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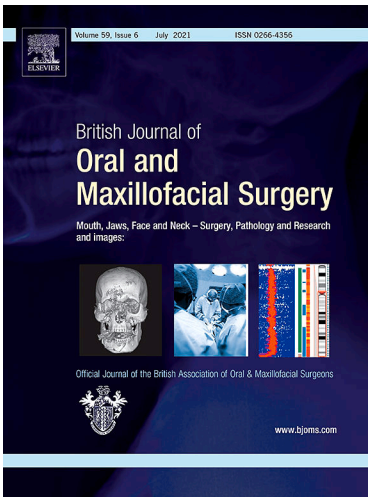

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Evaluating the Influence of the Mandibular Canal Trajectory on the Duration of Postoperative Paraesthesia in Patients Undergoing Inferior Alveolar Nerve Lateralization: A Prospective Cohort Study

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Abstract

This prospective cohort study aims to evaluate the influence of the mandibular canal trajectory on the duration of postoperative paraesthesia in patients undergoing inferior alveolar nerve lateralization (IANL). Twenty patients received a total of 50 dental implants, and their postoperative paraesthesia duration, implant success rate, and anatomical variables were assessed. All patients experienced temporary neurosensory disturbances postoperatively during the first week, but none reported permanent issues at the 12-month follow-up. The median paraesthesia duration was 120 days, and no significant differences were detected between genders, anaesthesia types, or patient satisfaction. No significant association was found between the mandibular canal trajectory and postoperative paraesthesia duration. The implant success rate was 100%, with all implants integrating successfully. Our findings suggest that IANL is a safe and effective method for dental implant placement in atrophic mandibles.

Keywords: Mandibular canal; Paraesthesia; Dental implants; Survival analysis; Mandibular nerve lateralization

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Introduction

Dental implant rehabilitation in the posterior region of the mandible often presents challenges due to the inferior alveolar nerve (IAN) and limited bone height. Inferior alveolar nerve lateralization (IANL) is a surgical technique utilised to overcome these challenges and achieve dental implant placement with an appropriate length and without the need for bone-grafting procedures.[1, 2] However, the most significant potential complication associated with IANL is postoperative paraesthesia, which can impact patient satisfaction and overall treatment success.[1, 3]

Damage may occur at various stages of the IANL procedure, including flap elevation, mental nerve tension, osteotomy for nerve exposure, or implant insertion.[4, 5] Damage or complications may arise from exerting excessive traction with a small contact area instrument on the neurovascular bundle during its extraction from the canal or nerve traction during surgery, which could lead to ischemia of the neurosensory bundle.[6] The distance of the mandibular canal from the lateral cortical border and the length of the opening window in the anterior-posterior direction affect nerve traction. Thus, the measurement of this distance could impact the duration of postoperative paraesthesia.

This study hypothesises that the trajectory of the mandibular canal influences the duration of postoperative paraesthesia. To test this hypothesis, we assessed the impact of the mandibular canal trajectory on postoperative paraesthesia in patients undergoing IANL.

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Materials and Methods

In this prospective cohort study at Marmara University Dentistry, we examined IANL patients from June 2016 to December 2021. Inclusion criteria involved atrophied posterior mandibles, no graft/implant history. Exclusions included radiotherapy, bone-modifying agents, >10 cigarettes/day, and neurosensory impairment.

The data collection included demographic information (age, gender) and surgical details (duration of surgery, intraoperative findings). We also documented intraoperative and postoperative complications to assess their potential impact on the outcomes. Additional information collected included bone width above the inferior alveolar canal, implant stability quotient (ISQ) values, and patient satisfaction. Patients were scheduled for regular follow-up visits at 10 days, one month, two months, three months, six months, and one-year post-surgery. We assessed the surgical site, healing progress, paraesthesia, implant stability, and patient satisfaction at these visits. We specifically evaluated postoperative paraesthesia duration during these follow-up appointments to understand its relationship with the mandibular canal trajectory.

Mandibular Canal Trajectory

Our study evaluated the mandibular canal trajectory using anatomic spatial factors observed in . Cone-beam computed tomography (CBCT) scans, namely the distances from the nerve canal to the buccal cortex and from the nerve canal to the inferior border of the mandible. In our study, virtual implants (I1, I2, and I3) were strategically positioned at the estimated implant placement sites to support prostheses in the locations where teeth 5, 6, and 7 would typically be found. When tooth 5 was present in cases, measurements were taken with reference to a line passing through the long axis of tooth 5 (referred to as L1). This approach standardized the measurement process, allowing for consistent and comparable results (Fig. 1).

