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PIEZOSURGERY ASSISTED INFERIOR ALVEOLAR NERVE TRANSPOSITION AND SIMULTANEOUS IMPLANT PLACEMENT FOR MANAGEMENT OF VERTICAL MANDIBULAR RIDGE DISCREPENCIES

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ABSTRACT

Inferior alveolar nerve (IAN) mobilization for patients suffering from severe vertical bone loss is a viable treatment option However, the technique has been used for over 20 years, it has the potential for postsurgical neurosensory changes. The aim of this study was to evaluate the piezoelectric assisted IAN lateralization and simultaneous implant placement in resorbed mandibular posterior ridges.

Material and methods: Ten patients with posterior mandibular ridge atrophy in need for (IAN) lateralization and immediate implant placement were selected to participate within this study.

Results: The pin tactile discrimination test showed normal sensory function of the inferior alveolar nerve from the 3rd months postoperative (100%) in all patients, Unlike the two-point discrimination test where the inferior alveolar nerve function was (25%) at the 3rd month postoperative then increased to be (50%) at the 6th month postoperative. Implant stability quotient (ISQ) mean values were discovered to be statistically significant increasing immediately postoperative, 3 and 6 months later in all implants. Finally, there was an increase in bone density around the installed implant.

Conclusion: Although the current surgical modality is a technique sensitive, it may be a less risky procedure through the proper preoperative CBCT planning and the use of piezoelectric surgical device.

KEYWORDS: IAN buccal transposition, Inferior alveolar nerve (IAN) lateralization, immediate implant, neurosensory disturbance.

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INTRODUCTION

For the past two decades, dental implant therapy has been the treatment of choice for edentulous mandibles; as a result, a variety of surgical procedures have been developed to address the lack of bone height in the severely atrophic posterior mandible to avoid IAN damage. The lateral mobilization of the IAN, alveolar distraction, autogenous bone grafts onlay or inlay, guided bone regeneration using barrier membranes, and short implants are some of these options. When the bone height above the IAN canal is less than 5 mm and the inter-arch space is insufficient to accommodate onlay bone grafts, the only choice for rehabilitating patients with Osseointegrated implants is lateral nerve mobilization. [1-3]

IAN displacement has been employed for almost 20 years with a high rate of success and survival. It is, however, a difficult technique with a substantial chance of sensory disruption. Despite the risks, the lateralization technique has some advantages over other treatments, including a shorter surgical time, lower costs, and the option to use longer implants for bicortical anchorage, improved primary stability, and a biomechanically beneficial crown-Implant relationship. (Barbu et al. 2014) [3,4].

Repositioning of the inferior alveolar nerve is done through its lateralization or transposition by the aid of a Piezotome that uses piezoelectric vibrations to cut bone tissue while soft tissue is preserved. Tomaso Vercellotti invented the method, which has now been patented. It's safe to use in oral, maxillofacial, cranial, and spinal surgery. It is feasible to cut hard tissue while keeping soft tissue unaffected [5, 6].

The lateralization technique for the inferior alveolar nerve (LIAN) enables for the placement of implants to rectify or shift them closer to the ideal location, allowing for a better direct vision during surgery. Unlike reconstruction implants implanted in the region with grafts, the implant is encased in a better-quality bone by using the higher cortical and basal bodies of the jaw. In comparison to graft-based reconstruction, the lateralization procedure does not require donor areas, which reduces patient morbidity, lowers costs, allows for the immediate placement of long implants (because all of the remaining jawbone is used), and avoids patients waiting six to eight months for treatment. [7].

The danger of postsurgical neurosensory abnormalities, including irreparable nerve damage and functional implications, is a significant drawback. This may also involve neurosensory problems such as anesthesia, paresthesia, hypoesthesia, tingling, and burning sensations, but is not restricted to them.[8]

This study focused on the effectiveness of the use of piezoelectric surgery in IAN buccal transposition for single stage management of vertically compromised alveolar bone.

MATERIALS AND METHODS

This study was carried out as a prospective clinical trial in which 10 patients were chosen and operated under general anesthesia at the Oral and Maxillofacial surgery department, Faculty of Dentistry, Alexandria university. The university's ethical committee granted the necessary ethical approval. The nature of the study was explained to each patient, who signed their informed consent. All procedures used in studies involving human subjects complied with the institutional and/or national research committee's ethical requirements, as well as the 1964 Helsinki Declaration and its subsequent revisions or comparable ethical standards.

