Neurosensory Recovery Following Skeletonization of Mental Nerve During Open Reduction & Internal Fixation for Mandibular Fractures

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Submitted for Publication: 16-02-2023
Accepted for Publication 21-10-2023

How to Cite: Ahmed M, Zulfiqar G, Khan SFA, Iftikhar B, Mahmood A. Neurosensory Recovery Following Skeletonization of Mental Nerve During Open Reduction & Internal Fixation for Mandibular Fractures. APMC 2023;17(4):421-426. **DOI: 10.29054/APMC/2023.1241**

ABSTRACT

Background: Intraoral open reduction and internal fixation (ORIF) procedures used to treat mandibular fractures can result in neurosensory abnormalities due to soft tissue and nerve manipulation. While treating fractures located in the parasymphysis and anterior body regions, where the inferior alveolar and mental nerves are located, there is limited access which can impede correct reduction and hinder the use of optimal fixation. To counter these problems, better access can be gained through skeletonization of the mental nerve, which is known to result in neurosensory disturbances. However, the extent of neurosensory deficits that may result from these procedures and the degree of their recovery remain unknown in current literature. **Objective:** The primary purpose of our study was to evaluate and correlate the objective and subjective neurosensory recovery of the mental nerve following skeletonization during Open Reduction and Internal Fixation of mandibular fractures. **Study Design:** This was a prospective observational study. **Settings:** The adult subjects having mandibular fractures treated at Jinnah Hospital, Lahore Pakistan, a level III tertiary care hospital. **Duration:** The study duration was from July 1, 2022 and December 31, 2022. **Methods:** Demographic details were taken and preoperative objective and subjective neurosensory assessment was performed. Following surgery, postoperative objective and subjective neurosensory assessment was performed on post op day 1, after 1 and 6 weeks. Collected data was analysed with significance level of <0.05. **Results:** Twenty-four subjects who completed regular follow-up visits for 6 weeks were included in this study. All subjects had objective or subjective neurosensory deficit preoperatively. Following surgery, all the subjects had FSR grade S0 and subjective loss of sensation at immediate postoperative assessment after surgery. 87.5% of the subjects had complete objective and subjective neurosensory recovery at the end of 6 weeks. There was a significant negative correlation between objective and subjective neurosensory recovery during the initial stages of the study, which became non-significant by the end of 6 weeks. **Conclusion:** Following mental nerve skeletonization during ORIF of subjects with mandibular fractures having some degree of preoperative paraesthesia, a majority of subjects achieved complete neurosensory recovery 6 weeks postoperatively. Therefore, it is expected for a skeletonized mental nerve to return to normal function within 2 months after ORIF for mandibular fractures.