Postoperative Paraesthesia Assessment

We employed Westermark et al.'s subjective method to assess neurosensory disturbance (NSD) pre- and post-surgery.[7] The neurosensory function of the lower lip and chin was graded on a five-point scale (fully numb, practically numb, impaired sensitivity, almost normal, and completely normal). NSD was absent before surgery. After surgery, von Frey hairs and a sharp mechanical probe were used to measure light touch and pain perception. Degrees 4 and 5 (near normal and totally normal) indicated sensory recovery (NSD negative), whereas degrees 1, 2, and 3 (completely numb, almost numb, and diminished sensitivity) indicated NSD positivity. One examiner without clinical knowledge assessed the patients.

Complications

Intraoperative complications were recorded during the surgical procedure, including iatrogenic nerve injury, haemorrhage, and mandibular fracture. Postoperative complications were evaluated at 10 days, one month, three months, six months, and 12

months after the surgery. These complications included neurosensory disturbances (e.g., hypoesthesia, paraesthesia, hyperesthesia), implant failure, infection, and mandibular fracture.

Implant Success Criteria

Implant stability was determined using ISQ values as measured by resonance frequency analysis (RFA) during the implant placement and follow-up visits. All ISQ values above 60 were considered stable. Success, defined as fully functional and complication-free implants one year post-placement, adhered to Albrektsson's criteria: firm anchorage, no radiolucent areas, annual bone loss ≤ 0.2 mm after the first year, and no pain, discomfort, or infection.[8]

Surgical Procedure

The surgical procedure for IANL was performed under local anaesthesia. After achieving adequate anaesthesia, a full-thickness mucoperiosteal flap was elevated extending at least 1 cm beyond the anticipated site of the osteotomy. The anterior osteotomy extended 2 cm posterior to the mental foramen, and the posterior osteotomy extended 1 cm posteriorly beyond the intended position of the most distal implant.

The IAN was exposed by creating a window in the cortical bone of the mandible using a piezosurgery device. Once exposed, the nerve was gently separated from its bony canal with a freer elevator. The IAN was then carefully mobilised and retracted laterally to allow access to the underlying bone for implant placement. Implants were placed according to the manufacturer's guidelines to ensure primary stability and optimal positioning. The IAN was subsequently placed back in its original position without using a membrane (Fig. 2).

The buccal cortical plate was fixed with an osteosynthesis screw and the mucoperiosteal flap was reapproximated with resorbable sutures. Patients were provided with postoperative care instructions, which covered pain management with analgesics, maintenance of oral hygiene, and a soft diet in the first week following the surgery. Implant loading was performed after a healing period of three to six months depending on the individual patient's bone quality and implant stability.

Statistical Analysis

Data were collected and analysed using Prism software (version 9, GraphPad Software Inc., Boston, MA, USA). Descriptive statistics were calculated for all continuous variables, while frequencies and percentages were used for categorical variables. The normality of the data was tested with the Shapiro-Wilk test, and the non-parametric Mann-Whitney U-test was carried out to compare paraesthesia duration between male and female groups since the data were not normally distributed. Additionally, one-factor analysis of variance (ANOVA) was conducted to assess the relationship between patient satisfaction, anaesthesia type, and paraesthesia duration. Significant pairwise differences between the three mandibular inferior border thickness groups (I1-I2, I1-I3,

and I2-I3) were identified through one-factor ANOVA followed by the Bonferroni post-hoc test for multiple comparisons. Spearman's rank correlation coefficients were calculated to determine the associations between paraesthesia duration and anatomical variables. To examine the associations between NSD at different time points and the anatomical measurements, Spearman correlation analyses were performed. The correlations between NSD (10 days, 1 month, 3 months, and 12 months) and variables including thicknesses of the buccal cortex, diameter of the nerve canal, and thickness of the mandibular inferior border were assessed. A survival analysis employing the Kaplan-Meier method and the log-rank test was conducted to examine the relationship between anatomical measurements and postoperative paraesthesia duration. Hazard ratios (Exp(B)) and their 95% confidence intervals were computed with Cox proportional hazards regression analysis. A p-value of less than 0.05 was considered statistically significant for all tests.