Patients were assigned to our study and were selected properly according to the following inclusion criteria; both genders and age ranging between 30 and 50 years old presented with mandibular edentulous posterior alveolar bone willing to restore their lost teeth by implants. The remaining vertical height measured from the crest of the ridge till the inferior alveolar nerve was less than 8mm, interarch distance of less than 6mm and with at least 5mm of bone width to accommodate single stage implants following IAN buccal transposition.

On the other hand, exclusion criteria included patients unfit for general anesthesia, patients with vitamin D levels less than 12 ng/ml and patients with history of irradiation and bisphosphonates therapy.

Preoperative Preparation

The patient's full medical history were taken included the basic personal information, as well as past medical and dental history including timing of extraction, and current medications were all considered.

Then a thorough radiographic examination was performed; all patients were asked to present with a standard orthopantomgram and a CBCT to assess alveolar ridge dimensions; ridge width and remaining vertical ridge height measured from crest of the ridge till IAN.

Also a profound clinical examination was done to all cases to assess the interarch distance to insure the absolute indication for IAN buccal transposition. Diagnostic casts were done and mounted on semi-adjustable articulator to fabricate surgical stents necessary to locate planned prosthetically-driven implants.

Operative phase

All patients were operated at the Operating Room of Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Alexandria University under general anaesthesia and complete aseptic condition.

Intraoral disinfection was done with Betadine (Povidoneiodine, 7.5%, Nile Co.for Pharmacueticals and Chemical Industries).

Local anesthesia infiltration at the buccal vestibule with Mepivacaine HCL 3% 1.8 ml carpules a vasoconstrictor at the surgical site. The incision was made using scalpel blade number 15 just buccal to the crest of the ridge with two vertical releasing incisions then the mucoperiosteal flap was reflected and skeletonization of the mental nerve from the underlying tissue was performed atraumatically.

Inferior alveolar nerve Buccal Transposition technique (Figure 1)

Rectangular shaped buccal osteotomy was performed 3 mm behind the mental foramen, using the Piezotome (acteon, France), following the line of the nerve canal presurgically planned on the CBCT. The superior horizontal osteotomy was performed using BS-1 TIP with approximate 5 mm distance inferiorly to the ridge crest minimizing the risk of fracture of the upper bone plate. The inferior horizontal osteotomy was positioned 4-5 mm away from the top horizontal osteotomy seeking to create favorable conditions for later repositioning of the removed cortical plate, as well as to have a good access for nerve manipulation. The posterior limit of the horizontal osteotomies was 3 mm posteriorly to the intended position of the most distal implant. After the horizontal osteotomies was done, the vertical osteotomies introduced using BS-5 tip; a diamond coated insert with blunt edges to avoid nerve injury. Before removing the buccal plate and expose the medullary bone four demarcations were made in the remaining bone structure and in the bone window for future guidance during its reposition. The remaining cancellous bone was removed using SL-2 round diamond coated tip until the inferior alveolar neurovascular bundle exposed and then retraction using a nerve retractor.

The nerve is buccally transported and retracted safely; then implants (s-Clean Tapered endosseous submerged Implants) were installed under direct vision lingual to the retracted bundle according to the preplanned implant diameters and lengths following the usual protocol. After inserting the implants, the primary stability of each implant was checked with a resonance frequency analyzer (Osstell).

A layer of collagen membrane (20x30mm) was placed between the nerve and the implants. Finally, the cortical bone plate shaped to reduce its thickness at the expense of its inner surface, and subsequently reintroduced over the bony window, restoring the continuity and contour of the mandible.