Keywords: *Neurosensory recovery, Mental nerve, Mandibular fractures.*

INTRODUCTION

Neurosensory abnormalities commonly result from the soft tissue and nerve manipulation used in modern intraoral open reduction and internal fixation (ORIF) procedures to treat mandibular fractures.[1] The intraoral technique offers an attractive and generally less traumatic alternative to extraoral mandibular approaches, which may produce unsightly scars and facial nerve abnormalities. However, the presence of inferior alveolar and mental nerves close to some mandible fractures, including those of the parasymphysis and anterior body, may restrict access, prevent correct reduction, and hinder the use of optimal fixation. The degree of mandibular neurosensory deficits that may emerge from these techniques and the extent of their recovery has yet to be established in the literature. An efficient and successful method for treating mandibular fractures in the parasymphysis and anterior body region with ORIF involves employing Champy's Principle by using upper and lower border miniplates with mono-cortical screw.[2-5] Proper access, reduction, and fixation of upper and lower border load-sharing mini-plates for these fractures will typically necessitate mental nerve skeletonization. Skeletonization of a sensory intact mental nerve will always result in postoperative mental nerve neurosensory impairments, varying from transitory hypoesthesia to permanent anaesthesia and perhaps dysesthesia.[6] This is true even if the patient is already traumatically paresthetic. The mental nerve's functional and subjective neurosensory recovery following skeletonization in ORIF of mandibular fractures is not fully understood. This study's main research question was: "What is the time to subjective and functional sensory recovery of the mental nerve in adult participants treated with mental nerve skeletonization for intraoral open reduction and rigid internal fixation for mandible fractures. The secondary question was, "What is the relationship between functional neurosensory recovery and subjective neurosensory deficit intensity in adult individuals treated with mental nerve skeletonization for intraoral open reduction and stiff internal fixation of mandible fractures. We hypothesize that regardless of age or fracture severity, subjective and functional sensory recovery following mental nerve skeletonization for ORIF of mandible fractures will occur in the majority of subjects, with strong correlations between FSR and subjective mental nerve sensory deficit intensity. There is a need for more literature in our part of the world regarding the extent and degree of neurosensory deficit following surgical management of mandibular fractures and the correlation between subjective and objective neurosensory recovery. This study will help to understand the degree to which the manipulation of a skeletonized mental nerve during surgery causes neurosensory deficit and how long it takes to recover. It will also establish the correlation between the subjective perception of the subjects regarding the neurosensory recovery of their mental nerve and the objective results of neurosensory assessment.

The specific objectives of this study were to 1) estimate the time required for the mental nerve to regain subjective and functional neurosensory function following skeletonization in ORIF of mandible fractures and 2) compare the relationships between the subjective perception of the severity of neurosensory deficit and the clinically determined objective value. The primary null hypothesis was that functional sensory recovery of the mental nerve following skeletonization during open reduction and internal fixation in patients with mandibular fractures will not return by postoperative week 6. The primary alternative hypothesis was that functional sensory recovery of the mental nerve following skeletonization during open reduction and internal fixation in patients with mandibular fractures will return by postoperative week 6. The secondary null hypothesis was that there would not be any significant correlation between functional sensory recovery of mental nerve and subjective neurosensory deficit following skeletonization of the mental nerve in ORIF of mandible fractures. The secondary alternative hypothesis was that there would be a significant correlation between functional sensory recovery of mental nerve and subjective neurosensory deficit following skeletonization of the mental nerve in ORIF of mandible fractures.

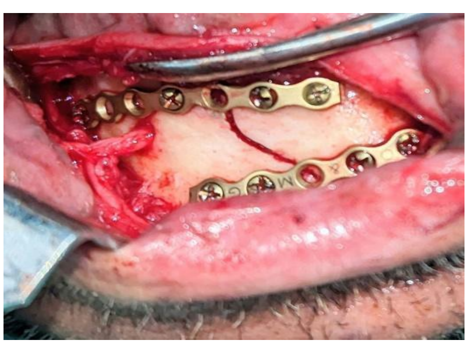
METHODS

The study was a prospective observational study. Subjects included in this study were managed by the Department of Oral and Maxillofacial Surgery at Jinnah Hospital, Lahore, Pakistan, a level III Tertiary care hospital. The patients were treated between July 1 2022 and December 31, 2022. The study was approved by the Ethical Review Board (Ref. No.: 280/21/07/2022/S1 ERB Dated: 21/07/2022) of Allama Iqbal Medical College, Lahore and was designed and conducted according to the Declaration of Helsinki and Good Clinical Practice guidelines. Sample size calculated from win-pepi with significance level of 5% power of study of 80%, Assumed SD Subjective Neurosensory Assessment (VAS) in Experimental group of 0.699 to detect a difference of 0.3 required sample size of 24 subjects from the study of Cillo *et al*.[7] We included consenting adults of both genders having mandibular fractures being treated with intraoral open reduction and internal fixation necessitating skeletonization of mental nerve for exposure and access, with at least some degree of neurosensory deficit preoperatively at the affected side and no neurosensory disturbance on the infraorbital nerve distribution of the opposite side. While we excluded Patients whose fractures were treated by closed reduction, treated by extraoral approach, grossly comminuted fractures requiring load-bearing fixation, pan-facial fractures or any concomitant midfacial fractures, history of previous surgical treatment involving the mandible, history of acquired or congenital neurosensory deficits, or having mandibular fractures that did not necessitate skeletonization of mental nerve, were excluded from the study. After approval from the hospital ethical committee, all included subjects were asked to provide written informed consent. The basic information of the subjects, i.e., name, age, gender, and medical history, were noted. A general physical examination was carried out on all subjects. Fracture pattern and location were identified. Preoperative subjective and objective neurosensory assessment was done.