Results

This study involved 20 patients with postoperative paraesthesia ranging in duration from 30 to 360 days. The sample included 12 male participants and 8 female participants. There was a slightly higher proportion of males, and the females were generally older than the males. Various measurements were taken, including bone width above the alveolar canal, buccal cortex thickness at three points (I1, I2, I3), mandibular inferior border thickness at three points (I1, I2, I3), nerve canal diameter, and surgery duration. No significant differences between genders were observed for these variables (Table 1). A total of 50 dental implants were placed in the 20 patients.

All patients experienced neurosensory disturbance postoperatively in the first week. The median paraesthesia duration for both the male and female groups was 120 days, and no significant difference was found between them ($U=39$, $p=0.521$, $r=0.16$). Additionally, no significant relationship was detected between gender, patient satisfaction (five-point scale), anaesthesia type, or paraesthesia duration (days). The results showed that none of the participants experienced permanent anaesthesia during the study period. Significant pairwise differences between all three mandibular inferior border thickness groups (I1-I2, I1-I3, and I2-I3) were identified through one-factor ANOVA and the Bonferroni post-hoc test with p-values of less than 0.05.

Spearman correlations revealed no significant association between paraesthesia duration and any of the anatomical variables (Table 2). Correlation analyses were conducted to investigate the relationships between NSD (Neurosensory Disturbance) at different time points (10 days, 1 month, 3 months, and 12 months) and various anatomical measurements. The results showed that there were no significant associations between NSD at any time point and thicknesses of the buccal cortex, diameter of the nerve canal, or thickness of the mandibular inferior border. However, a medium, positive correlation was observed between NSD at 10 days, 1 month, and 6 months, respectively, and bone width above alveolar canal, although these correlations were not statistically significant ($p > .05$). Additionally, NSD at 12 months demonstrated a significant high, negative correlation with Diameter of the nerve canal ($r = -0.51$, $p = .022$). Similarly, a survival analysis examining the relationship between anatomical measurements and postoperative paraesthesia duration yielded no statistically significant coefficients, which emphasises the lack of a clear relationship

between these variables and paraesthesia survival rates (Fig. 3). Regarding implant success, our study demonstrated a 100% success rate, with all 20 patients experiencing successful implant integration and no implant loss during the follow-up period (Fig. 4).

Discussion

Inferior alveolar nerve lateralization has few complications, but neurosensory disturbances are the most common due to the nerve manipulation. Our study examined the impact of the mandibular canal trajectory and related factors on postoperative paraesthesia duration in IANL patients. An important factor that can influence the likelihood of these complications is the configuration of the mandibular canal, including the spatial position of the canal, individual differences, such as a bifid mandibular canal,[9] various facial types,[10] cranial and caudal height changes due to alveolar atrophy,[11] and sex and age.[12, 13] In addition, the lingual positioning of the mandibular canal[14, 15] or a significant reduction in the vertical body dimension of the mandible[16] may increase the risk of fracture. Understanding these factors can improve postoperative outcomes and decision-making for patients and clinicians considering IANL procedures.

There is a wide range of literature on postoperative neurosensory disturbance duration, and it has produced varying results. In our study, all patients experienced neurosensory impairment in the first week, but none exhibited it at the 12-month follow-up. According to our survival analysis, the first and second months were important cut-off points. Some studies have reported complete recovery in all patients,[17, 18] while others have documented persistent disturbances in a small percentage of cases.[3, 5] For instance, Abayev and Juodzbalys have found that 99.47% of IANL procedures were associated with transient neurosensory disturbances, and only 0.53% showed permanent neural damage.[5] In another study, 100% of patients experienced dysesthesias in the first week, but this figure gradually decreased to 3.7% by the end of the 18-month follow-up.[19] Similarly, Hashemi has found that neurosensory disturbances were present in all cases one week postoperatively. Twenty-six patients still experienced it after one month, and three reported it after six months, with tingling sensations remaining permanent in the latter.[20] In our study, all patients experienced decreased paraesthesia over time, and none had permanent issues. Overall, the majority of studies, including ours, suggest that neurosensory disturbances often decrease over time, and only a small percentage of cases result in permanent issues.

