ORIGINAL ARTICLE

INFERIOR ALVEOLAR NERVE IMPAIRMENT SUBSEQUENT TO REDUCTION OF MANDIBULAR FRACTURES

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ABSTRACT

Background: Consequent Injury to branches of the trigeminal nerve is a well-recognized risk of dental and oral surgical procedures. Neurosensory impairment of inferior alveolar nerve is seen in traumatic mandibular fractures and after the reduction of these fractures. We conducted a study at Oral & Maxillofacial Surgery Department of Lahore Medical and Dental College from November 2016 to July 2017, to assess the frequency of inferior alveolar nerve impairment after reduction of open and close mandibular fractures.

Methods: In this randomized controlled trial 60 patients with mandibular fractures between lingula and symphysis and matching the inclusion criteria were inducted and allocated into two groups; Group 1 patients were treated by open reduction and internal fixation by 2mm mini hole plate. Group 2 were treated by closed reduction achieved by eyelet intermaxillary fixation. The inferior alveolar nerve function was clinically evaluated on seventh postoperative day. The results of these evaluations were recorded in a specially designed proforma. Data was analyzed by using SPSS Version 10.0.

Results: The mean age of patients was 25.25 ± 9.207 years (range 15 to 60). In this study there were 53 (88.3%) males and 7 (11.7%) females (male to female ratio 7.57: 1). Using chi-square test we found closed reduction group was statistically significant [p-value = 0.001 (< 0.0001)]. in getting the higher NST score compared to open reduction.

Conclusion: There is relatively greater risk of sensory impairment of inferior alveolar nerve with open reduction and internal fixation compared to closed reduction of mandibular fractures.

KEYWORDS: Inferior alveolar nerve, mandibular fractures,peripheral nerve injuries, neurosensory test

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INTRODUCTION

Injury to branches of the trigeminal nerve is a documented risk of dental and oral surgical procedures. The most commonly injured branches of the trigeminal nerve are the inferior alveolar nerve (IAN) and the lingual nerve, while injury to the infraorbital nerve occurs less commonly. Injury of the long buccal nerve, greater palatine nerve and nasopalatine nerve is usually insignificant[1-4].

Nerve injuries may occur during third molar removal, orthognathic surgery, management of maxillofacial trauma, implant surgery, preprosthetic surgery, salivary gland surgery, surgery for oral pathology e.g. tumors or cysts, endodontic therapy and local anesthetic injections[5-11].

Mandible is second most commonly fractured bone of the facial skeletal and constitutes 79.7% of all facial fractures, incidence of mandibular fractures

in Pakistan is 67%[12,13]. There are different modalities for the management of mandibular fractures; close reduction and indirect fixation is commonly achieved by maxillio-mandibular fixation (MMF) using arch bars, ivy loops, or suspension screws and wiring[14,15]. Open reduction involves surgical exposure of fracture site and reduction followed by direct fixation with 2mm titanium plate and screws 2x7 mm in size.. Open reduction and internal fixation is desirable due to higher patient comfort and early restoration of function, conversely it may upturn the hazard of inferior alveolar nerve injury compared to close reduction[16]. According to literature frequency of abnormal neurosensory test (NST) were present in 40.9% of cases treated with open reduction while no instance of abnormal neurosensory test (0%) was seen in cases treated with closed reduction[17,18].

Neurosensory deficits of inferior alveolar nerve are seen frequently in traumatic mandibular fractures. Incidence of post-traumatic inferior alveolar nerve deficit ranges from 5.7% to 58.5% preoperatively, o.4 to 91% postoperatively and permanent impairment of the nerve has been reported up to 45%[17-19]. This injury results in loss of sensations in the mental and lower lip regions affecting quality of life[20]. Depending upon the nature and severity of nerve disturbance sensory impairments of inferior alveolar nerve may present as paresthesia, hypoesthesia, hyperesthesia, dysesthesia and anesthesia of lower lip, chin and lower teeth. Patients may also complain of lip biting and compromised drinking, eating and talking[21.22].