Surgical Technique: Following splinting the upper and lower dental arches using Erich's archbar, a mandibular vestibular incision was made at the fracture site above the level of the mental foramen. Subperiosteal dissection was done till the fracture was exposed. The dissection was continued to skeletonize the mental nerve, and the branches were bluntly dissected to be freed from the soft tissue to allow proper retraction. Following the reduction of the fracture, occlusion was established, and intermaxillary fixation was done. After intermaxillary fixation, the reduced fracture segments were fixed with a 2mm load-sharing miniplate at the lower and upper border of the mandible with a minimum of 2 screws on each side of the fracture line.[2,4] Once fixation was complete, the surgical site was thoroughly washed using copious amounts of normal saline, and primary closure was done in a layered fashion using resorbable Vicryl sutures. Intermaxillary fixation was kept for two weeks postoperatively while the patient was on a liquid diet. (Figure-1,2)

Figure 1: Orthopantomogram showing reduction and fixation

Figure 2: Per-operative clinical photograph showing skeletonization of nerve and reduction and fixation of fracture



Based on the Mental and Infraorbital nerve distribution, the face was divided into four quadrants, each supplied by the mentioned nerves on either side. The quadrant with the mandibular fracture was defined as the affected side, while the quadrant on the opposite side with the intact infraorbital nerve was defined as the control. A professional who was unaware of the affected side carried out neurosensory evaluations of the four quadrants. The neurosensory examinations were done at three levels. Level A consisted of static two-point discrimination assessed with the help of a geometric divider. Level B consisted of tensile light touch assessment using von Frey's monofilaments and brush-stroke direction. Level C consisted of the evaluation of pain sensation via the pinprick method. A standardized method for peripheral sensory nerve evaluation, known as Functional Sensory Recovery (FSR), approved by the Medical Research Council (MRC), was used to categorize patients according to the findings of the assessment.[3] The subject was considered to achieve FSR if they had an intact light touch, pain sensation, and a two-point discrimination of less than 20mm. (Figure-3) The MRC scoring system consists of 6 levels: S4 (good localization of stimulus with 2-point discrimination 2 to 6 mm), S3+ (as per S4, but with 2-point discrimination 7 to 12 mm), S3 (return of some superficial pain/tactile sensation without overreaction and the presence of 2-point discrimination less than 12 mm), S2+ (return of some superficial pain/tactile sensation with overreaction), S2 (return of some superficial/tactile sensation), S1 (return of deep cutaneous pain), and S0 (anaesthetic) (Figure 3). MRC scores (S0 to S4) were recorded preoperatively and postoperatively on day 1, at 1 week and 6 weeks.

Figure 3: Medical Research Council approved FSR grading

FSR	Grade	Required Parameters
No	S0	No sensation
	S1	Pain sensation (deep)
	S2+	Pain sensation (superficial)
	S2	Pain and touch sensation
	S2+	Pain and touch sensation with some overreaction
Yes	S3	As S2+, without overreaction and w/static 2PD 15-20 mm
	S3+	As S3, static 2PD 7-15 mm
	S4	As S3+, static 2PD < 7 mm