Common causes of nerve damage include traction from a spatula during the mucoperiosteal flap procedure, pressure due to inflammation or fluid retention around the nerve, and mandibular body fracture.[5] The neurosensory disturbance period may relate to the compression and tension applied to the IAN during the nerve retraction procedure as well as the direct contact between the IAN and the dental implants.[4, 21] In our study, we found no association between the mandibular canal trajectory and the duration of postoperative paraesthesia. We also measured the wall thickness lateral to the nerve and found that it did not significantly affect postoperative paraesthesia, which was potentially because of the small number of patients and the use of piezo surgery in all procedures. The design of the window, including its anterior and posterior borders, may have also played a role in the lateralization of the nerve and contributed to our low paraesthesia rate. Additionally, the presence of a thick buccal

cortex and a lingually oriented trajectory of the mandibular canal did not influence the postoperative neurosensory disturbance duration.

In our study, we encountered no major complications during IANL. However, complications such as mandibular fracture, infection, implant loss, and neurosensory disturbances have been reported in the literature.[3] Although mandibular fracture following IAN reposition is infrequent, it has been associated with a significant loss of structural integrity during buccal cortex osteotomy and multiple implant placements.[14, 16]

The implant success rate in our study was 100%, which is consistent with the high success rates of IANL procedures reported in the literature. Implant survival rates at IANL sites vary from 93.8% to 100%.[22] The success rate was determined using the clinical-radiological criteria proposed by Zarb and Albrektsson,[23] and implant stability was assessed in ISQ units[24] ranging from 1 to 100. These assessment methods have been widely applied in the literature to establish implant success rates and stability.[25]

Some possible limitations to this study should be acknowledged. First, there was a relatively small sample size, which could affect the generalisability of the results. In addition, there was no control group, which makes it difficult to compare the outcomes of IANL with those of other implant placement techniques.

Conclusions

In conclusion, our study demonstrates that IANL (inferior alveolar nerve lateralization) is a safe, effective, and predictable approach for implant placement in the atrophic mandible, leading to high success rates and minimal complications. Our findings indicate that temporary neurosensory disturbance is the most common complication observed.

Conflict of Interest

None.

Ethics Statement/Confirmation of Patient Permission

The study was approved by the institutional Ethics Committees (2016-31). Informed consent was obtained from all participants prior to their inclusion in the study. The study was registered on clinicaltrials.gov (NCT05811741).

References

Journal Pre-proofs

1. Castellano-Navarro JM, Castellano-Reyes JJ, Hirdina-Castilla M, et al.Neurosensory issues after lateralisation of the inferior alveolar nerve and simultaneous placement of osseointegrated implants. Br J Oral Maxillofac Surg 2019; 57:169-73.

2. Hirsch JM, Branemark PI. Fixture stability and nerve function after transposition and lateralization of the inferior alveolar nerve and fixture installation. Br J Oral Maxillofac Surg 1995; 33:276-81.

3. Palacio Garcia-Ochoa A, Perez-Gonzalez F, Negrillo Moreno A, et al. Complications associated with inferior alveolar nerve reposition technique for simultaneous implant-based rehabilitation of atrophic mandibles: A systematic literature review. J Stomatol Oral Maxillofac Surg 2020; 121:390-6.

4. de Vicente JC, Pena I, Brana P, et al. The use of piezoelectric surgery to lateralize the inferior alveolar nerve with simultaneous implant placement and immediate buccal cortical bone repositioning: A prospective clinical study. Int J Oral Maxillofac Surg 2016; 45:851-7.

5. Abayev B, Juodzbalys G. Inferior alveolar nerve lateralization and transposition for dental implant placement. Part II: A systematic review of neurosensory complications. J Oral Maxillofac Res 2015; 6:e3.

6. Hassani A, Kalantar Motamedi MH, Saadat S. Inferior alveolar nerve transpositioning for implant placement: A textbook of advanced oral and maxillofacial surgery, 2013.

7. Westermark A, Bystedt H, von Konow L. Inferior alveolar nerve function after sagittal split osteotomy of the mandible: correlation with degree of intraoperative nerve encounter and other variables in 496 operations. Br J Oral Maxillofac Surg 1998; 36:429-33.

8. Albrektsson T, Zarb G, Worthington P, et al. The long-term efficacy of currently used dental implants: A review and proposed criteria of success. Int J Oral Maxillofac Implants 1986; 1:11-25.

9. Orhan K, Aksoy S, Bilecenoglu B, et al. Evaluation of bifid mandibular canals with cone-beam computed tomography in a Turkish adult population: A retrospective study. Surg Radiol Anat 2011; 33:501-7.

10. Dos Santos Oliveira R, Maria Gomes Oliveira A, Cintra Junqueira JL, et al. Association between the anatomy of the mandibular canal and facial types: A cone-beam computed tomography analysis. Int J Dent 2018; 2018:5481383.

