Vol.19, No.3, Page 245- 252, 2025 https://doi.org/10.59628/jchm.v19.i3.1818 ISSN 2958-7476 JCHM

Sana'a University Journal of Medical and Health Sciences

A Preliminary Comparative Study of the Effects of Advanced Platelet-Rich Fibrin and Resorbable Collagen Membranein Inferior Alveolar Nerve Lateralization and Immediate Dental Implant Placement.

Hisham Hwaiti [1] *, **Yasser Ahmed Alrubaidi** [1], **Taghreed Ahmed M Al-Kibsi** [1] **and Yahya Al-Hadi** [1]

[1] **Department of Oral Maxillofacial Surgery, Faculty of Dentistry, Sana University, Yemen.**

*Corresponding author:e-mail: hash775992327@gmail.com

Abstract

Background: Barrier membranes such as resorbable collagen and platelet-rich fibrin (PRF) are commonly used in surgical procedures to enhance healing and reduce the risk of neurosensory disturbance (NDs). While collagen membranes act as passive barriers, PRF, an autologous, cost-effective alternative, actively promotes tissue regeneration through sustained release of growth factors.
Objective : To compare the efficacy of platelet-rich fibrin (PRF) and resorbable collagen membranes in protecting the inferior alveolar nerve (IAN) and enhancing healing following nerve injury.
Methods: A prospective, randomized clinical trial involving nine edentulous posterior mandible sites requiring inferior alveolar nerve lateralization (IANL) was conducted in Yemen from July to November 2024. Following implant placement, patients were randomly assigned to receive either a collagen membrane or autologous platelet-rich fibrin (PRF) membrane placed between the nerve and implants. The nerve function and implant success were monitored postoperatively. Data were analyzed using Friedman and Wilcoxon tests, with significance set at $p < 0.05$.
Results: The study included patients aged 24–72 years with a mean age of 56.22±16.49, with a male predominance (77.78%). Surgical procedures were performed on the right side in 55.56% and on the left side in 44.44% of cases. A statistically significant difference in ND was observed across follow-ups on day one, week one, month one, month three, and month six (^{2}=30.3, $p<0.001$). Pairwise comparisons revealed significant improvements from day one to month one (p=0.03), day one to month three (p=0.008), and day one to month six (p=0.005), whereas the difference between day one and week one was not significant (p=1.00). No significant correlations were found between ND recovery and patient age or membrane type at any follow-up interval ($P > 0.05$).
Conclusions: This preliminary study demonstrated that IANL with immediate implant placement is an effective technique for rehabilitating atrophic posterior mandibles. ND improved significantly within six months post-surgery, with most patients recovering fully or experiencing only mild symptoms. Implant success was high, and no significant link was found between nerve recovery and the membrane type.

Article Info

Keywords:
Platelet-Rich Fibrin, Resorbable Collagen Membrane, Inferior Alveolar Nerve Lateralization, Immediate Dental Implant

Article History:
Received:18-May-2025 ,
Revised:31-May-2025 ,
Accepted:21-June-2025 ,
Available online:30-June-2025