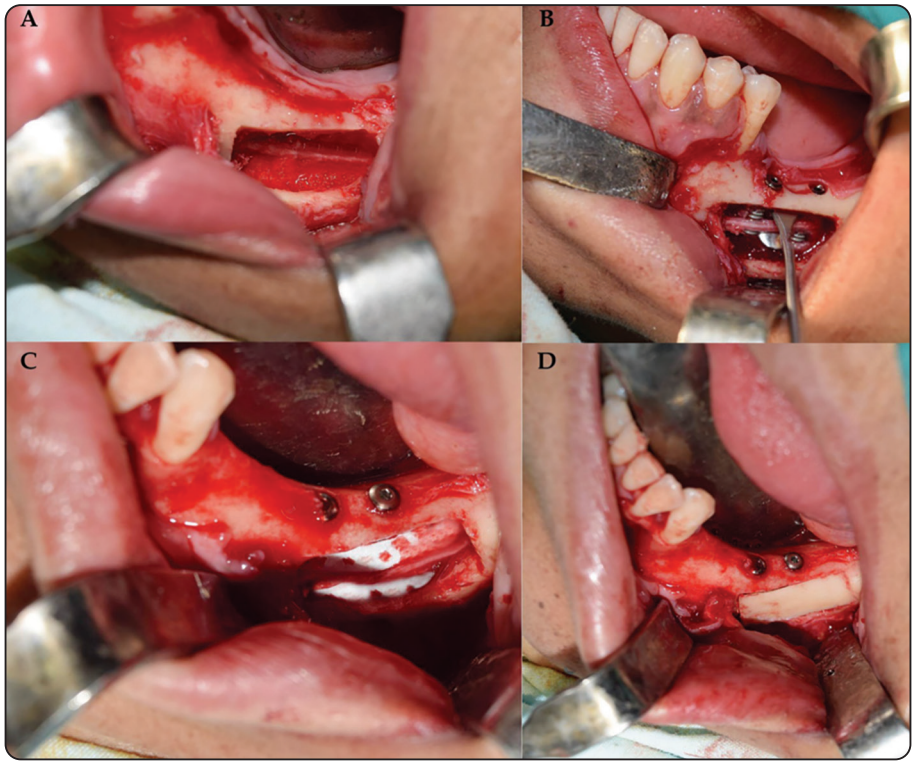

Fig. (1) (A) Osteotomy by piezoelectric device and removal of buccal plate of bone. (B) Retraction of IAN and implant placement. (C) Placement of collagen membrane as a barrier between the nerve and implant. (D) Positioning of buccal cortical plate of bone.

The bony plate simply stabilized under the sutured mucoperiosteal flap. For all cases, 4/0 vicryl suture material (Johnson Int, Belgium) was used to close intraoral incisions.

Post-operative phase

Patients were instructed to apply ice packs for 20 minutes every hour for the first 12 hours to decrease amount of edema.

All patients were prescribed with antibiotics and nonsteroidal anti-inflammatory drugs twice daily for seven days (Cataflam 50 mg tablets, Novartis pharma AG, Basle, Switzerland; Augmentin 1 gm tablet, SmithKline Beecham pharmaceutical Co., England). After 24 hours patients were instructed to rinse with 0.12% chlorhexidine mouthwash for 7 days (Hexitol mouthwash, the Arab medicine firm for pharmaceutical and chemical industries, Cairo, A.R.E).

Long term follow-up

Clinical examination

Assessment of the IAN function was performed preoperatively (base line), immediate postoperative, at one month, three months and six months postoperatively through:

A) Clinical neurosensory tests (Figure 2)

1. Pin tactile discrimination test

It is performed with a sharp instrument at the lower lip to the inferior third of the chin. The patient was asked to respond verbally to each pin prick. A positive or negative reply was the only option at each point. Regular timed stimuli were avoided so that the patient doesn't anticipate the test [9].

2. Two-point of discrimination test

The test was carried out using a caliper and a mill metric ruler. Three different caliper settings were

examined: closed (distance between tips smaller than 14mm), partially open (17mm) a completely open (larger than 20mm) [9].

Great care was taken to ensure that both caliper tips came in to contact with the skin at the same time and with the same force. The following scores were used: 2=normal sensitivity, patient could discriminate between the tips at shorter distance than 14mm, 1=decreased sensitivity, patient could distinguish between tips only when the caliper was calibrated at between 14 and 20,0=no sensitivity Patients couldn't tell which tip it was, even if these were more than 20mm apart.

All tests repeated 3 times consecutively, and the measurements were averaged. Care was taken to ensure that the points touched the skin surface at the same time.