11. Ulm CW, Solar P, Blahout R, et al. Location of the mandibular canal within the atrophic mandible. Br J Oral Maxillofac Surg 1993; 31:370-5.

12. Velasco-Torres M, Padial-Molina M, Avila-Ortiz G, et al. Inferior alveolar nerve trajectory, mental foramen location and incidence of mental nerve anterior loop. Med Oral Patol Oral Cir Bucal 2017; 22:e630-5.

13. Yamashita FC, Iwaki LCV, Yamashita AL, T, et al. Position of the mandibular canal before and after bilateral sagittal split ramus osteotomy: A cone beam computed tomographic study. Br J Oral Maxillofac Surg 2022; 60:279-85.

14. Losa PM, Cebrian JL, Guinales J, et al. Mandibular fracture after inferior alveolar nerve lateralization: A rare and misunderstood complication. J Craniofac Surg 2015; 26:e682-3.

15. Kan JY, Lozada JL, Boyne PJ, et al. Mandibular fracture after endosseous implant placement in conjunction with inferior alveolar nerve transposition: A patient treatment report. Int J Oral Maxillofac Implants 1997; 12:655-9.

16. dos Santos PL, Gaujac C, Shinohara EH, et al. Incomplete mandibular fracture after lateralization of the inferior alveolar nerve for implant placement. J Craniofac Surg 2013; 24:e222-4.

17. Martinez-Rodriguez N, Barona-Dorado C, Cortes-Breton Brinkmann J, et al. Implant survival and complications in cases of inferior alveolar nerve lateralization and atrophied mandibles with 5-year follow-up. Int J Oral Maxillofac Surg 2016; 45:858-63.

18. Lorean A, Kablan F, Mazor Z, et al. Inferior alveolar nerve transposition and reposition for dental implant placement in edentulous or partially edentulous mandibles: A multicenter retrospective study. Int J Oral Maxillofac Surg 2013; 42:656-9.

19. Martinez-Rodriguez N, Barona-Dorado C, Cortes-Breton Brinkmann J, et al. Clinical and radiographic evaluation of implants placed by means of inferior alveolar nerve lateralization: A 5-year follow-up study. Clin Oral Implants Res 2018; 29:779-84.

20. Hashemi HM. Neurosensory function following mandibular nerve lateralization for placement of implants. Int J Oral Maxillofac Surg 2010; 39:452-6.

21. Rathod M, Kshirsagar RA, Joshi S, et al. Evaluation of neurosensory function following inferior alveolar nerve lateralization for implant placement. J Maxillofac Oral Surg 2019; 18:273-9.

22. Kan JY, Lozada JL, Goodacre CJ, et al. Endosseous implant placement in conjunction with inferior alveolar nerve transposition: An evaluation of neurosensory disturbance. Int J Oral Maxillofac Implants 1997; 12:463-71.

23. Zarb GA, Albrektsson T. Towards optimized treatment outcomes for dental implants. J Prosthet Dent 1998; 80:639-40.

24. Meredith N, Book K, Friberg B, et al. Resonance frequency measurements of implant stability in vivo. A cross-sectional and longitudinal study of resonance frequency measurements on implants in the edentulous and partially dentate maxilla. Clin Oral Implants Res 1997; 8:226-33.

25. Sennerby L, Meredith N. Implant stability measurements using resonance frequency analysis: Biological and biomechanical aspects and clinical implications. Periodontol 2000 2008; 47:51-66.