1. INTRODUCTION

Rehabilitation of a posterior atrophic mandible with dental implant placement is complicated by the critical amount of residual bone above the mandibular canal [1]. A recent systematic review by Tan et al. (2012) [2] analyzed dimensional changes in the hard and soft tissues of the alveolar ridge within 12 months of tooth extraction. The findings revealed that after 3 months of healing, horizontal bone resorption measured 2.2 mm at the crest 1.3, 0.59, and 0.3 mm at 3, 6, and 9 mm apical to the crest, respectively. By 6 months, vertical bone loss ranged between 11% and 22%, whereas horizontal resorption reached 29–63%. Notably, when both soft and hard tissues were considered together, a slight vertical increase of 0.4 mm was observed at 3 months. At the 12-month mark, vertical ridge resorption was approximately 0.8 mm, and combined horizontal loss of soft and hard tissues was 1.3 mm and 5.1 mm at 3 and 12 months, respectively [3]. Dental implant reconstruction presents several challenges, particularly in terms of achieving sufficient bone quantity (height and width) and quality. Conditions such as periodontitis, extended edentulism, and the long-term use of removable dentures can lead to significant alveolar bone resorption. Moreover, anatomical factors, such as jaw morphology, position of the maxillary sinus, and proximity of the inferior alveolar nerve (IAN) canal, often limit the feasibility of implant placement [4] The inferior alveolar nerve (IAN), a major branch of the mandibular nerve, provides sensory innervation to the mandibular teeth, periodontium, lower lip, and jaws. It enters the mandible through the mandibular foramen in a circular form encased by dense connective tissue, and then travels downward and forward within the mandibular canal, typically positioned beneath the root apices[5].Within the mandibular canal, it runs through the inferior alveolar artery (IAA), vein, and lymph vessels, constituting the inferior alveolar neurovascular bundle [5]. Assessing the relative position of the inferior alveolar nerve canal in relation to mandibular anatomical landmarks is clinically important for reducing the risk of complications, such as neurosensory disturbances (ND), following invasive mandibular surgeries. In addition to evaluating bone height and width, cone beam computed tomography (CBCT) provides a valuable analysis of the course and position of the canal, enhancing surgical planning and safety [6]. Inferior alveolar nerve (IAN) lateralization is a technically demanding surgical procedure that involves exposing the neurovascular bundle from its bony canal and carefully retracting it to allow immediate implant placement [7]. Successful execution of this technique requires substantial clinical expertise, thorough understanding of the mandibular anatomy, and the ability to manage potential complications. ND, including temporary or permanent anesthesia, paresthesia, dysesthesia, and hyperesthesia, are the most significant risks associated with this procedure [8].Additionally, there is a risk of mandibular fracture, particularly in cases of severe atrophy in which bone volume is reduced. Comparative studies have shown a higher incidence of NDs in patients undergoing foramen displacement than in those undergoing IAN lateralization [9]. Platelet-rich fibrin (PRF), introduced in the early 2000s, has been widely used as an adjunctive material in various oral and maxillofacial surgical procedures and has shown promising neuroregenerative potential [10]. PRF, along with its variant, leukocyte-PRF (L-PRF), is derived from a second-generation platelet concentrate. It primarily consists of platelets, growth factors, cytokines, and leukocytes, embedded within a dense protein matrix. Unlike platelet-rich plasma (PRP), PRF contains a cohesive fibrin scaffold that enables sustained and gradual release of growth factors, thereby supporting tissue regeneration. PRF has garnered growing attention for its simplicity of preparation, cost-effectiveness, versatility, and ease of clinical application [11]. It is produced by centrifuging a blood sample in vacuum tubes without anticoagulants for around 10 minutes, resulting in a stable, elastic, and adhesive fibrin clot that can be shaped to fit various anatomical areas. Extensive research has explored the clinical benefits of PRF in multiple oral and maxillofacial procedures such as third molar extractions, ridge preservation, sinus lifts, alveolar cleft repair, dental implant placement, treatment of medication-related osteonecrosis of the jaw (MRONJ), and closure of oroantral communications [10]. Recent studies have shown that PRF may aid in the recovery of the IAN following various surgical procedures including sagittal split osteotomy, nerve repositioning, and genioplasty, underscoring its growing role in nerve regeneration and functional recovery [12] In 2018, Yemen, a country with limited socioeconomic resources and a population of approximately 28.7 million in 2018 [13], faced significant challenges in oral healthcare. Poor oral hygiene and limited access to dental services contribute to high rates of tooth loss, which, in turn, leads to progressive alveolar bone resorption. Owing to delayed rehabilitation and reliance on removable prostheses, which can further accelerate bone loss,this issue remains largely unaddressed. Notably, this preliminary study is the first of its kind in Yemen to explore alternative approaches beyond removable dentures for managing alveolar bone atrophy.

2. AIM OF STUDY

To compare the efficacy of platelet-rich fibrin (PRF) versus resorbable collagen membranes in protecting the inferior alveolar nerve and promoting healing following nerve lateralization and immediate implant placement in atrophic mandibles.

3. MATERIALS AND METHODS

3.1. Study design

This preliminary prospective randomized clinical trial compared PRF collagen membranes in Inferior Alveolar Nerve Lateralization and immediate dental implant placement in severely resorbed mandibles using convenience sampling to obtain a sample size of 9 sites of (IANL) in five patients.

3.2. Study area

The study was carried out on patients with posterior mandibular atrophies in the public and private departments of the Faculty of Dentistry and Dental Clinics in Sana'a City from August 2024 to September 2024.