The objective of this study was to apprise IAN disturbances concomitant with open and close reduction of mandibular fracture by evaluating the sensory impairment score for each patient. It possibly will promote us to re-establish our management guidelines regarding mandible fractures.

METHODS

This randomized clinical trial was conducted from November 20,2016 till July30, 2017 in the second largest city of Pakistan, Lahore. A total number of 60 patients presenting with mandibular fractures between lingula and symphysis and matching the inclusion criteria were recruited for the study, from the Department of Oral and Maxillofacial Surgery, Lahore Medical and Dental College. Permission was attained from the Research and Ethics Committee of the Institute to conduct this study. Anonymity of the patients was assured and an informed consent was obtained from each individual patient. Inclusion criteria set for the study was: 1) Patients within age range of 15 to 60 years from both genders. 2)Patients with fracture of mandible between lingula and symphysis, simple and compound fractures with displacement less than 5mm. 3)Patients with normal clinical neurosensory testing in inferior alveolar nerve region. Patients presenting with a severe head injury or a history of trigeminal neuralgia, sclerosis, diabetes (BSF>126 mg/dl and BSR>180 mg/dl) or fractures older than two weeks were excluded from the study. After comprehensive clinical and radiological assessment of patients with mandibular fracture and intact sensation of mental and lower lip region, 60 patients were selected for study and divided into two groups randomly by using lottery method. Group 1 patients were treated by open reduction along with direct internal fixation. All the open reductions were performed under general anesthesia by same operator, transoral approach with vestibular incision and direct fixation with 2mm miniplates using monocortical screws size of 2x7mm according to Shampys technique. Group 2 patients were treated with closed reduction achieved by digital manipulation of bony fragments and restoration of occlusion by eyelet intermaxillary fixation[23]. Neurosensory testing was performed on each patient on 7th postoperative day. During clinical neurosensory testing the patients closed their eyes and separate their lips comfortably. The lower lip and the mental region were divided into four zones, and each zone was measured separately Neurosensory testing followed the protocol of Zuniga and Essick[24] based on two point discrimination; measured by a vernier caliper having two pointed ends (Fig.1), proprioception as light touch was tested with a cotton wisk (Fig.2).and noxious stimuli was measured with a sharp dental prob. Neurosensory score was assigned between 0-4 after each test was repeated trice. Data was recorded on a specially designedproforma (attached as annexure-A).

Data was entered and analyzed using statistical package for social sciences (SPSS Version 10.0). Chi square test was test of significance to compare frequency of inferior alveolar nerve impairment in both groups, p-values less than or equal to 0.05 was considered to be significant.

Figure 1: Two point discrimination

Figure 2: Light touch

RESULTS

A total number of 60 patients with mandibular fractures between lingula and symphysis were included. Most of the patients i.e. 25 (41.7%) were in age group of 20 to 29 years, 19 (31.7%) were in 15 -19 years, 10 (16.7%) were in 30 - 39 years and 6 (10%) were in 40 – 60 years age group. The mean age of these 60 patients was 25.25 ± 9.207 years with an age range of 15 to 60 years. In this study there were 53 (88.3%) males and 7 (11.7%) females with 7.57: 1 male to female ratio.

The parasymphyseal fracture was seen in 30 (50%) of the patients in which 16(53.3%) were treated with open reduction and 14(46.7%) were taken in closed reduction. The body fracture was seen in 16 (26.7%) of the patients in which 6(20%) were treated with open reduction and 10 (33.3%) were managed with closed reduction. Angle fracture was also seen in 14 (23.3%) of the patients in which 8 (26.7%) were treated with open reduction and 6(20%) were managed with closed reduction. The fracture site in both study groups was statistically same, i.e. p-value = 0.492. **(Table 1)**

TABLE 1: FREQUENCY OF FRACTURE SITE IN BOTH STUDY GROUPS

		Study design		Total
		Open Reduction	Closed Reduction	
Fracture Site	Parasymphysis	16 (53.3%)	14 (46.7%)	30 (50%)
	Body	6 (20%)	10 (33.3%)	16 (26.7%)
	Angle	8 (26.7%)	6 (20%)	14 (23.3%)
Total		30 (100%)	30(100%)	60 (100%)
p-value = 0.492 (not-significant)				