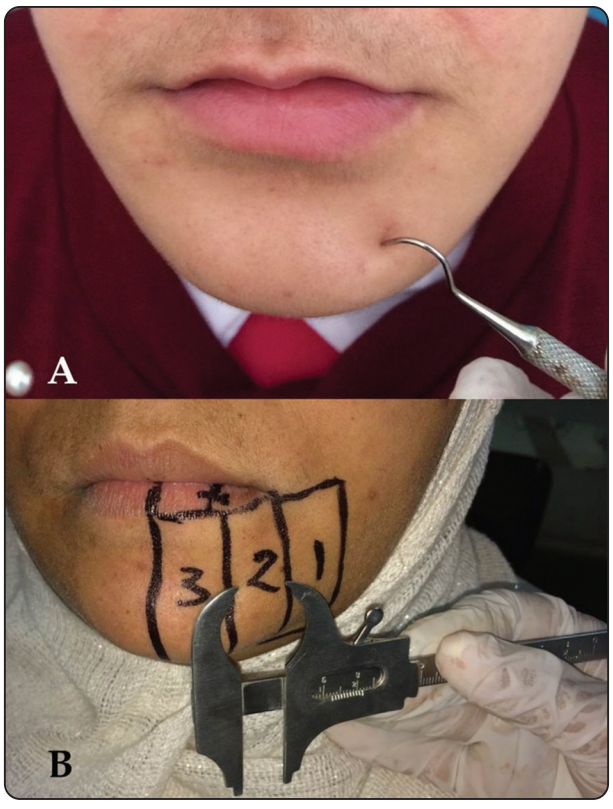

Fig. (2) (A) PIN-PRICK (nociceptive) test to evaluate the neurosensory disturbance. (B) Two point discrimination (mechanoceptive) test to evaluate the neurosensory disturbance.

B) Assessment of Implant Stability using osstell

Implant stability was measured for each implant 3 times, immediately after implant placement and at 6 months postoperative (Prosthetic phase).

A measurement of osstell is displayed as implant stability quotient (ISQ) from 1 to 100 where signify the highest implant stability.[10,11]

Radiographic evaluation

Radiographic evaluation of the dental implant was done to evaluate marginal bone level and bone density around the placed implants by means of Cone beam CT, taken immediately after surgery, 3 and 6 months later, using on "OnDemand 3D software". (Figure 3)

Prosthetic phase

After six months of healing, the healing abutments were unscrewed using a manual screwdriver in an anti-clockwise direction. It was determined that the implant prosthetic platform was free of bone and soft tissue. A fixture mounts suitable for the open-tray impression technique were placed on the implant bodies and tightened by manually rotating the inner screws clockwise until the mounts were below the level of the mucosa.

To give room for the fixture mounts, a window was cut out of a plastic stock tray over the area of the implants. The impression tray was examined in the oral cavity to ensure that the fixture mounts and screws were visible. The fixture mounts were syringed with a light-bodied additive silicone impression compound. The impression tray was filled with heavy-bodied addition silicone impression material and seated precisely in the mouth. Before it set, the excess impression material was scraped off the screw of the fixture mounting. To prevent impression material from becoming caught in screw, the openings were filled with cotton.