3.3. Sample Size

Formula of Sample size calculation for (clinical trials or clinical interventional studies) according to [14]: -

$$sample \quad size = \frac{2SD^2(Z_{\alpha/2} - Z_\beta)}{d^2} \tag{1}$$

SD: Standard deviation = From the previous study by [15]=14.26 $Z_{\alpha/2} = Z_{0.05/2} = Z_{0.025} = 1.96(FromZtable)$ at a type 1error of 5% and confidence level of 95%. $Z_\beta = Z_{0.20} = 0.842$ (From Z table) at 80% power. d = effect size = difference between mean follow-up time =20.62 So now formula were: N= 2(14.26) x^2 (1.96+0.84) $x^2 \frac{}{(20.62}$x^2)= 7.49 Sample size = 7.49 The sample size was 8 nerve lateralization. To enhance the reliability of the study and enable meaningful comparisons with previous similar research, an additional margin of over 10% was included in the sample size. Ultimately, based on calculations using the Formula of Sample size calculation for (clinical trials or clinical interventional studies), the total sample comprised 9 sites of (IANL).

3.4. Inclusion and exclusion criteria

3.4.1. Inclusion criteria

- Patients aged above 18 years [9].
- Patients with a bone height above the IAN measuring less than 7.0 mm [16].

3.4.2. Exclusion criteria

- Patients who received bone atrophy correction using alternative techniques
- Subjects had any systemic disease [16].

3.5. Preoperative phase

Detailed demographic data were collected from the patients, including name, age, gender, occupation, address, and phone number, present and past medical and dental history.

3.5.1. Clinical examination

In the clinical examination, all patients underwent adental examination (extra-oral and intra-oral examination) in dental clinics using a dental mirror, ball-tipped WHO dental explorer probe, dental tweezer, and Michigan periodontal probe. Sterile examination tools using an autoclave class B were used. These instruments are used to assess the following

- Oral health and oral hygiene status.
- Suitable inter arch distance.
- Dimensions of edentulous ridge.
- Soft tissue condition.

3.5.2. Radiographic examination

Panoramic radiographs were obtained to assess the condition of the patients' teeth and jawbone, as well as to detect any oral infections requiring treatment. These images also served as baseline documentation for comparison before and after treatment. CBCT were revealed significant vertical and horizontal bone loss (bone quantity) and bone density (bone quality) in the mandibular premolar and molar areas, with residual bone above the IAN ranged from < 7.0 mm.[16].

3.6. Surgical protocol

An intraoral crestal incision was made, extending from the retromolar region to a vertical releasing incision positioned mesially to the thoughtful location of the mental foramen. A full-thickness mucoperiosteal flap was carefully elevated to allow for adequate access. To expose the inferior alveolar neurovascular bundle, a cortical bony window was created using bone-cutting discs mounted on a piezoelectric device following standardized surgical parameters: The anterior border was cut 3-4 mm distal to the mental foramen. The posterior border was cut 4-5 mm distal to the site of the most distal implant. The upper and lower borders were cut 2–3 mm above and below the mandibular canal, respectively.(Figure (1))

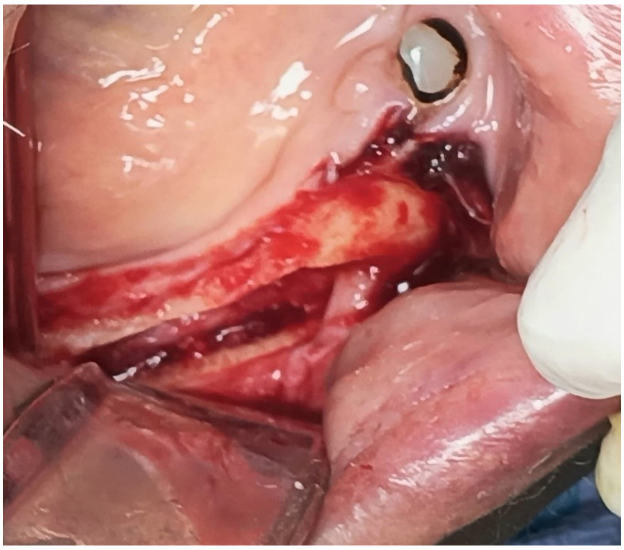

Figure 1. Exposed of IAN canal

3.6.1. Nerve lateralization

The cortical bone block was removed with the aid of a periosteal elevator and kept hydrated in a saline solution. After osteotomy, the mandibular canal is exposed and the IAN is gently manipulated to remove cancellous bone fragments that may hinder full mobilization of the IAN. The nerve is retracted laterally by a specially fabricated instrument (elastic tape) and carefully protected in a way that allows implant bed preparation through its medial surface up to the desired bone depth. (Figure (2)) [**18**].