According to the neurosensory testing (NST), 39 (65%) patients scored 4: 12 (40%) were treated with open reduction and 27 (90%) were treated with closed reduction. There were 13 (21.7%) patients who scored 3 out of which 11 (36.7%) were treated with open reduction and 2 (6.7%) were treated with closed reduction. Patients with NST 2 were 5 (6.7%) patients in which 4 (13.3%) were treated with open reduction and 1 (3.3%) was treated with closed reduction. 3 (10%) patients treated in open reduction got 1 score but none of the patients from close reduction group got the score 1. Using chi-square test we found closed reduction group was statistically significant in getting higher NST score compared to open reduction, i.e. p-value = 0.001 (< 0.0001). (Table 2)

TABLE 2:POST-OPERATIVE NEUROSENSORY SCORING AND FREQUENCY OF IAN DEFICIT (OPEN VERSE CLOSE REDUCTION OF MANDIBULAR FRACTURES)

		Study design		Total
		Open Reduction	Closed Reduction	
Score	4	12 (30.7%)	27 (69.3%)	39 (65%)
	3	11 (84.6%)	2 (15.4%)	13 (21.7%)
	2	4 (80%)	1 (20%)	5 (6.7%)
	1	3 (100%)	0 (0%)	3 (6.7%)
Neurosensory Deficit(NSD)	Yes	18(85.7%)	3(14.3%)	21(35%)
	No	12 (30.7%)	27 (69.3%)	39 (65%)

1. NST score
p-value = 0.001 (significant)closed reduction group was statistically significant in to get the higher NST score as compare to open reduction(< 0.0001).

2. Frequency of Neurosensory deficit
p-value = 0.000 (significant) patients treated with closed reduction group had significantly less NS deficit as compared to open reduction treatment, i.e. p-value = 0.000 (<0.0001).

There were 21 (35%) patients who had NS deficit or disturbance, in these 21 patients 18 (60%) belonged to open reduction and only 3 (10%) belonged to closed reduction. There were 27 (90%) of the closed reduction group who didn't have any NS deficit but in open reduction group 12 (40%) patients had NS defect or disturbance. Using chi-square test we have found that patients treated with closed reduction group had significantly less NS deficit compared to open reduction treatment, i.e. p-value = 0.000 (<0.0001).

DISCUSSION

Fractures of mandible can be managed by open reduction to achieve direct internal fixation or by close reduction and indirect fixation. Open reduction and internal fixation is more acceptable due to higher patient comfort and early restoration of function, however it may increase risk of inferior alveolar nerve injury compared to close reduction. There is dearth of data documenting IAN deficits associated with treatment of mandibular fractures. Moreover, there is inadequate information regarding prognosis for recovery of IAN neurosensory function. Previous data shows incidence of post-traumatic inferior alveolar nerve deficit ranges from 5.7% to 58.5% preoperatively, 0.4 to 91% postoperatively and permanent impairment of the nerve has been reported up to 45%[25-26].

In this study the mean age of patients was 25.52 ± 9.21 years with range of 15-60 years, male being the dominant gender (88.3%). This is comparable to study of Leslie R. Halpern and Kaban who reported mean age of 29.5 ± 11.2 years[14]. This study confirms that age has no significant effect on inferior alveolar nerve injuries postoperatively.