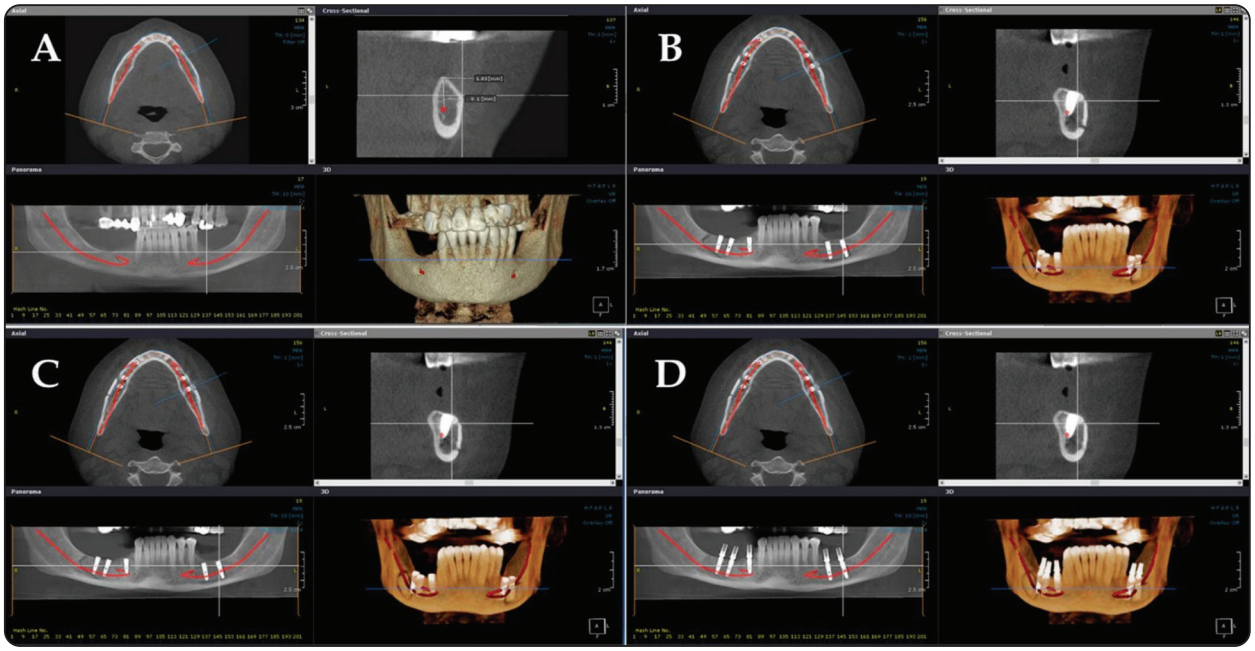

Fig. (3) (A) Preoperative CBCT. (B) Immediate postoperative CBCT. (C) After 3 months CBCT. After 6 months CBCT.

After the impression material sets, the mounts were separated from the implant by un-screwing the long screw inside the mounts. Then the impression tray was removed from the mouth with the fixture mounts remaining secured in the impression. The impression material was verified to be completely adapted around the implants and the mounts. Then the healing abutments were placed back onto the implants to prevent soft tissue collapse.

The implant analogues were attached to the fixture mount by hand screwing the long screws through the access holes in the impression tray while keeping the analogue in place. The analogues were secured to the impression fixture mounts in a safe and precise manner. Impression with the fixture mounts connected to the analog, bite registration, opposing impression, and shade of the restoration was sent to the dental laboratory.

Delivering the screw-retained crown (Figure 4)

The healing abutments were unscrewed with the manual screwdriver and peri-implant mucosa was assessed for the absence of inflammation. The crowns were soaked in chlorhexidine mouthwash for sanitization for 2 min then were placed onto the implants and tightened with the manual screwdriver. A little cotton plug was put into the screw access channels after the contour and occlusion of the crowns were adjusted as needed. The remaining channels were temporarily filled with a temporary filler.

The patient was allowed to use the new restoration for a few weeks after the X-ray confirmed that the crowns fit properly. Then, using a calibrated torque wrench attached to an appropriate screwdiver, the prior interim filling was removed, and the abutment screws were re-tightened to the recommended torque value. A small cotton pellet was placed again into the screw access channels; the openings were filled with a composite resin restoration. Prior to being discharged until the next recall appointment, the patient received proper oral hygiene instructions.

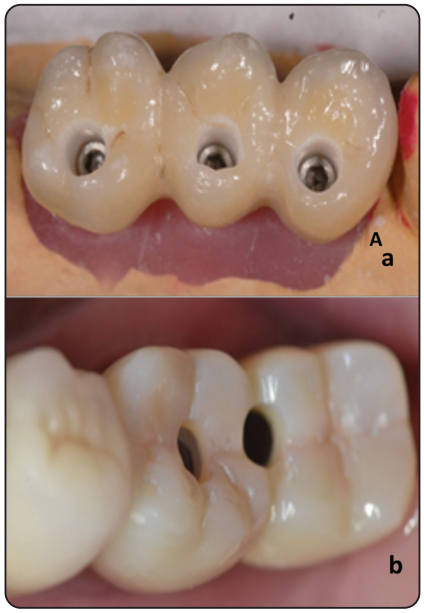

Fig. (4) (A) In Lab final screw retained bridge fabrication (B) Final screw retained prosthesis delivered 6 months postoperatively.

RESULT

The current study was conducted on 10 patients 3 males and 7 females with age range 30-50 years having posterior edentulous mandibles with alveolar height less than 8 mm above the level of inferior alveolar nerve. A total number of 23 implants from Dentium SuperLine (korea) have been inserted simultaneously after nerve lateralization with diameters varying between 4.0mm and 4.5mm and different lengths 8mm, 10mm and 12mm.

One patient who underwent bilateral procedure experienced painful unilateral dysesthesia that lasted 3 months and required carbamazepine and then narcotics for pain control. The pain eventually subsided, and although detailed objective testing for this patient revealed normal sensation, she reported altered sensation.