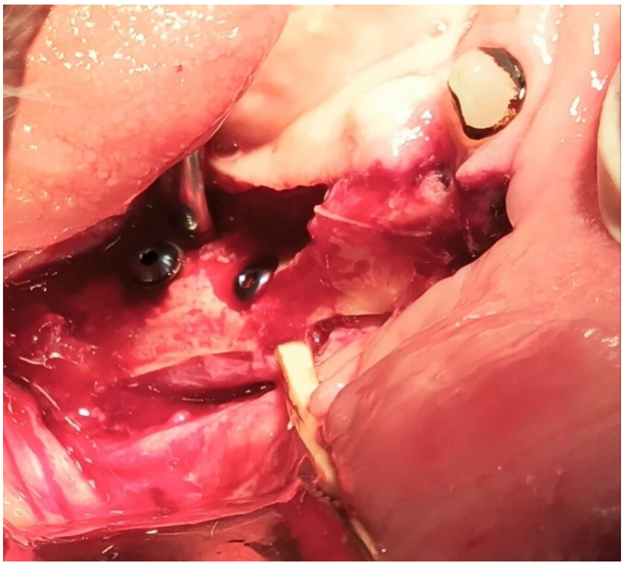

Figure 2. Nerve retracted laterally instrument (elastic)

3.6.2. Implant placement

An Any Ridge Megagen dental implant was then inserted at the ideal locking depth in accordance with the predetermined position and direction. The selected implants should be long enough (8.5–13 mm) to allow anchorage in the basal cortical bone of the mandibular body and provide adequate locking and stability, and a delayed loading technique was used. [17].

3.6.3. Nerve repositioned PRF preparation

Draw blood from the patient using a cannula or directly by syringe and fill a plain tube,60 ml of venous blood samples were collected in vacutainer tubes. The tubes were immediately centrifuged at 3000 rpm for 8–10 min. The fibrin clot was gently extracted from the tube and separated from surrounding layers using scissors. The PRF was then pressed in a special PRF box to produce PRF membranes. The inferior alveolar nerve (IAN) was carefully repositioned to gently rest against the implants. On one side, a platelet-rich fibrin (PRF) membrane was placed between the implant surface and the neurovascular bundle, whereas on the contralateral side, a resorbable membrane was used in the same position (Figure (3)a and (3) b).

3.6.4. Tissue approximation and suturing

In the final step, the soft tissues were carefully approximated and sutured using interrupted stitches with 3-0 silk sutures

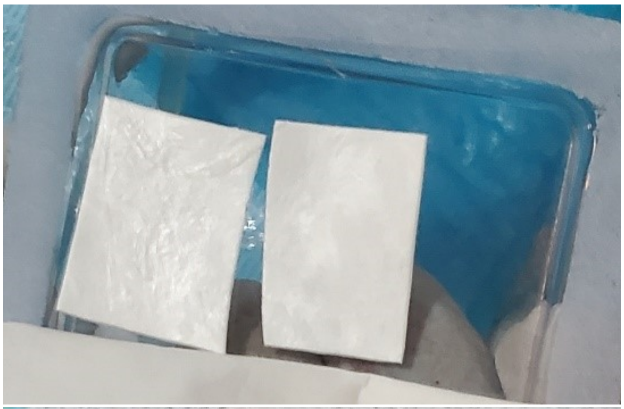

Figure 3. a: Resorbable Collagen Membrane Figure 3. b: Platelet Rich Fibrin (PRF)

3.7. Post operative follow up

Subjective evaluation of the neurosensory function of the IAN using a cotton tip applicator with Kriovit Ice Spray was used to determine sensation (Static Touch Detection Tests) (figure (1,2)), and the pin-prick test by insulin needle and tip of explorer prob was performed preoperatively as a baseline and then postoperatively at time intervals (one week, one month, three months and six months) to describe the alteration in sensation in the lower lip and chin by two calibrated examiners [18] Implant success rate was determined by primary stability during insertion by a ratchet, and then X-rays (panoramic and CBCT) were taken at 3 and 4 months after implant loading to check for marginal bone loss (MBL). The degree of osseointegration of the implants was determined by examining whether the implants were both painless and immobile under torque and loading, and whether any pathology was detected in the X-rays during the examination [2].