Journal Pre-proofs

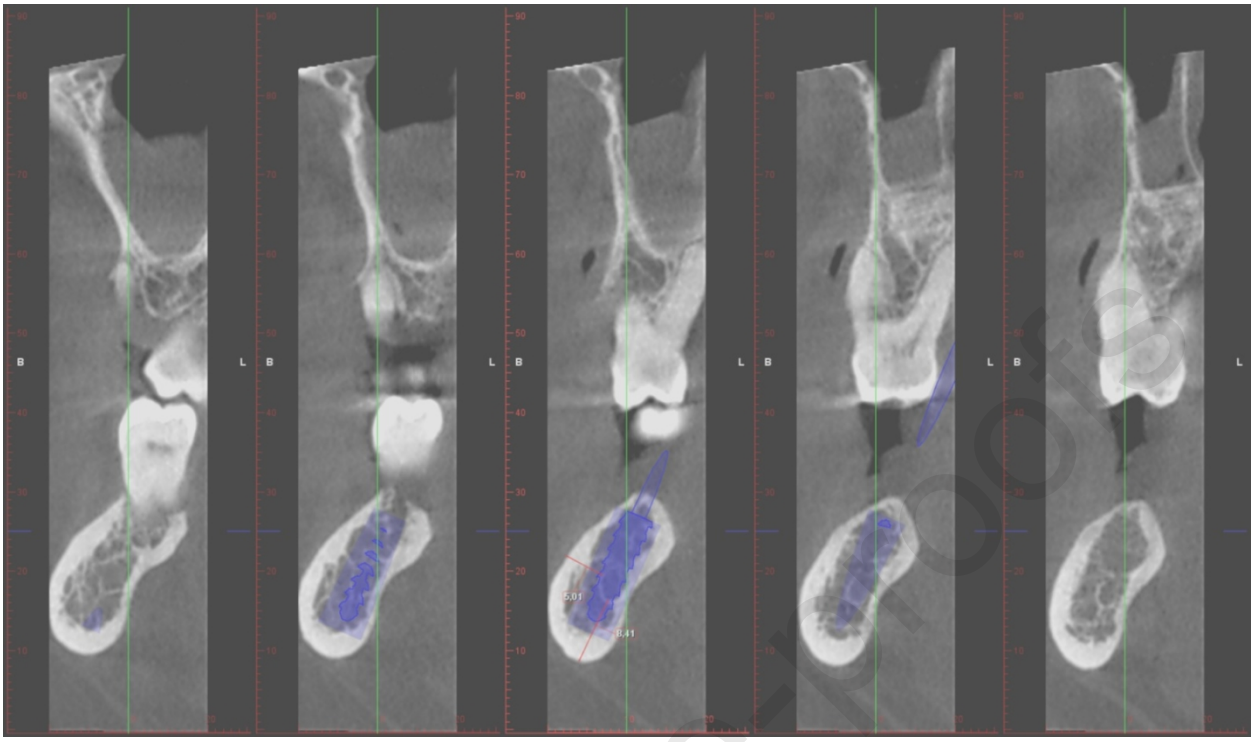

Fig. 1. Measurement of thickness of buccal cortex and mandibular inferior border.

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		Gender		
		Male	Female	*p* Value
	Frequency	12	8	
Age	Mean	52.5	56.63	0.15
	Std. Deviation	6.01	5.63	
Bone width above alveolar canal	Mean	4.93	4.95	0.97
	Std. Deviation	0.84	0.8	
Thicknesses of the buccal cortex I1	Mean	3.08	2.98	0.34
	Std. Deviation	0.27	0.15	
Thicknesses of the buccal cortex I2	Mean	2.91	2.87	0.52
	Std. Deviation	0.29	0.16	
Thicknesses of the buccal cortex I3	Mean	2.71	2.73	0.91
	Std. Deviation	0.27	0.15	
Thickness of the mandibular inferior border I1	Mean	6.47	6.12	0.25
	Std. Deviation	0.3	0.38	
Thickness of the mandibular inferior border I2	Mean	6.99	6.69	0.39
	Std. Deviation	0.28	0.41	
Thickness of the mandibular inferior border I3	Mean	7.46	7.23	0.18
	Std. Deviation	0.26	0.41	
Diameter of the nerve canal	Mean	2.57	2.53	0.67
	Std. Deviation	0.14	0.12	
Duration of Surgery (min.)	Mean	88.92	80	0.18
	Std. Deviation	13.37	13.09	

Table 1. Descriptive table comparing male and female subjects across various measurements, with Mann-Whitney test p-values indicating no significant difference between genders for any of the variables assessed. Abbreviations:from anterior to the posterior I1, first virtual implant; I2, second virtual implant; I3, third virtual implant.