Clinical results

A) Clinical Neurosensory result

Assessment of inferior alveolar nerve function was performed preoperatively (base line), immediately after operation, one month, three months and six months postoperatively.

1. Pin tactile discrimination test

The pin tactile discrimination test showed normal sensory function of the inferior alveolar nerve from the 3rd month postoperative (100%) (Table 1).

2. Two-point of discrimination test:

The two-point discrimination test where the function of inferior alveolar nerve were (25%) at the 3rd month postoperative then increased to be (50%) at the 6th month postoperative (Table 2).

B) Implant stability quotient (ISQ) with Osstell

Implant stability quotient (ISQ) mean values were found to be statistically significant throughout the study periods after comparing the mean ISQ values obtained immediately postoperative and those obtained at 6 months postoperative for all implants. At the immediate post-operative time the mean ISQ value was (57.48 ± 0.96) AT six months' post-operative the mean ISQ value was (69.12 ± 0.88).

Radiographic evaluation (Figure 4)

The mean marginal bone level measured from the CBCT was found to be statistically significant at the intervals of 1, 3 and 6 months postoperatively, the decrease in marginal bone level was found to be statistically significant with mean of (2.04±0.80) after the first month postoperative and then decreased to be (1.81±0.78) at 3rd month post-operative and it was (1.61±0.78) at the 6th month postoperative (Table 3).

Regarding bone density measured from CBCT, a statistically significant increase was recorded throughout the follow up period. The mean bone density was (104.14±11.26) at the first month post-operative, then it was increased to be (114.75±11.26) at the 3rd months post-operative and it was (124.92±9.72) at sixth month post-operative (Table 4).

TABLE (1) Comparison between pin-tactile (nociceptive) test different follow-up periods.

Pin-prick (nociceptive) test	Pre	Immediate	1st month	3rd month	6th month	Q	p
Min. – max.	1.0 – 1.0	0.0 – 1.0	0.0 – 1.0	1.0 – 1.0	1.0 – 1.0		
Mean ± SD.	1.0±0.0	0.67±0.49	0.83±0.39	1.0±0.0	1.0±0.0		
Median	1.0	1.0	1.0	1.0	1.0	12.800*	0.012*
Negative	0(0.0%)	4(33.3%)	2(16.7%)	0(0.0%)	0(0.0%)		
Positive	12(100.0%)	8(66.7%)	10(83.3%)	12(100.0%)	12(100.0%)		
$p_{Imm.}$		0.005*	0.157	1.000	1.000		
Sig. bet. periods			p_1=0.157,p_2=0.005*,p_3=0.005*, p_4=0.157,p_5=0.157,p_6=1.000				

Q: Cochran's Q Test, *Sig. bet. periods were done using Post Hoc Test (*Dunn's*)*
$p_{pre.}$: p value for comparing between pre and each other periods
p_1: p value for comparing between Immediate and 1st month
p_2: p value for comparing between Immediate and 3rd month
p_3: p value for comparing between Immediate and 6th month
p_4: p value for comparing between 1st month and 3rd month
p_5: p value for comparing between 1st month and 6th month
p_6: p value for comparing between 3rd month and 6th month
****: Statistically significant at p ≤ 0.05***

TABLE (2) Comparison between 2point discrimination (mechanoceptive) test at different follow-up periods.

2 point discrimination (mechanoceptiv) test	Pre	Immediate	1st month	3rd month	6th month	Fr	p
0	0(0.0%)	11(91.7%)	4(33.3%)	4(33.3%)	2(16.7%)		
1	0(0.0%)	1(8.3%)	8(66.7%)	5(41.7%)	4(33.3%)		
2	12(100.0%)	0(0.0%)	0(0.0%)	3(25.0%)	6(50.0%)		
Min. – Max.	2.0 – 2.0	0.0 – 1.0	0.0 – 1.0	0.0 – 2.0	0.0 – 2.0	36.918*	<0.001*
Mean ± SD.	2.0±0.0	0.08±0.29	0.67±0.49	0.92±0.79	1.33±0.78		
Median	25.0	0.0	1.0	1.0	1.50		
$p_{Imm.}$		<0.001*	<0.001*	0.006*	0.156		
Sig. bet. periods			p_1=0.197,p_2=0.039*,p_3=0.001*, p_4=0.439,p_5=0.033*,p_6=0.175				