3.8. Data management and Statistical analysis

All data were collected and analyzed using statistical software (SPSS Version 27; SPSS Inc., Chicago, USA). Non-parametric tests were performed to measure the differences between the pre-and postoperative times (Friedman and Wilcoxon). The chi-squared (χ^2) test was used to measure the association between two or more categorical variables. The continuity correction chi-square was used alternatively for 2 × 2 tables or likelihood ratio chi-square test for more than 2 × 2 tables. P < 0.05 were con¬sider statistically significant

3.9. Ethical Considerations

All experimental procedures were approved by the Medical Ethics Committee of the Faculty of Medicine at Sana'a University. Oral and sheet consent were obtained from the patients.

4. RESULT

4.1. Descriptive Characteristics

Nine procedures were performed on five patients, one of whom underwent unilateral surgery, eight underwent bilateral surgery, and all patients were free of medical history except for one who had controlled diabetes. 31 implants were placed, with an average of 6.2 implants per patient, or three implants per procedure. In figure (4)), all of the patients (77.78%) were men, except one (22.22%), and the age of the patients was between 24 and 72 years, with a mean of age was 56.22±16.49.

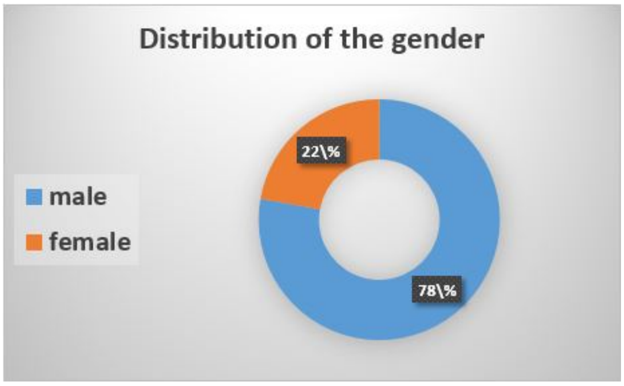

Figure 4. Distribution of the gender

4.2. Neurosensory disturbance

In Table (1), we show that all of the patients except one (88.9%) experienced recovery, and (11.1%) patients (only one patient) reported anesthesia.

Table 1. Frequency of neurosensory disturbance after six months from operation

ND	Frequency	Percent
Normal (recovery)	8	88.9
Light hypoesthesia	0	0.0
Moderate hypoesthesia	0	0.0
Anesthesia	1	11.1
Total	9	100.0

4.3. Differences between ND during first day, first week, first month, third month and sixth month after surgery

There was a highly significant difference between ND during the first day, first week, first month, third month, and sixth month after surgery (χ^2=30.3, p < 0.001) (Table 1).

Table 2. differences between neurosensory disturbances

Neurosensory disturbances		
Time Period	Value	P-value
After one day	χ^2	
After one week		
After one month	30.3	0.001*
After three months		
After six months		

*Fridman test

4.4. Corelate between ND during first day, first week, first month, third month and sixth month after surgery with type of membrane

As outlined in Table (3), the analysis revealed no statistically significant correlation between the type of membrane used during the surgical procedure and the incidence of nerve disturbance (ND) at one, three, and six months postoperatively. The correlation coefficients (r = -0.04, -0.29, and -0.39, respectively) indicated weak-to-moderate negative associations at these intervals. However, the corresponding p-values (p = 0.90, 0.44, and 0.29, respectively) exceeded the conventional threshold for statistical significance (p < 0.05), suggesting that these associations were not meaningful. Accordingly, these findings suggest that the type of membrane employed did not exert a statistically significant influence on the presence or severity of nerve disturbances during the postoperative period.

Table 3. Correlation between ND with type of membrane

Time period	R	P-value
After one month	- 0.04	0.90
After three months	-0.29	0.44
After six months	- 0.39	0.29

point biserial Correlation

4.5. Dental implant survival rate

Of the 31 dental implants placed, 30 achieved successful osseointegration, with a high success rate of 96.8%. This outcome reflects the favorable integration of implants with the surrounding osseous tissue. Only one implant (3.2%) failed to osseointegrate, indicating a minimal incidence of implant failure and underscoring the overall reliability and clinical efficacy of the surgical protocol.

