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# EVALUATION OF COMPUTER ASSISTED SURGICAL GUIDE IN PRESERVING INFERIOR ALVEOLAR NERVE DURING HARVESTING BONE GRAFT

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### *ABSTRACT*

This prospective case series study aimed to evaluate the accuracy of computer assisted surgical guide in preserving inferior alveolar nerve during harvesting bone graft. The study's variables included the precision of CBCT scans to identify the position of IAN and their distance away from the autogenous bone graft and the amount of bone available over IAN at external oblique ridge (EOR). The study included six patients with alveolar ridge deficiency that required alveolar ridge augmentation. The surgical guides were properly seated in all patients, except in one patient, in which the guide needed adjustment using stone bur to get well seated and the surgical procedure was completed as usual. The mean harvesting time for all the cases was 17.3 ± 4.1 minutes. The postoperative neurosensory function of the IAN was evaluated based on subjective and objective tests. Using sharp/blunt discrimination test, light touch test and VAS, it was found that all patients (100.0%) had normal sensation from the first week.

**KEYWORDS:** Inferior Alveolar Nerve, Bone Graft; Computer Surgical Guide.

## INTRODUCTION

Augmentation with bone grafts is one of the most common surgical techniques in oral and maxillofacial surgery to repair the congenital or acquired alveolar defects. All grafts require an adequate blood supply, osteogenic cells supplied and mechanical support, by the host, graft material, or both (Paul N et al., 2022). Autogenous bone grafting involves bone obtained from the same individual receiving the graft. An autogenous bone increases the efficacy of the bone grafting procedures due to its biologically active proteins, growth factors, and applicable osteogenic cells to the recipient site (Tolstunov L et al., 2019). Also autogenous bone grafts are characterized by high biocompatibility, regenerative potential, osteo-conductive, osteo-inductive and osteogenic properties, minimal risk of allergic or immune responses, resistance to infections and less risk of graft rejection as the graft is originated from the patient's body (Kloss F et al.,2018).

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An autogenous bone graft site can be extra oral or intra oral. Intraoral donor sites in the mandible include mandibular symphysis, retromolar region (ramus), edentulous sites, or lingual exostosis. These regions are suitable for corticocancellous bone grafts (Chiapasco M et al., 2018).

One of the most complicating factors in harvesting the autogenous bone graft from retromolar area is inferior alveolar nerve (IAN) impairment resulting in postoperative numbness of the lower lip and chin. Certainly, the best way to minimize the complication rate of the harvesting autogenous bone graft is achieved by careful surgical planning, delicate technique, and readiness ability to identify and treat the complications when they occur through using several imaging modalities such as; panoramic radiographs, conventional computed tomography and CBCT. So, computer-assisted planning has recently advanced safety in the harvesting surgeries of intraoral autogenous bone graft (Batbold D et al., 2020).

The surgical guide is a small customized tool made from a sterilizable material that guides saw and/or drill in the planned position and transfer this plan to the actual procedure. So, they provide accurate surgical resections or osteotomies based on preoperative imaging. The surgical guide fits exactly on a predetermined part of the patient's bone (Khalil R et al., 2020). Laverty D et al., 2018 suggested the use of virtual planning and fabricating CAD/CAM surgical guides from the planning; provide sufficient information related to proper cutting plans, maintain the IAN integrity, and accurately translate the diagnostic information from pre surgical diagnostic work-up, so the surgery is more expectant and less stressful. Finally, it could be used to clearly explain the surgical procedures (Atef M and Mohamed A, 2018). Therefore, the study's aim was to evaluate the accuracy of computer assisted surgical guide in preserving inferior alveolar nerve during harvesting bone graft.

## MATERIAL AND METHODS

### Study Design

This prospective case series study involved six patients with alveolar ridge deficiency that required alveolar ridge augmentation. The patients were chosen from the Oral and Maxillofacial Surgery Department's Outpatient Clinic at the Faculty of Oral and Dental Medicine for Girls at Al-Azhar University and Al-Zahraa University Educational Hospital in Egypt. The study was approval by Al-Azhar Faculty of Oral and Dental Medicine for Girls' ethical committee. All treatment procedures, indications, goals, risks, benefits, side effects, options, and the favorable outcomes were explained for all patients and informed consents had been signed.