	Paresthesia duration (days)		Duration of surgery	
	r	p (2-tailed)	r	p (2-tailed)
Thicknesses of the buccal cortex I1	0.19	0.41	0.46	***0.04**
Thicknesses of the buccal cortex I2	0.19	0.41	0.45	0.45
Thicknesses of the buccal cortex I3	0.05	0.82	0.35	0.13
Thickness of the mandibular inferior border I1	0.05	0.83	0.48	***0.03**
Thickness of the mandibular inferior border I2	0.07	0.75	0.41	0.06
Thickness of the mandibular inferior border I3	0.13	0.57	0.29	0.21
Diameter of the nerve canal	0.42	0.06	0.31	0.19

Table 2. Correlation between paraesthesia duration, duration of surgery, and various anatomical measurements. Asterisks (*) indicate statistically significant correlations ($p < 0.05$). Abbreviations:from anterior to the posterior I1, first virtual implant; I2, second virtual implant; I3, third virtual implant

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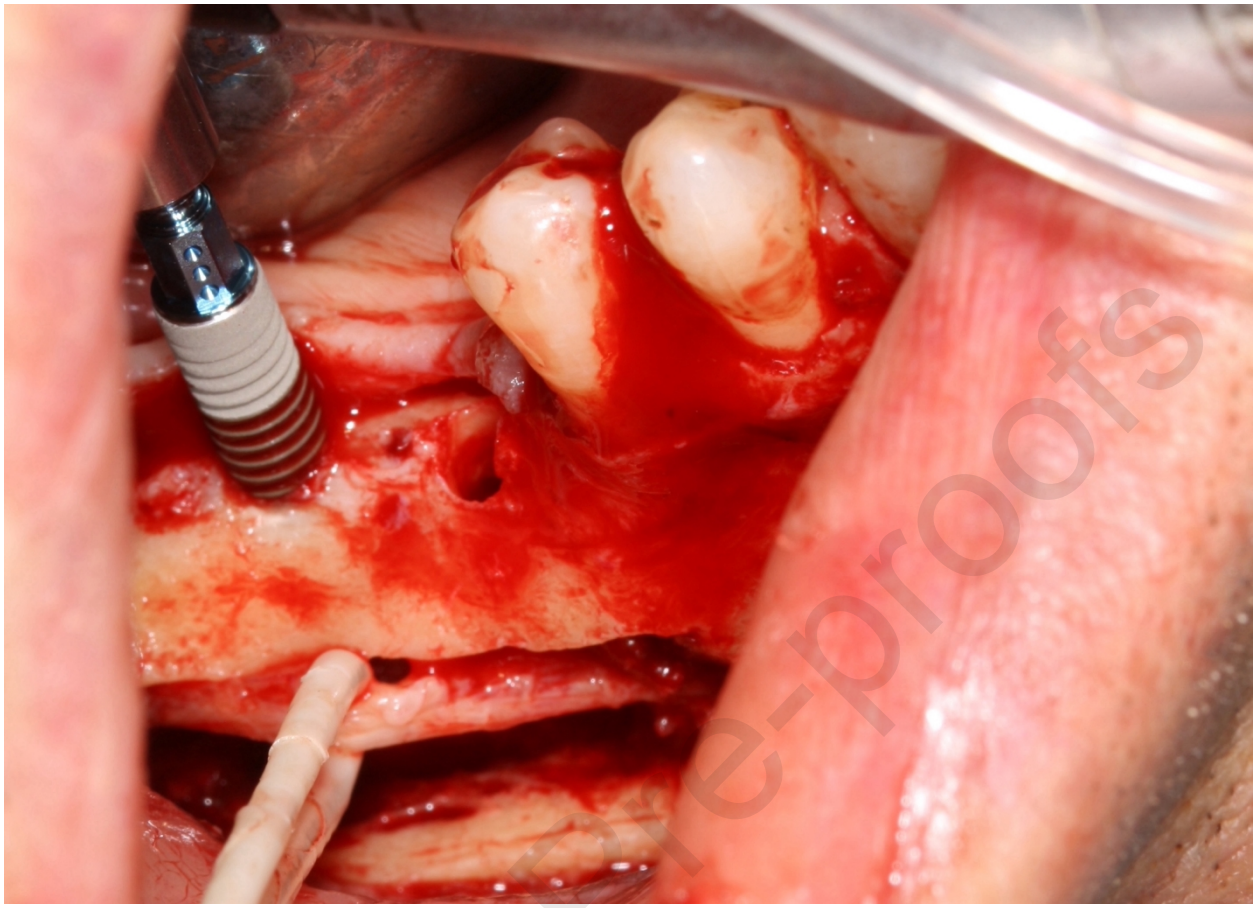

Fig. 2. Intra-op view of careful retraction the nerve and implant placement.