4.6. Other complication

Ultimately, no complications were observed in addition to neurosensory disturbance (ND); specifically, there were no incidences of infection or mandibular fracture throughout the postoperative period.

5. DISCUSSION

Posterior mandibular atrophy is a common and challenging scenario in oral and maxillofacial surgery. Various surgical techniques have been developed to manage these conditions, each of which offers distinct advantages and limitations. These include alveolar distraction osteogenesis [19]; onlay and inlay autologous bone grafting [20], and guided bone regeneration using autologous bone particles, allografts, or xenografts [21, 22]. These regenerative procedures are frequently supplemented with titanium mesh or reinforced membranes to enhance stability[23, 24]. Additional approaches such as the use of tilted implants (e.g., the "All-on-Four" concept) and short implants have also been employed as alternatives to circumvent anatomical limitations.

5.1. Neurosensory disturbances

Our findings are supported by a broader literature review. Among 350 patients who underwent IANL across multiple studies, 93% experienced immediate ND postoperatively and 6% had persistent ND at the end of the follow-up period. In nine studies [9, 15, 25, 26, 27, 3, 28, 29, 30] , full recovery was documented by six months, particularly in cases involving IANL. These findings are consistent with our six-month recovery rate (88.9%) and further establish the viability of this technique. However, seven studies could not be included in these aggregated results due to reporting limitations: five studies [15, 30, 31, 32, 33] failed to provide detailed data on immediate ND, while two others [16, 34] presented data based on procedural outcomes rather than on individual patients. These inconsistencies in data reporting underline the need for standardized outcome measures and follow-up protocols in future research.

5.2. Collagen membrane versus PRF

Building on the findings of this study, the lack of a statistically significant difference in postoperative nerve disturbance (ND) outcomes between platelet-rich fibrin (PRF) and artificial collagen membranes highlights a key consideration in clinical decision-making. Although both membrane types exhibited comparable effectiveness in facilitating sensory nerve recovery, a broader evaluation of their clinical and biological implications is required. From a biological perspective, PRF offers several intrinsic advantages that extend beyond its structural roles. In contrast to artificial collagen membranes, which function primarily as passive physical barriers, PRF serves as a bioactive matrix that is capable of modulating the local wound environment. It continuously releases a variety of growth factors, such as platelet-derived growth factor (PDGF), vascular endothelial growth factor (VEGF), and transforming growth factor-beta (TGF-β)over time, thereby promoting a regenerative microenvironment conducive to enhanced soft and hard tissue healing. Importantly, the neuroregenerative potential of PRF, particularly when applied in proximity to the inferior alveolar nerve (IAN), has been substantiated by both histological and clinical studies in animal models and human patients. The findings of the present study are consistent with prior research by [12, 31, 35]), which reported favorable outcomes following the use of PRF to enhance IAN regeneration during elective surgical procedures. These results support the clinical utility of PRF as a safe and biologically beneficial alternative to synthetic membranes in cases where nerve preservation and regeneration are of primary concern. This study had several limitations. First, the limited financial resources available during this study significantly affected the sample size. The financial constraints not only affected patient recruitment, but also limited access to advanced diagnostic tools and materials, thereby influencing the overall scope and depth of the investigation. Second, the follow-up period was limited to six months, which may not fully capture long-term neurosensory recovery or implant performance. Third, while the study utilized a randomized design, blinding was not possible because of the visible differences between membrane types, which may introduce assessment bias. Finally, the study did not assess patient-reported outcome measures (PROMs), such as quality of life or subjective sensory perception, which could provide a more comprehensive evaluation of recovery.

6. CONCLUSIONS

This study showed that IANL with immediate implant placement is an effective technique for rehabilitating atrophic posterior mandibles. ND improved significantly within six months post-surgery, with most patients recovering fully or experiencing only mild symptoms. Implant success was high, and no significant link was found between nerve recovery and membrane type. Within the limitations of this small-scale pilot study, both PRF and collagen membranes showed comparable outcomes in nerve healing and implant success following IANL. However, larger trials are required to confirm these findings.

ACKNOWLEDGMENTS:

Authors sincerely thank all academic staff and administrators in the College of Dentistry, University of Science and Technology, Sanaa, Yemen. Who helped us to conduct this study

CONFLICTS

Authors have no conflicts of interest to disclose.

