-aided design (CAD) images has allowed the accurate transfer of planning information to implant placement. For implant planning and placement, the association of CAD and CAM techniques provides some advantages with regard to the 3D determination of the subject's jaw anatomy and fabrication of anatomic models and surgical guides.[9]

Immediate implant placement has become popular technique to replace the hopeless teeth, but immediate implants are more at risk for failure than implants placed in mature bone has received increasing attention in the previous years. At the beginning of the century, a review of immediate placement of single-tooth implants by Vignoletti and Sanz (2014) concluded that immediate placement, even with grafting procedures, is still not fully validated with no clear evidence of consistent clinical outcomes. These authors also mentioned some important factors that must be taken into account in order to achieve a successful outcome when placing immediate implants, including: 1) Substantial thickness and integrity of socket walls; 2) Adequate vertical and horizontal position of the implant; 3) Gingival thickness and integrity and 4) Patient factors such as hygiene and smoking.[10]

Cosyn et.al. showed that immediate implant placement had a higher risk than delayed procedure for early implant failure due to a lack of osseointegration.[11]

In order to overcome issues and achieve better long-term results, different technologies have been developed for the placement of implants. One of the most globally accepted methods is the use of digitally designed surgical guides. To achieve the ideal implant positioning use of 3D printing surgical guide for placement of immediate implant is gaining popularity to become an alternative technique for guiding the placement of immediate implant.[12]

Minimally invasive guided flapless implant surgery offers advantages over the conventional flap access approach. There may be minimized bleeding, decreased surgical times, minimal patient discomfort, high patient acceptance, minimal alveolar bone loss, good soft tissue outcome and no suturing needed.

Flapless surgery prevents the reflection of soft tissues reducing the surgical trauma. As a result, the necessary process of healing of the wound is minimal, with an absence of scar and its typical complications of conventional surgery as the dehiscence of the flap. The absence of suture in the majority of cases contributes equally to the best postoperative appearance of the surgical area.[13]

As in the flapless technique it implies only a essential orifice on the mucosa in the flapless technique, blood supply is hardly affected compared to what takes place in surgeries with large flaps which are forced to be designed broad-based in order to avoid flap necrosis.[13] It should be recalled that the vascularization of the underlying bone is determined by three essential sources: major supra-periosteum vessels, vascular plexus of the periodontal ligament, and the vessels of the alveolar bone. With the absence of a tooth, the flap reflection entails a loss of the blood supply of the supra periosteum vessels, so the bone vascularization depends upon its own vessels, which is a poor blood source in the case of cortical bone. This will imply a certain level of bone resorption during healing in cases that occur with a mucoperiosteum flap reflection.[14]

Several studies corroborate that bone resorption that follows flap surgery causes a decrease of the vascularization threatening the final aesthetic results. Thus, Kim in 2009 conducted study in dogs that in areas where flapless implant placed resulted much richer vascularization than the area in conventional flap surgery.[15]

Jeong and cols in 2007 published a comparative study in dogs about socket healing after the insertion of an implant with or without flap, showing that sites with flapless technique showed a higher-osseointegration (greater contact bone implant-BIC) and less peri-implant bone loss, which was measured by greater crestal bone height in these implants.[16]

Studies affirm that a digitally guided positioning is related to a correct management of interdental spaces, thus facilitating optimal oral hygiene.[17,18]

You et al. 2009[19] repeated the previous model, finding three months after the implant surgery that the flapless technique could reduce gingival inflammation, reduce the height of the junctional epithelium and reduce the bone loss.

As noted from the revision of the scientific evidence, flapless technique presents certain limitations as well, the lack of flap reflection and the small diameter of mucous opening make a minimal surgery field exist, thus the vision is very limited, hindering the correct view of cortical bone, the form of the crest or the concavities. Which may give rise to complications such as fenestration of cortical, bad implant placing and its bad angulation. As a consequence of all this, it will be fundamental to make a correct previous diagnosis, both clinical and radiological, as well as a proper surgery planning in order to prevent improvisations and intra operatory complications.[14,20]

Apart from decreasing the timing needed for the planning and the surgical procedures, a complete digital workflow allows an appropriate control of the surgical steps that favors an optimal end result, allowing the one-stage plan of surgical as well as prosthetic rehabilitation.[21]

Lambert et al.[22] highlight how surgeons who had positioned less than 50 implants had a double failure rate compared to more expert surgeons. One possible explanation for the poor outcome of implants placed by inexperienced surgeons is the frequency of problems such as excessive heat during drilling, failure to stabilize the implant, lack of adequate planning. Therefore, a digitally planned guidance could improve the outcomes of less expert surgeons reducing possible problems, mostly in cases of treatment with multiple implants. In a recent study conducted on maxillary models, the accuracy of freehand implant surgery performed by an experienced operator was compared to static guided implant surgery performed by an inexperienced operator: at the apex of the implant, the accuracy of implant placement using a surgical guide was significantly higher than that of free-hand implantation. The mean difference between the planned and actual implant positions at the apex was 0.68 mm for the experienced group using the freehand technique and 0.14 mm for the non-experienced group using the surgical guide technique.

In the present case reports digital planning allowed to evaluate the quality of the bone and the length of the implants that needed to be positioned. The advantages of the surgical guide was to execute the implant placement in a more conservative way. The effective outcome of the prosthetic rehabilitation confirms the accuracy of the diagnostic-therapeutic course that was followed and the digital approach allowed for the surgery to be performed in a minimally invasive way, thus minimizing surgical time, it gives high patient satisfaction & less discomfort to the patient.

CONCLUSION

The new developments and technologies in implant dentistry such as digital impression, real time navigation, merging of radiographic and clinical data have a positive impact on guided surgery. In this article case reports of immediate implant placement, guided flapless and guided open flap access for implant placement using static navigation were presented. The benefit of this procedure was improved patient comfort, minimal bleeding, less post operative pain, and good soft tissue healing, minimal changes in crestal bone loss with good implant stability.

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