Tateykilizuka and Christian Lindqvist published the most relevant data available on the incidence of sensory deficit after mandibular fractures involving the mandibular canal. This was a study of sensory disturbances associated with rigid internal fixation of mandibular fractures. Theytreated 214 mandibular fractures with ORIF, 172 fractures (63.7%) were reevaluated for inferior alveolar nerve injuries, and 58.15% had postoperative inferior alveolar nerve dysfunction[27]. Marchena, Padwa and Kaban performed retrospective evaluation of 150 mandibular fractures at risk for IAN injury between the mandibular and mental foramina. Eighty four of their patients (56%) had a post-injury/pretreatment IAN abnormality. Patients with sensory disturbance had a significantly higher frequency of displaced fractures than those without sensory disturbance. Sixteen of 24 patients (66.7%) with an abnormal post-injury/ pretreatment sensory examination reported a permanent sensory deficit, 55% of these patients complained of impairment[28]. Giancarlo Renzi, Andrea Carboni and Filippo Giovannetti studied 97 consecutive patients with 103 facial fracture involving emergence areas of supra-orbital nerve, infra orbital nerve and the region between mandibular and mental foramin. The incidence of trigeminal impairment was 54.4% in non-displaced fractures and 88.2% in displaced fracture after treatment. In this study the incidence of inferior alveolar nerve injury in non-displaced mandibular fracture was 47.3%[29].The nerve may be stretched or compressed near the mandibular foramen during medial retraction, or directly severed by surgical instruments. If the nerve has been exposed, it may be necessary to manipulate it when detaching it from the bony fragments. The nerve may also be stretched as the distal bone fragment is mobilized and repositioned[30].

In one study frequency of abnormal neurosensory test (NST) found in 40.9% of cases treated with open reduction while no instance of abnormal neurosensory test (0%) was seen in cases treated with closed reduction.[31]

Other investigators are also of the view that neither age nor any other preoperative patient characteristic seems to be related to this complication though fracture displacement of more than 5 mm, normal preoperative neurosensory status and method of treatment are directly related to increased risk of inferior alveolar nerve injury[32]

Leslie R. Halpern and Kaban had conducted a cohort study composed of 61 patients with 97 fractured sites and concluded from their work that the patients with fracture displacement of more than 5mm had a 6-fold increased risk for an adverse effect on the neuro sensory score after treatment compared with patients with fracture displacement of less than 5mm[32]. In our study we included the patients who had the fracture displacement of less than 5mm to minimize the number of variables. The treatment was offered according to non-probability sampling that is closed reduction and open reduction with internal fixation. Eighteen patients (60%) who received ORIF had abnormal neuro sensory tests one week postoperatively, while in case of CRIF only three patients (10%) had abnormal neuro sensory test.

Among the twenty-one (35%) of our patients 13(21.7%) had neuro sensory scoring of 3 and five (6.7%) patients had neurosensory scoring of 2 and three patients had score 1. Those eighteen patients (27.4%) who had mild to moderate nerve injury were expected to recover within 8 weeks. In our three months follow up of IAN injury showed good prognosis and our 70% of the patient resumed loss sensation of IAN during first three months, this outcome is comparable to work of Renzi and Carboni. It is reported that complete recovery of severe sensory nerve injuries take about one year.[33,34]

Despite careful planning, observation of a margin

of safety and avoidance of any violation of the mandibular canal and mental foramen, the incidence of temporary nerve injury still ranges from 0.4% to 91% and the incidence of persisting injury ranges from 0% to 45%[18-19]. Lifting of the mucoperiosteal flap close to the mental foramen, or deeper drilling than planned, and use of compression plates may have caused the nerve injuries. The IAN travels within the mandibular bone and is therefore a supported nerve. Following injury, the nerve will remain in position and regenerate in a relatively short time unless displaced by fragments of bone from the roof of the canal. Thus, after injury to the IAN, good recovery is generally expected.[35]Further longitudinal prospective studies with long term follow up are required to see the recovery pattern of IAN in subsequentmonths.

CONCLUSION

This study concludes that one week postoperatively majority (60.3%) of patients from ORIF group had sensory disturbance of inferior alveolar nerve, whereas only 3(10%) patients from the CRF group had sensory disturbance of inferior alveolar nerve. However, among the 60.3% patients who underwent ORIF and had postoperative neurosensory disturbance of IAN, 36.7% had NST score of 3 and 13.3% had score 2 which are considered mild to moderate injuries with good prognosis and recover within one to three months.

Reduction of mandibular fractures may predispose inferior alveolar nerve to injury, affecting the quality of life and may be subject of litigation and malpractice suits. Result of this study may enforce to take patient consent regarding IAN nerve injury associated with particular treatment modality of mandibular fracture. It further helps to establish our management guidelines regarding mandible fracture. Further studies are required to isolate the causes of inferior alveolar nerve injury during the procedure of open reduction.