ETHICAL COMMITTEE

The study protocol was reviewed and approved by the research ethical committee of the College of Dentistry, Sana'a University, Sana'a, Yemen, letters were sent to the hospital manager to permit to conduct the study.

FUNDING

the authors declare no funding

REFERENCES

[1] A. Sethi, S. Banerji, and T. Kaus. "Inferior alveolar neurovascular bundle repositioning: a retrospective analysis". In: *Int. J. Oral Maxillofac. Surg.* 46.4 (2017), pp. 518–523.

[2] J.F. Diaz and L.N. Gias. "Rehabilitation of edentulous posterior atrophic mandible: inferior alveolar nerve lateralization by piezotome and immediate implant placement". In: *Int. journal oral maxillofacial surgery* 42.4 (2013), pp. 521–526.

[3] B.R. Chrcanovic and A.L.N. Custódio. "Inferior alveolar nerve lateral transposition". In: *Oral maxillofacial surgery* 13 (2009), pp. 213–219.

[4] H.H. Enezei, A.A. Khalil, and T.N. Naif. "A clinical analysis of surgically managed mandibular fractures: Epidemiology, Clinical Profile, patterns, treatments, and outcomes". In: *Int Med J* 27.4 (2020), pp. 1–4.

[5] L.F. Rodella et al. "A review of the mandibular and maxillary nerve supplies and their clinical relevance". In: *Arch. oral biology* 57.4 (2012), pp. 323–334.

[6] H. Khorshidi et al. "Cone beam computed tomographic analysis of the course and position of mandibular canal". In: *J. maxillofacial oral surgery* 16 (2017), pp. 306–311.

[7] J.R. Zuniga. "Sensory outcomes after reconstruction of lingual and inferior alveolar nerve discontinuities using processed nerve allograft—a case series". In: *J. Oral Maxillofac. Surg.* 73.4 (2015), pp. 734–744.

[8] M.H. Lin et al. "Risk assessment of inferior alveolar nerve injury for immediate implant placement in the posterior mandible: a virtual implant placement study". In: *J. dentistry* 42.3 (2014), pp. 263–270.

[9] M. Rathod et al. "Evaluation of neurosensory function following inferior alveolar nerve lateralization for implant placement". In: *J. maxillofacial oral surgery* 18 (2019), pp. 273–279.

[10] J. Canellas et al. "Platelet-rich fibrin in oral surgical procedures: a systematic review and meta-analysis". In: *Int. journal oral maxillofacial surgery* 48.3 (2019), pp. 395–414.

[11] C.C. Zumarán et al. "The 3 R's for platelet-rich fibrin: A "super" tri-dimensional biomaterial for contemporary naturally-guided oro-maxillo-facial soft and hard tissue repair, reconstruction and regeneration". In: *Materials* 11.8 (2018), p. 1293.

[12] P. Behnia et al. "Does leucocyte-and platelet-rich fibrin enhance neurosensory recovery after genioplasty? A double-blind, split-mouth, randomised clinical trial". In: *Br. J. Oral Maxillofac. Surg.* 61.8 (2023), pp. 534–539.

[13] K. Garber et al. "Estimating access to health care in Yemen, a complex humanitarian emergency setting: a descriptive applied geospatial analysis". In: *The Lancet Glob. Health* 8.11 (2020), e1435–e1443.

[14] J. Charan and T. Biswas. "How to calculate sample size for different study designs in medical research?" In: *Indian journal psychological medicine* 35.2 (2013), pp. 121–126.

[15] A. Lorean et al. "Inferior alveolar nerve transposition and reposition for dental implant placement in edentulous or partially edentulous mandibles: a multicenter retrospective study". In: *Int. journal oral maxillofacial surgery* 42.5 (2013), pp. 656–659.

[16] G. Deryabin and S. Grybauskas. "Dental implant placement with inferior alveolar nerve repositioning in severely resorbed mandibles: a retrospective multicenter study of implant success and survival rates, and lower lip sensory disturbances". In: *Int. J. Implant. Dent.* 7.1 (2021), p. 44.

[17] M.A. Tomazi et al. "In-Block Lateralization as a New Technique for Mobilization of the Inferior Alveolar Nerve: A Technique Case Series". In: *J. Oral Implantol.* 47.4 (2021), pp. 333–341.