Fr:* Friedman Test, *Sig. bet. periods was done using Post Hoc Test (*Dunn's*)
$p_{pre.}$: p value for comparing between pre and each other periods
p_1: p value for comparing between Immediate and 1st month
p_2: p value for comparing between Immediate and 3rd month
p_3: p value for comparing between Immediate and 6th month
p_4: p value for comparing between 1st month and 3rd month
p_5: p value for comparing between 1st month and 6th month
p_6: p value for comparing between 3rd month and 6th month
****: Statistically significant at p ≤ 0.05***

TABLE (3) Comparison between different periods according to marginal bone level (n=10).

	1st (n=10)	3rd (n=10)	6th (n=10)
Marginal bone level			
Min. – Max	1.02 – 3.52	0.77 – 3.31	0.55 – 3.11
Mean ±SD.	2.04 ± 0.80	1.81 ± 0.78	1.61 ± 0.78
Median	1.82	1.71	1.47
Sig.bet. periods	$p_1<0.001^*, p_2<0.001^*, p_3<0.001^*$		

Sig. bet. periods was done using Wilcoxon signed ranks test
p_1: p value for comparing between 1st and 3rd
p_2: p value for comparing between 1st and 6th
p_3: p value for comparing between 3rd t and 6th
****: Statistically significant at p ≤ 0.05***

TABLE (4) Comparison between different periods according to bone density (n=10).

	1st (n=10)	3rd (n=10)	6th (n=10)
Bone density			
Min. – Max	90.53–127.89	99.01–136.93	110.36–145.2
Mean ± SD.	104.14±11.26	114.75 ± 11.26	124.92 ±9.72
Median	101.81	114.73	125.47
Sig.bet. periods	$p_1<0.001^*, p_2<0.001^*, p_3<0.001^*$		

Sig. bet. periods was done using Post Hoc Test (LSD) for ANOVA with repeated measures
p_1: p value for comparing between 1st and 3rd
p_2: p value for comparing between 1st and 6th
p_3: p value for comparing between 3rd t and 6th
****: Statistically significant at p ≤ 0.05***

DISCUSSION

In oral surgery, posterior mandibular atrophy is a common and difficult condition. Alveolar distraction, onlay and inlay autologous bone grafting, guided bone regeneration with autologous bone particles such as allografts or xenografts, which are then covered with titanium mesh or titanium reinforced membranes, tilted or 'all-on-four' procedure, and the placement of short implants (less than 8 mm) were all used to treat this problem with varying degrees of success. [12].

Inferior alveolar nerve lateralization and transposition are techniques that most satisfy the later rehabilitation of atrophic jaws. In these procedures, the implant placement occurs in the correct position or as close as possible to the ideal, favored with a direct view at the time of surgery. Furthermore, implants have a better occlusal load distribution, good biomechanics, high success rate, a single operational step, a shorter treatment time, a lower cost, and less patient morbidity. Therefore, the main issue with implanting correct length implants is IAN bundle injury. [13, 14]

In this study we present Inferior alveolar nerve(IAN) lateralization by using a piezoelectric device and immediate implants placement in severely atrophic posterior mandibular ridge.

Regarding osteotomy technique, we used the piezoelectric device with bone surgery special inserts due to its positive clinical effects including precise and accurate micrometric bone cutting, bleeding control, absence of bone necrosis and with minimal soft tissue injury. This coincides with Eggers G et al (2004) [15] who reported that the traditional techniques as bur and saw that usually used in osseous surgery has several disadvantages, including bone overheating and damage to the adjacent tissues, (IAN) damage is an obvious risk with lateralization techniques.

Greenwood M (16), stated that during nerve repositioning (NR) the IAN can be damaged during three phases of lateralization: During the flap elevation; it has been reported that the damage caused by stretching of peripheral nerve is reversible if the lengthening doesn't exceed 5% to 7% of the total nerve length. Also Vercellotti in 2000 [17] said that injury might occur during the osteotomy and/or insertion of implants, due to improper handling of the inferior alveolar bundle [8].

In one single case in our study, the patient experienced prolonged non response to the position and fine touch by two point discrimination test more than 6months due to injury of A-alpha fibers, which is goes with Rosenquest (1992) and Bovi (2005)

[18,19] who postulated the repositioning of the nerve directly against dental implants may results in the implant threads causing chronic irritation that could induce long standing edema and intraneural fibrotic scar tissue formation. Such direct contact between the IAN and sharp implant threads could potentially induce symptoms.