The subject's eyes were closed for the pinprick and monofilament neurosensory assessments. In the middle of each quadrant, perpendicular contact to the skin was made by the monofilament until a minor bend was noticed or a pinprick sensation was experienced. In case the subject reported no feeling, a larger monofilament was utilized until the individual reported feeling the monofilament. The threshold was again verified by ensuring the patient could not feel the earlier, smaller filament.[8,9] A geometric divider measured on a ruler was used to conduct the two-point discrimination neurosensory evaluation. The assessment was started with the divider in a closed position. Perpendicular contact was made to the skin at the centre of the quadrant with the closed divider, and the divider was opened incrementally, each increment approximately 1mm, until the subject could differentiate between the two pointed ends of the divider. The distance between the two pointed ends was measured on a ruler. This was repeated three times, and the average value was noted.[8] A ten-point visual analogue scale (VAS) was used to measure the intensity of subjective mental and contralateral infraorbital neurosensory deficit. The VAS had a scale of 0 to 10, with 10 representing severe neurosensory impairment and 0 representing no neurosensory impairment. The subjective assessment was done once preoperatively and postoperatively on day 1, after 1 week and at 6 weeks. The correlation between objective and subjective neurosensory deficit assessments at the control and affected sites was completed with the Pearson correlation coefficient comparing FSR and VAS for each postoperative visit. All the patients were optimized for surgery, and a single surgical team performed open reduction and internal fixation with mental nerve skeletonization under standard protocols. Postoperative subjective and objective neurosensory assessment was done on day one, 1 week and 6 weeks. All the data was noted on a predefined Performa. The data was analysed using SPSS Version 27.0. The categorical variables, i.e. gender, objective neurosensory assessment, and subjective neurosensory assessment, are presented as frequency and percentages. The quantitative variables, i.e. age, are presented as mean and standard deviation. The normality of the data was checked using the Shapiro-Wilk Test. The relevant parametric and non-parametric tests were applied. Pearson correlation coefficient was applied for the correlation between categorical variables, and an independent T-test was applied for the correlation between categorical and quantitative variables. A p-value of <0.05 was taken as significant.

RESULTS

Twenty-four subjects who completed all the follow-up postoperative protocol requirements to 6 weeks were included in the data analysis for this study. The cohort who completed the study had a mean age of 27 years (SD: 1.44). 15 subjects (62.5%) were under 30 years of age, whereas 9 subjects (37.5%) were over 30 years of age (Table-1). The study population was predominantly constituted of male subjects, with 21 subjects (87.5%) and a female population of 3 subjects (12.5%). 12 subjects (50%) had FSR grading of S3+, whereas 3 subjects (12.5%) had preoperative FSR grade S3, and 9 subjects (37.5%) had preoperative FSR grade S4. The immediate postoperative assessment of FSR was done on the same day of surgery, and all subjects had an FSR grade of S0 (no sensation). This result is also comparable with other studies. The second postoperative assessment occurred an average of 7 days after surgery, and 17 subjects (70.8%) had achieved an FSR grade of S2 (return of some superficial/tactile sensation). 4 subjects (16.66%) had achieved FSR grade S3+, and 3 subjects (12.5%) had FSR S1. This was further improved by the third postoperative assessment, an average of almost 42 days after surgery, with 17 subjects (70.8%) achieving an FSR grade of S4 (pain and touch sensation without overreaction and static two-point discrimination of less than 7 mm). 4 subjects (16.66%) achieved FSR grade S3+, whereas 3 subjects (12.5%) had an FSR grade S2 by the end of 6 weeks. All subjects had preoperative VAS scores of equal to or < 4. The postoperative assessment of VAS was done on the same day of surgery, and 20 subjects (83.33%) had a VAS score of 2, whereas 4 subjects (16.66%) had a VAS score of 4. The immediate postoperative subjective neurosensory assessment of VAS was done on the same day of surgery. All subjects had a VAS score greater than 8 for the affected mental neurosensory deficit intensity with 12 subjects (50%) had a VAS score of 9, eight (8) subjects (33.33%) had a VAS score of 10 and four (4) subjects (16.66%) had a VAS score of 4. The second postoperative subjective neurosensory assessment was an average of 7 days after surgery. All subjects had VAS greater than 4 for affected mental neurosensory deficit intensity, with 13 subjects (54.16%) had a VAS score of 6, seven (7) subjects (29.1%) had a VAS score of 7 and four (4) subjects (16.66%) had a VAS score of 4.The third postoperative subjective neurosensory assessment occurred an average of 42 days after surgery, and 87.5% of subjects had achieved subjective neurosensory deficit intensity VAS of 2 or less, with seventeen subjects having VAS=1 and four subjects having VAS=2. Three subjects had a VAS=6 after 42 days. Statistically significant negative correlations between two-point discrimination and subjective neurosensory assessment of the skeletonized mental nerve distribution were found preoperatively ($r = 0.44$, $P < .05$) and at postoperative week 1 ($r = 0.81$, $P < .001$). Postoperative week 6 did not have statistically significant correlations. The correlation of preoperative objective neurosensory assessment (FSR value) and age was assessed by the Pearson test of significance, which came out to be statistically non-significant with a p-value of 0.445, which means age has no effect on preoperative FSR score. The correlation of preoperative subjective neurosensory assessment score and age was assessed by the Pearson test of significance, which came out to be statistically non-significant with p=0.586, which means age has no effect on preoperative VAS score with p 0.586.