### Inclusion and Exclusion Criteria

Patients were enrolled in the study if they had alveolar ridge deficiency with sufficient bone at retromolar area (donor site). Medically compromised patients with medical conditions that prevented the bone healing, were excluded.

### Study Variables

The precision with which CBCT scans identified the position of IAN and their distance away from the autogenous bone graft and the amount of bone available over IAN at external oblique ridge (EOR) were the study's predicted variable. The primary outcome variables were: 1) the accuracy of setting of surgical guide, 2) the postoperative neurosensory evaluation.

### Preoperative Planning and Simulation for Computer Assisted surgical guide

The patients were submitted to full arch impression which was made with impression material; irreversible hydrocolloid (Alginate) impression material; and pre-operative maxillofacial CBCT scans. The DICOM files of the CBCT were imported onto 3 Diagnosys software (Version 4.2, 3Diemme, Italy) which enables virtual diagnosis, surgical planning, preoperative segmentation, and digital tracing the inferior alveolar nerve. Dental cast was poured from the impression then the stone model of the patient scanned using an optical table top scanner (open technologies, Brescia, Italy), the optical scan of the cast was registered to the CBCT using the teeth as common landmarks in both images, and saved as a Standard Triangle Language (STL) format.

By using the software tools, the bone of the jaw was segmented to remove any unwanted parts of the image (to get rid of any CBCT artifacts). The teeth with artifacts from CBCT were removed, the gingival part of the cast was removed & merging was performed between bone from CBCT & teeth from the cast without the gingiva at the area of operation. Then threshold was adjusted to choose the density for exporting as STL file later.

The whole project was then exported as STL including the cast, the bone and inferior alveolar canal. After planning, the simulation of data was introduced into Plastycad software (version4.2, 3Diemme, Italy) to design the surgical guide which has suitable window with the inferior side of the guide being above the inferior alveolar canal by 2mm. The design was then saved and converted into STL format for printing (Figure 1).

### Surgical Procedures

All patients underwent surgery with local anesthesia, a mucoperiosteal flap was reflected to expose the mandibular body at retromolar area to gain access to the harvesting bone. The pre-fabricated surgical guide stent was placed, making sure the stent was fully seated before surgical osteotomies were performed. The osteotomies were carried out with an osteotomy kit for Piezotome (Variosurg.3 NSK Company Japan) using cutting tips (USN2, USN1R, USN1L) according the preoperative planning.

After that the guide was removed and the marked cortical plates were separated from the underlining medulla using bibeveled chisel placed at the superior cut and gentle malleting to allow its separation completely to harvesting the bone block (Figure 2). Finally, the donor site wound was closed using 3-0 Vicryl tension free sutures and grafting procedures were started.

### Postoperative evaluation

The following clinical neurosensory tests were done to assessment of sensory function of IAN, and the patients were asked to close their eyes while the tests were performed.

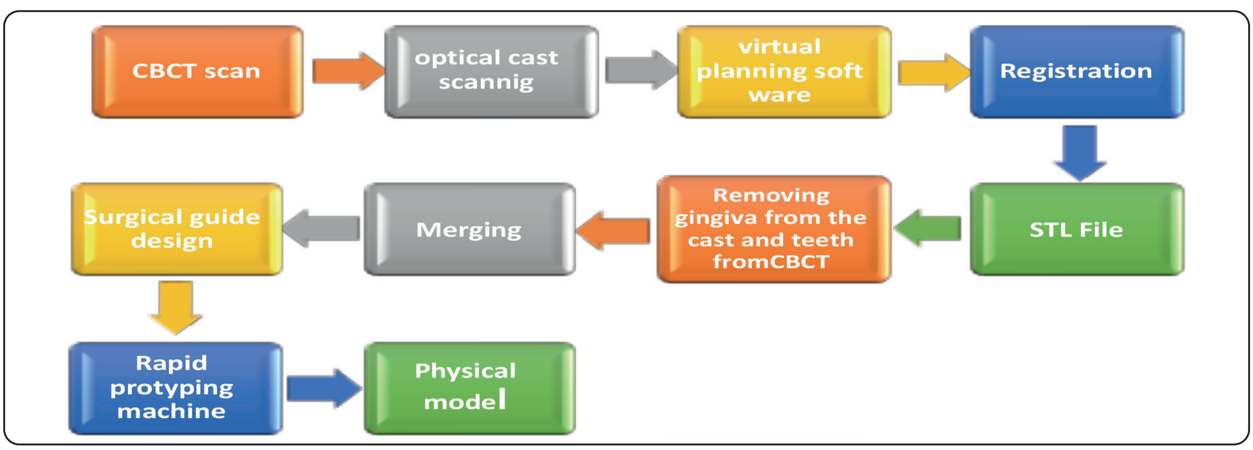


Fig. (1): Schematic diagram showing step-by-step sequence to fabricate the surgical guide.