[18] B. Vetromilla et al. "Complications associated with inferior alveolar nerve repositioning for dental implant placement: a systematic review". In: *Int. journal oral maxillofacial surgery* 43.11 (2014), pp. 1360–1366.

[19] M. Chiapasco et al. "Alveolar distraction osteogenesis for the correction of vertically deficient edentulous ridges: a multicenter prospective study on humans". In: *J. Prosthet. Dent.* 92.6 (2004), p. 587.

[20] J.L. Lopez-Cedrun. "Implant rehabilitation of the edentulous posterior atrophic mandible: the sandwich osteotomy revisited". In: *Int. J. Oral & Maxillofac. Implant.* 26.1 (2011).

[21] D. Buser et al. "Long-term stability of osseointegrated implants in bone regenerted with the membrane technique. 5-year results of a prospective study with 12 implants". In: *Clin. oral implants research* 7.2 (1996), pp. 175–183.

[22] C. Dahlin, U. Lekholm, and A. Linde. "Membrane-Induced Bone Augmentation at Titanium Implants. A Report on Ten Fixtures Fallowed From 1 to 3 Years After Loading". In: *Int. J. Periodontics & Restor. Dent.* 11.4 (1991).

[23] M. Roccuzzo et al. "Vertical alveolar ridge augmentation by means of a titanium mesh and autogenous bone grafts". In: *Clin. Oral Implant. Res.* 15.1 (2004), pp. 73–81.

[24] T. von Arx and B. Kurt. "Implant placement and simultaneous ridge augmentation using autogenous bone and a micro titanium mesh: a prospective clinical study with 20 implants". In: *Clin. oral implants research* 10.1 (1999), pp. 24–33.

[33] J. Jensen, O. Reiche-Fischel, and S. Sindet-Pedersen. "Nerve transposition and implant placement in the atrophic posterior mandibular alveolar ridge". In: *J. oral maxillofacial surgery* 52.7 (1994), pp. 662–668.

[34] J. Castellano-Navarro et al. "Neurosensory issues after lateralisation of the inferior alveolar nerve and simultaneous placement of osseointegrated implants". In: *Br. J. Oral Maxillofac. Surg.* 57.2 (2019), pp. 169–173.

[25] I.H. Garoushi et al. "Evaluation of the effect of the lateralized inferior alveolar nerve isolation and bone grafting on the nerve function and implant stability.(Randomized Clinical Trial)". In: *Clin. Implant. Dent. Relat. Res.* 23.3 (2021), pp. 423–431.

[26] M. Peleg et al. "Lateralization of the inferior alveolar nerve with simultaneous implant placement: a modified technique". In: *Int. J. Oral & Maxillofac. Implant.* 17.1 (2002).

[27] H. Mahmood-Hashemi. "A modified technique of inferior alveolar nerve repositioning: results in 11 patients". In: *Acta Medica Iran.* (2006), pp. 273–276.

[28] G. Gasparini et al. "Long Term Follow-Up in Inferior Alveolar Nerve Transposition: Our Experience". In: *BioMed Res. Int.* 2014.1 (2014), p. 170602.

[29] E. Dursun et al. "Management of limited vertical bone height in the posterior mandible: short dental implants versus nerve lateralization with standard length implants". In: *J. Craniofacial Surg.* 27.3 (2016), pp. 578–585.

[30] F. Kablan. "Superioralization of the inferior alveolar nerve and roofing for extreme atrophic posterior mandibular ridges with dental implants". In: *Ann. Maxillofac. Surg.* 10.1 (2020), pp. 142–148.

[31] A. Khojasteh et al. "The effect of a platelet-rich fibrin conduit on neurosensory recovery following inferior alveolar nerve lateralization: a preliminary clinical study". In: *Int. J. Oral Maxillofac. Surg.* 45.10 (2016), pp. 1303–1308.

[32] P.F. Nocini et al. "Clinical and electrophysiological assessment of inferior alveolar nerve function after lateral nerve transposition". In: *Clin. Oral Implant. Res.* 10.2 (1999), pp. 120–130.

[35] R. Tabrizi et al. "Can platelet-rich fibrin accelerate neurosensory recovery following sagittal split osteotomy? A double-blind, split-mouth, randomized clinical trial". In: *Int. journal oral maxillofacial surgery* 47.8 (2018), pp. 1011–1014.