DISCUSSION

Mandibular fractures are common facial injuries that often necessitate surgical intervention for proper alignment and healing to restore function and aesthetics. During ORIF of mandibular fractures, the surgeon may encounter the mental nerve, especially when dealing with fractures involving the mandibular body, parasymphysis or symphysis. This exposure is necessary for better visualization and access to fracture segments, but it poses a significant risk to the mental nerve's integrity. The mental nerve is a branch of the Inferior Alveolar Nerve responsible for providing sensation to the lower lip and chin region, making it a critical concern in maxillofacial surgery. Any neurosensory disturbance involving the mental nerve is seen as a serious discomfort to a person as it directly affects their speech articulation, feeding, chewing, ability to hold fluid in the oral cavity and greatly increases the chances of injury by lip biting, thus reducing their overall quality of life. As discussed above, at times, exposure and manipulation of the mental nerve during surgical management of certain mandibular fractures cannot be avoided without compromising on the accuracy of reduction or the rigidity of fixation. It is also established in literature that exposure of the mental nerve in such a way always results in some degree of neurosensory deficits.[10] Therefore, it is imperative to understand the factors governing the neurosensory recovery of the mental nerve after skeletonization. The term "skeletonization" refers to the exposure of the nerve by removing or retracting the soft tissues covering it. The proximity of the mental nerve to the surgical site makes it susceptible to inadvertent injury or skeletonization. The extent of mental nerve skeletonization can vary widely depending on the surgical technique, surgeon's experience, and the fracture's complexity. While some surgeries may only involve minimal nerve manipulation, others may necessitate partial or complete skeletonization. In most cases, sensory deficits are temporary, gradually improving over time. Sensation typically begins to return within weeks to months after surgery as nerve fibres regenerate and heal. However, complete recovery may take several months to a year or more. The primary specific aim of this study was to determine the time taken to objective and subjective neurosensory recovery. By the end of this study, 87.5% of the subjects had complete objective neurosensory recovery as well as subjective perception of complete recovery. These results are comparable to a previous study by Cillo *et al*.[7] in which subjects with no preoperative neurosensory disturbance were taken. The slight difference in the results from the study mentioned above can be explained by considering the subjects in the mentioned study had no preoperative neurosensory deficit, whereas, in our study, the subjects had at least some degree of neurosensory disturbance preoperatively, which was not seen in previous studies. Another specific aim of this study was to determine the correlation between subjective and objective neurosensory recovery. The statistically significant negative correlation between the objective and subjective assessment, which was initially seen during the study, was ultimately proven to be non-significant by the end of the study. This is also comparable to the study by Cillo et al.[7] The initial negative correlation can be explained by the suggestion that subjective perception of neurosensory deficit intensity is affected by the subject's overall physical condition and state of mind. This was suggested by Shintani *et al*,[11] who also declared that subjective neurosensory assessment must be combined with objective assessments for accurate results. The subjective assessment may reveal certain neurosensory disturbances not indicated in quantitative esthesiometry.[11] As the neurosensory recovery continued over the duration of our study, the negative correlation was found to become non-significant by the end. This gives an interesting insight into the neurophysiology of neurosensory recovery, which, although it is beyond the scope of this study, can be a valuable start-point for future studies in an effort to understand this complex mechanism more clearly. Monitoring and managing neurosensory recovery are essential aspects of postoperative care. Surgeons must educate patients on realistic expectations and the potential for sensory changes. Additionally, careful surgical techniques, including minimizing nerve manipulation and protecting neural tissue during the procedure, can help optimize sensory outcomes. Research in the field of maxillofacial surgery and neurosensory recovery following the skeletonization of the mental nerve during procedures like open reduction and internal fixation (ORIF) of mandibular fractures has been ongoing. Studies have consistently shown that neurosensory recovery following mental nerve skeletonization can vary widely among patients. Factors such as age, the extent of nerve injury, and the specific surgical technique employed all play a role in determining the speed and degree of recovery.[12,13]