Fig. (2): Intra operative clinical photograph demonstrating osteotomy with guide seated on the buccal side of EOR using piezoelectric surgical plate.

### Patient Questionnaire (PQ)

A score was given from 0 to 100 based on visual analogue scale (VAS); in order to examine subjective symptoms and discomfort related to sensory alterations within the area supplied by the IAN. Each patient was specifically asked if there was any difference in sensation of lower lip or chin between operated and un-operated sides. The patients rated their discomfort according to the following scores: score 0-20 (total loss of feeling or sensation); score 20-40 (abnormal sensation which is unpleasant); score 40-60 (abnormal sensation that is not unpleasant); score 60-80 (increase or decrease sensitivity to stimulation) and score 80-100 (normal sensation).

### Sharp/blunt discrimination

In this test, a dental probe with sharp tip and blunt handle was applied to the skin over the chin region and the patients were asked whether the stimulus was sharp or blunt (Figure 3A).

### Light Touch (LT) Test

It is done by gently touching (tactile stimulation) the skin and evaluating detection the threshold of the patient using cotton stick. The stimulus was randomly applied to the test sites during 1 of 2 intervals which were 10 seconds apart (Figure 3B)

### Statistical Analysis

All test data was converted and manipulated by using SPSS software program version 25 (SPSS Inc., Chicago, IL, USA). The data, the mean± standard deviation (SD), range, and percentages were determined. P-values less than 0.5 were considered statistically significant. One way ANOVA test was used to analyze and compare the study's results. Comparison across time in VAS was done using Friedman test for non-parametric data.

## RESULTS

### Patients' Demographic Features

The study included six patients who had alveolar bone defects that were selected for alveolar bone

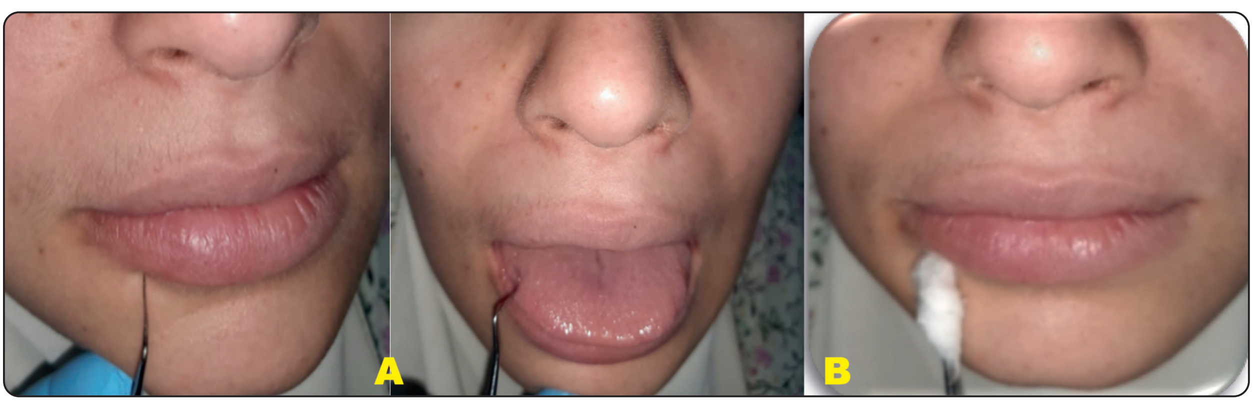


Fig. (3): Photographs demonstrating clinical neurosensory tests: (A) sharp/blunt discrimination test; (B) Light touch test (LT).

augmentation. There was a 83.3 percent female predominance. The patients' average age was 26.17 ± 5.0 years, with a range between 19- 33 years (Table 1).

***Intra-operative clinical result***

The surgical guides were properly seated in all patients, except in one patient, in which the guide needed adjustment using stone bur to get well seated and the surgical procedure was completed as usual. The mean harvesting time for all the cases was 17.3 ± 4.1 minutes.