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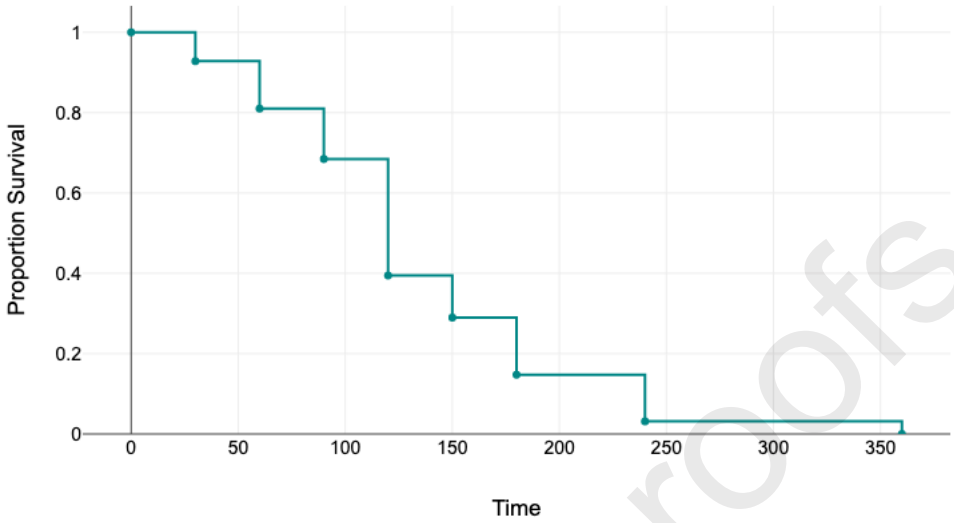

Fig. 3. Survival analysis of postoperative paraesthesia duration in relation to anatomical factors: buccal cortex thickness, mandibular inferior border thickness, and nerve canal diameter.

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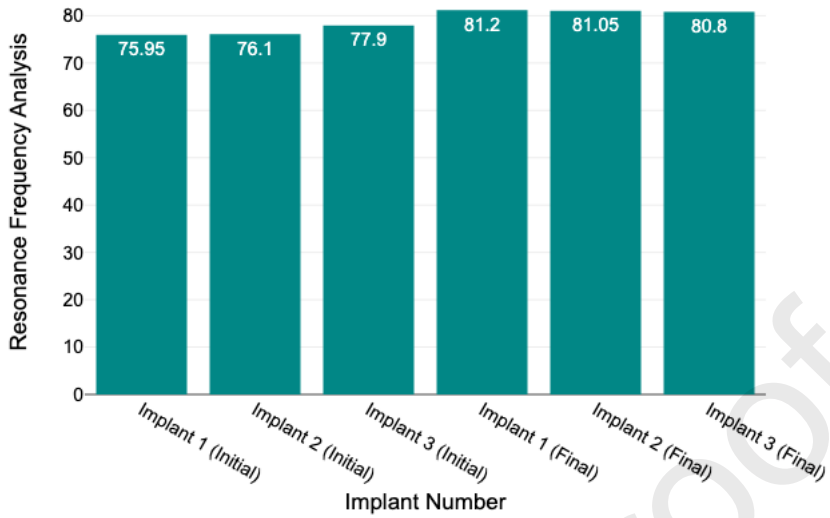

Fig. 4. Distribution of RFA values for the 50 dental implants placed in the study.

		Gender		
		Male	**Female**	***p* Value**
	Frequency	12	8	
Age	Mean	52.5	56.63	0.15
	Std. Deviation	6.01	5.63	
Bone width above alveolar canal	Mean	4.93	4.95	0.97
	Std. Deviation	0.84	0.8	
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	r	p (2-tailed)	r	p (2-tailed)
Thicknesses of the buccal cortex I1	0.19	0.41	0.46	**0.04***
Thicknesses of the buccal cortex I2	0.19	0.41	0.45	0.45
Thicknesses of the buccal cortex I3	0.05	0.82	0.35	0.13
Thickness of the mandibular inferior border I1	0.05	0.83	0.48	**0.03***
Thickness of the mandibular inferior border I2	0.07	0.75	0.41	0.06
Thickness of the mandibular inferior border I3	0.13	0.57	0.29	0.21
Diameter of the nerve canal	0.42	0.06	0.31	0.19

Table 2. Correlation between paraesthesia duration, duration of surgery, and various anatomical measurements. Asterisks (*) indicate statistically significant correlations ($p < 0.05$). Abbreviations:from anterior to the posterior I1, first virtual implant; I2, second virtual implant; I3, third virtual implant

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