Regarding to the placement of collagen membrane as a barrier between the implant and inferior alveolar nerve to reduce the contact between them as the sharp implant threads can cause chronic irritation which can occasionally induce longstanding oedema and intraneural fibrotic scar tissue formation which is agreed with Kahnberg et al (2000) (20) advice the use of resorbable membrane.

Because the inferior alveolar nerve lateralization surgery may cause some degree of sensory impairment. Accurate and reproducible tests are mandatory to assess IAN conduction capacity following to nerve lateralization. In the present study two clinical objective tests were done: pin tactile discrimination test and two-point discrimination test.

The pin tactile discrimination test is perioceptive test while the two-point discrimination test is mechanoceptive test, they were used for preliminary evaluation of IAN function. This run parallel to the findings obtained by Arcuri et al (2006), Koichiro et al (2007) and Hashiba et al(2010) [21-23].

Regarding to the clinical neurosensory results of two point of discrimination test at the interval of immediate, one month, three months and six months postoperatively. The statistics showed that (91.7%) of all sides had abnormal sensation with score 0 in the immediate postoperative period, and then this percentage decreased to be mild (66.7%) at the first month post-operatively,(41.7%) at the third month postoperatively and returned to normal in (50%) of all sides and this agreed with Colella et al(2007) [24].

Regarding to the results of pin tactile discrimination test the statistics showed positive results in (66.7%) of all sides in the immediate postoperative period, and this percentage increased to be (83.3%) at the first month postoperative after that it reached (100%) at the third and six months' post-operative.

Our results are consistent with previous studies which revealed that the two-point discrimination test is the slowest to become normal, because it not wait only for the myelination and maturation of the nerve fiber but also for the miessner's corpuscles to become connected (slowly adapted A-alpha fibres). Pin-tactile discrimination test become normal faster because it is indicative of large quickly adapting, myelinated A-alpha nerve fibers, Wilgis (1982), Fredous and Macuregor (1985), Oksal et al (2004) and Greenwood &Corbet (2005) [25-27].

Primary implant stability after insertion is one of the important factor to the success of the implant therefore osstell was used to measure the implant stability quotient (ISQ). In the current study, the average ISQ value for installed implants immediately after surgery was (57.48±0.96). The mean ISQ value was improved throughout the study to be (69.12±0.88) at six months postoperative. These findings agreed with Yoon HG et al. (2011) [28] who reported that both bone quality and surgical technique have an influence on the primary implant stability.

Regarding bone density, a statistically significant increase was recorded throughout the follow up period. The mean bone density was (104.14±11.26) at the first month post-operative, then it was increased to be (114.75±11.26) at the 3rd months post-operative and it was (124.92±9.72) at sixth month post-operative. This significant increasing in the bone density all over the study periods it may be due to the organization and calcification of the blood at the site of the operation.

The use of the resorbable collagen membrane is an important factor that accelerate the new bone formation. This agreed with Schenk RK (1994) and Rothamel D (2005) [29, 30] who showed that the collagen membrane providing a barrier function during this initial stage and it acts as a scaffold for

osteoblastic cell attachment. These functions are critical while early bone tissue (osteoid) is formed allowing to increase the mineralization and enhance bone regeneration process.

Regarding the marginal bone levels at the intervals of 1, 3 and 6 months postoperatively, the decrease in marginal bone level was found to be statistically significant with mean of (2.04±0.80) after the first month postoperative and then decreased to be (1.81±0.78) at 3rd month post-operative and it was (1.61±0.78) at the 6th month postoperative. The expected marginal bone loss was evident on the radiographs which settled at the implant crestal module at the end of the 6th month which is consistent with Nadal et al (2014) [31].

CONCLUSIONS

Within the limitation of this study, buccal transposition of the IAN seems to be a useful adjunct for managing the atrophic posterior mandible with simultaneous implant placement. The feasibility of this technique necessitates an accurate and reproducible test to assess the IAN conduction capacity following to nerve lateralization. Although the current surgical modality is a technique sensitive, it may be a less risky procedure through the proper preoperative CBCT planning and the use of piezoelectric surgical device.

Conflict of interest

The authors declare that they have no conflicts of interest.

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