## Post-operative clinical observation

No postoperative infections were recorded, and the intraoral incisions healed without any complication. The postoperative neurosensory function of the IAN was evaluated based on subjective and objective tests. Using sharp/blunt discrimination test, light touch test and VAS, it was found that all patients (100.0%) had normal sensation from the first week (Table 2).

TABLE (1): Descriptive statistics of the demographic data

| Parameters | Descriptive Statistics |
|---|---|
| **Age (years):** | |
| • Mean ± SD | 26.17 ± 5.0 |
| • Range | 19 – 33 |
| **Gender :** | |
| • Male | 1 (16.7%) |
| • Female | 5 (83.3%) |

***SD: Standard Deviation***

TABLE (2) Descriptive statistics of postoperative clinical result regarding sensory function examination of IAN 20-40 (Abnormal Unpleasant Sensation); 60-80 (Decrease Sensitivity to Stimulation); 80-100 (Normal Sensation).

| Type of tests | Time of follow up examination | Sensation | Patients(6) |
|---|---|---|---|
| **Sharp/blunt discrimination test** | At first week | Normal<br>Abnormal | 6 100%<br>0 % |
| | At third week | Normal<br>Abnormal | 6 100%<br>0% |
| | At third month &sixth month | Normal<br>Abnormal | 6 100%<br>0% |
| **Light touch test** | At first week | Normal<br>Abnormal | 6 100%<br>0% |
| | At third week | Normal<br>Abnormal | 6 100%<br>0% |
| | At third month &sixth month | Normal<br>Abnormal | 6 100%<br>0% |
| **VAS** | At first week | 40-20<br>80-60<br>100-80 | 0%<br>0%<br>6 100% |
| | At third week | 80-60<br>100-80 | 0%<br>6 100% |
| | At third month &sixth month | 100-80 | 6 100.0% |

## DISCUSSION

Autogenous intraoral bone graft was chosen, as it is considered the most favorable donor site for intraoral bone augmentation procedures. It avoids cutaneous scar formation and eliminates the need for two distinct surgical sites with its possible complications. Moreover, it is more comfortable for the patient and makes the follow up more easily and the avoidance of the need to general anesthesia more possible (Kamal M et al., 2018). One of the serious complications reported with intraoral harvesting bone graft at retromolar area is IAN injury in the form of cutting, tearing, or laceration of the IAN (Corbella S et al., 2017). Therefore, the purpose of this prospective study was to evaluate the effectiveness of preoperative CAD-CAM technology in overcoming the possibility of IAN injury during bone graft harvesting.

Several studies attempted to provide parameters for a safe-zone for surgical procedures in the mandibular ramus region. It was reported that the bone adjacent to the inferior alveolar nerve toward the buccal cortex was thickest in retromolar region of the mandible with a mean dimension of 5.95 mm (Freire-Maia B et al., 2017). Similar results were obtained in our study; when calculating the distance to the nerve from the outer cortex of the mandible to the inferior alveolar canal was done (6.35 ± 0.7mm).

Customized 3D-printed surgical guide was used to outlined the osteotomies for bone grafting and reduce the risk of IAN injury during cutting through the cortical bone. In this study, all patients (100.0%) had normal sensation from the first week, these results demonstrated that the CAS guides were superior in preserving the IAN during bone graft harvesting. This correlation is in agreement with De Stavola L, et al 2017.

The customized surgical cutting guides were designed to have tooth and bone supported to avoid the possibility of stent misfit over the bone. They were positioned easily enabling an unequivocal insertion, this was consistent with Atef M and Mohamed A, 2018. In the present study, all guides were easily placed in their sites, except one guide which needed some adjustment to be well seated. They were stable with adequate retention on the bony surfaces, and they safely guided all the osteotomies. This finding was supported by other authors who found that CAS provided sufficient information regarding the proper cutting planes, maintaining the IAN integrity and significantly reducing the incidence of complications (Laverty D et al., 2018).

In conclusion, according to the study's findings, the use of CAS in harvested bone from EOR and the surgical guides enable the surgeons to perform preoperative planning and identify the safety margins between the mandibular canal and osteotomy. This saves the vital structures (IAN) and minimizes intra and postoperative complications.

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