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REFERENCES

1. Rezzani R, Rodella LF, Buffoli B, Labanc M. A review of the mandibular and maxillary nerve supplies and their clinical relevance. Arch Oral Biol. 2012;57(4):323-34.
2. Renton T, Janjua H, Gallagher JE, Dalgleish M, Yilmaz Z. UK dentists' experience of iatrogenic trigeminal nerve injuries in relation to routine dental procedures: why, when and how often? Br Dent J. 2013;214(12):633-42.
3. Renton T, Yilmaz Z. Managing iatrogenic trigeminal nerve injury: a case series and review of the literature. Int J Oral Maxillofac Surg. 2012 ;41(5):629-37.
4. Deppe H, Mucke T, Wagenpfeil S, Kesting M, Linsenmeyer E, Tolle T. Trigeminal nerve injuries after mandibular oral surgery in a university outpatient setting-a retrospective analysis of 1,559 cases. Clin Oral Investig. 2014; 5(4): e2.
5. Bhat P, Cariappa K. M. Inferior Alveolar Nerve Deficits and Recovery Following Surgical Removal of Impacted Mandibular Third Molars. J Maxillofac Oral Surg. 2012;11(3):304–308
6. Renton, T., Yilmaz, Z., Gaballah, K. Evaluation of trigeminal nerve injuries in relation
tothird molar surgery in a prospective patient cohort. Recommendations for prevention
Int J Oral MaxillofacSurg 2012; 41: 1509-1518.
7. Nazir A, Akhtar MU, Ali S. Assessment of different patterns of impacted mandibular third molars and their associated pathologies. J Adv Med Dent Scie.2014;2(2):14¬22.
8. McLeod NMH, Bowe D.C. Nerve injury associated with orthognathic surgery. Part 2: inferior alveolar nerve. Br J of Oral & Maxillofac.2016;54(4) 366-371.
9. Toma M, Berghahn M, Loth S, et al. Articaine and paresthesia in dental anesthesia: neurotoxicity or procedural trauma? Dentaltown. 2013:64-71.
10. Greenstein G, Carpentieri JR, Cavallaro J. Nerve Damage Related to Implant Dentistry: Incidence, Diagnosis, and Management. Compendium 2015;36: 652-658.
11. Martins RS, Bastos D, Siqueira1 MG, HeiseCH, Manoel, Teixeira J. Traumatic injuries of peripheral nerves: a review with emphasis on surgical indication. ArqNeuropsiquiatr 2013;71(10):811-814
12. Chema S.A, Amin F. Incidence and causes of maxillofacial skeletal injuries at Mayo Hospital Lahore, Pakistan. Br J. Maxillofac Surg. 2009;44:232-4.
13. Anwar M, Haider Z. Surgical Management of Mandibular Fractures by Different Treatment Modalities. Journal of Surgery Pakistan.2013; 18 (4):167-171.
14. Reginald H B. Management of fractures of mandibular body and symphysis. 2013;25(4):601-616.
15. Rehman B, Iqbal A, Afsar H, Qiamud Din, Riaz S. A comparative analysis of extraoral and intraoral approaches in mandibular angle fracture. JKCD 2015;5:16-19.
16. EL-Anwar MW, Sayed El-Ahl MA, Amer HS.Open Reduction and Internal Fixation of Mandibular Fracture without Rigid MaxillomandibularFixation .Int.Arch. Otorhinolaryngol. 2015;19(4):343-348.
17. Bede SYH, Ismael WK, Al-Assaf DA, Omer SS. Inferior alveolar nerve injuries associated with mandibular fractures. J CraniofacSurg