Neurosensory recovery often begins within weeks to months following surgery. However, complete recovery may take several months to a year or more, and some patients may experience permanent alterations in sensation. While many patients experience substantial sensory recovery, some may have persistent sensory alterations, such as tingling, numbness, or hypersensitivity. These changes can be long-lasting or permanent in some cases. Younger patients tend to have better outcomes in terms of neurosensory recovery. Nerve regeneration and reinnervation capacities naturally decline with age, making older individuals more prone to slower or less complete recovery. The surgical approach and technique used can significantly impact sensory outcomes. Surgeons with experience in delicate nerve preservation techniques achieve better results in terms of minimizing sensory disturbance.[6,14]

Some studies have explored the use of protective measures, such as nerve wraps or conduits, to shield the exposed mental nerve during surgery. These approaches aim to reduce the risk of nerve injury and improve postoperative sensory outcomes.[15] Sensory re-education exercises are sometimes recommended to help patients adapt to altered sensation and improve sensory function. These exercises can aid in the recovery process. In rare cases where patients experience severe and persistent sensory deficits, revision surgery may be considered to improve sensory outcomes.[16] However, this approach is typically reserved for select cases. A few limitations of our study include the short duration of follow-up, a relatively small sample size, as well as the participation of a single institute. Future studies should include a larger sample from multiple centers observed for a longer duration of time. In conclusion, following mental nerve skeletonization during ORIF of subjects with mandibular fractures having some degree of preoperative paraesthesia, a majority of subjects achieved complete neurosensory recovery after 6 weeks postoperatively. Therefore, it is expected for a skeletonized mental nerve to return to normal function within 2 months after ORIF for mandibular fractures.

CONCLUSION

Following mental nerve skeletonization during ORIF of subjects with mandibular fractures having some degree of preoperative paraesthesia, a majority of subjects achieved complete neurosensory recovery 6 weeks postoperatively. In conclusion, it is expected for a skeletonized mental nerve to return to normal function within 2 months after ORIF for mandibular fractures.

LIMITATIONS

A relatively small sample size observed over a limited duration of time at a single centre.

SUGGESTIONS / RECOMMENDATIONS

For future studies on this topic, conducting a multi-centre study with a larger sample size and for a longer duration is recommended.

CONFLICT OF INTEREST / DISCLOSURE

The authors declare that they have no conflicts of interest.

ACKNOWLEDGEMENTS

We would like to thank our mentor Dr. Gulraiz Zulfiqar (HOD, Oral and Maxillofacial Department, Allama Iqbal Medical College/Jinnah Hospital, Lahore) for his continuous help and guidance throughout the study period. We would also like to thank Dr. Mehwish Akhter (Allama Iqbal Medical College) for assisting us with the statistical analysis of the study data.

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