2012;23(6):1776–1778
18. Tay ABG. Inferior alvealor nerve injury in trauma induced mandible fractures. Am Assoc Oral Maxillofac Surg. 2007;65:40.e1.
19. Halpern LR, Kaban L.B, Dodson T.B. Perioperative neurosensory changes associated with treatment of mandibular fractures. J. Oral Maxillofac Surg. 2004;62:576-81.
20. Smith JG, Elias LA, Yilmaz Z, Barker S, Shah K, Shah S, Renton T. The psychosocial and affective burden of post traumatic neuropathy following injuries to the trigeminal nerve. J Orofac Pain. 2013;27(4):293-303.
21. Seddon HJ. Three types of nerve injury. Brain. 1943;66:237-88.
22. Kaya Y, Sarikcioglu L. Sir Herbert Seddon (1903-1977) and his classification scheme for peripheral nerve injury. Childs Nerv Syst. 2014.
23. Rahman P, Aslam A, Yunus M, Luqman U, Saleem Mm, Mughal J, Shah Sa. Optimal and Efficient Management of Mandibular Fractures. Pakistan Oral & Dental Journal. 2015 35(2):198-203.
24. Poort LJ, van Neck JW, van der Wal KG. Sensory testing of inferior alveolar nerve injuries: a review of methods used in prospective studies. J Oral Maxillofac Surg. 2009 Feb;67(2):292-300.
25. Zuniga JR, Essick GK. A contemporary approach to the clinical evaluation of trigeminal nerve injuries. Oral MaxillofacSurgClin North Am. 1992;4:353.
26. Schenkel JS, Jacobsen C, Rostetter C, Grätz KW, Rücker M, Gander T. Inferior alveolar nerve function after open reduction and internal fixation of mandibular fractures. J Craniomaxillofac Surg. 2016;44(6):743-748.
27. Iizuka T, Christian Lindqvist C. Sensory disturbances associated with rigid internal fixation of mandibular fractures. J Oral MaxillofacSurg 1991;49(12):1264-1268.
28. Marchena JM, Padwa BL, Kaban LB. Sensory abnormalities associated with mandib-ular fractures: incidence and natural history. J Oral MaxillofacSurg 1998; 56:822–825
29. Renzi G, Carboni A. Posttraumatic trigeminal nerve impairment: A prospective analysis of recovery patterns in a series of 103 consecutive facial fractures. J Oral Maxillofac Surg.2004;62:1341-46.
30. Song Q, Li S, Patil PM. Inferior alveolar and mental nerve injuries associated with open reduction and internal fixation of mandibular fractures: a Seven Year retrospective study. J.Craniomaxillofac Surg. 2014; 42(7):1378-81.
31. Tay AB, Lai JB, Lye KW, Wong WY, Nadkarni NV, Li W. Inferior Alveolar Nerve Injury in Trauma-Induced Mandible Fractures. J Oral Maxillofac Surg. 2015;73(7):1328-1340.
32. Halpern LR, Kaban L.B, Dodson T.B. Perioperative neurosensory changes associated with treatment of mandibular fractures. J. Oral Maxillofac Surg. 2004;62:576-81.
33. Rehman A, Noreen R, Ahmad T, Din Q. Post traumatic inferior alveolar nerve impairment and recovery pattern in mandibular fractures, J. Khyber College of Dentistry. 2014; 4(2):29-33
34. Basra B et al. Study of mental nerve injury in cases of fractured mandible Journal of Maxillofacial Trauma 2014;3(3):53-9.
35. Meyer RA, Bagheri SC. Microsurgical reconstruction of the trigeminal nerve. Oral MaxillofacSurgClin North Am. 2013;25(2):287-302.

ANNEXURE A - PROFORMA

Comparison of the frequency of sensory impairment of inferior alveolar nerve in open and close reduction of mandibular fractures

OPD NO _____ **Date:** _____
Name: _____ **Age/Gender:** _____
Contact: _____ **Date of Management:** _____
Fracture Site: _____ **Study Group:** _____

CLINICAL POST-OPERATIVE NEUROSENSORY TESTING

	R	L
Two point discrimination		
Fine touch		
Pin prick		
Neurosensory Scoring (4-0)		

Abnormal NST **Yes** ☐ **No** ☐
Inferior Alveolar Nerve Impairment **Yes** ☐ **No** ☐