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INFERIOR ALVEOLAR NERVE SENSITIVITY CHANGES AFTER MANDIBULAR TRAUMA

The investigation was performed on 195 patients, who had fracture on mandibular angle zone. In control group pain thresholds of infraorbital nerve and inferior alveolar nerve did not differ significantly ($p > 0.05$). Consequently, lesion degree of inferior alveolar nerve and its functional recovery dynamics were estimated objectively according to pain threshold and lesion index of neural function. Stump dislocation extent has influence on neural lesion: the more expressed dislocation, the higher likelihood of severe lesion of inferior alveolar nerve. Three degrees of neural lesion were identified in the case of mandibular angle fracture. When minor lesion of inferior alveolar nerve took place (17.4%), sensation recovered in 21 days after stump reposition and fixation; moderate lesion of nerve (55.8%) had sensory recovery after 28 days, and in the case of severe lesion of nerve (26.6%) neural function did not recover even after 90 days.

Keywords: Inferior alveolar nerve damage, mandible fracture.

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Introduction

Facial injuries are one of the main issues in maxillofacial surgery. They amount from 3.2% up to 8% of all injuries (Aleksandrov et al., 1986). 79.7% of all facial injuries fall to mandibular fractures (Vernadsky, 1999). From 18 to 30% of cases, lower jaw has fracture on angle zone (Blaeser et al., 2003; Ellis, 1985; Hendler, 1998). 36% of injured people are 20-29 years old. the injury occurs 8 times more frequently in men than in women (Gabrielli et al., 2003). 74% of mandibular injuries occur due to violence at home.

When mandibular fracture occurs on angle zone, inferior alveolar nerve always is injured, and sensation disorders (lower lips, chin, alveolar process) emerge at its innervation point. Patients feel on this area discomfort, paresthesia, sometimes even pain. This condition has negative influence on psycho-emotional status of person and reduces working capacity. Lesions of inferior alveolar nerve and vascular bundle have an influence on course of lower jaw healing (Campbell et al., 1987; Colin, 1997). Different methods are used to evaluate neuro-functional condition. Some authors (Davis, 2000; Ellis et al., 1985) while investigating post-traumatic and post-operational lesions of inferior alveolar nerve used sharp/blunt differentiation and two-point discrimination for sensory abnormalities. Other researchers (Jaaskelainen, 1999; Van Sickels et al., 1989) point that for evaluation of inferior alveolar nerve condition, thermal method is more precise than tactile method. Some investigators support intervention surveys (Blanas et al, 2004): special needle electrode is pricked below zygoma against lower jaw temporal joint 4-4.5 cm deep by foramen ovale; the other electrode is put by mental foramen; then the time of stimulus spread is registered. This method is recommended as an objective diagnostic method for examination of inferior alveolar nerve lesions and recovery dynamics. We suggest that this method is not appropriate for every patient, because it is associated with additional injury by reexamining. It is proven by experiments that the mean speed of impulse spread through inferior alveolar nerve is 65 m/s with no differences depending on side (Kubilius, 2001).

The objective of the study was to explore functional condition of inferior alveolar nerve by fractures of mandibular angle, to estimate degree of the fracture, and to investigate the dynamics of neuro-functional recovery.

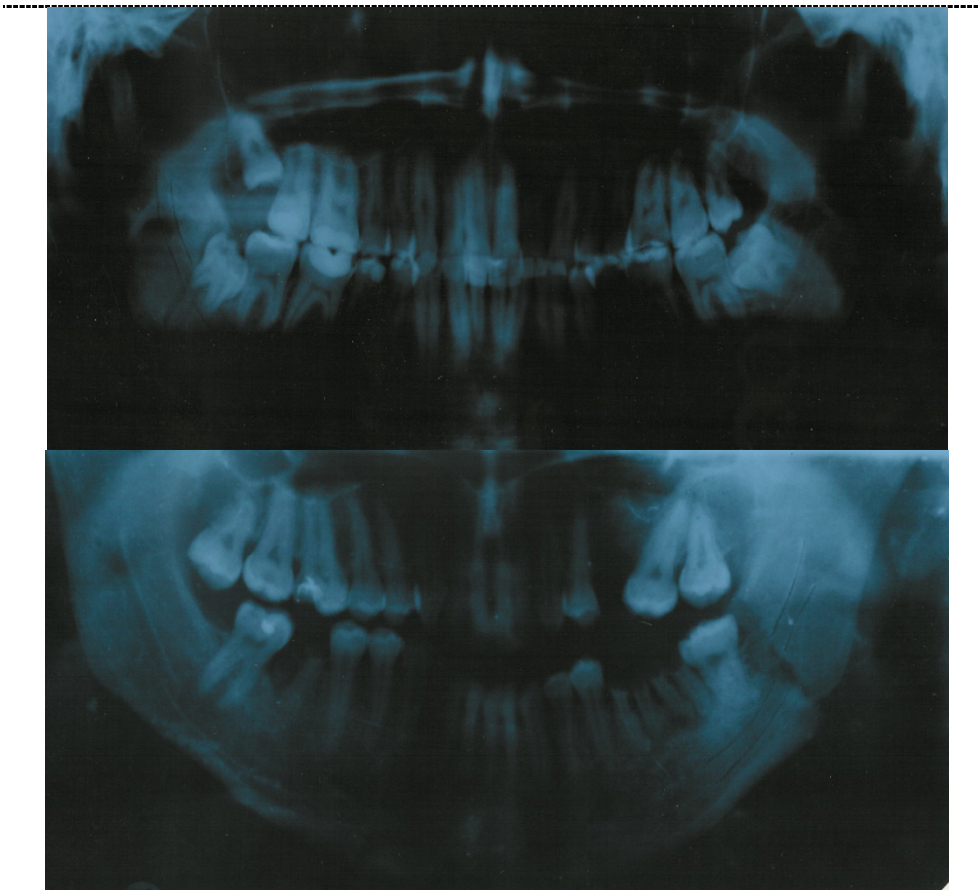
Material and methods

195 patients with mandibular angle fractures and miscellaneous lesions of inferior alveolar nerve were treated at the Department of Maxillofacial Surgery of Kaunas University of Medicine in 2006-2009. Control group comprised 20 persons who never had facial or jaw injuries. The distribution of respondents by age and sex is shown in Table 1. Among patients prevailed men (88.7%) and 15-44 years old persons (74.5%).

TABLE 1. THE DISTRIBUTION OF RESPONDENTS BY SEX AND AGE

Study participants	Sex				Age group								Total
	Male		Female		15-44		45-59		60-74		>74		
	n	%	n	%	n	%	n	%	n	%	n	%	
Patients	173	88.7	22	11.3	145	74.5	32	16.4	17	8.7	1	0.5	195
Control group	14	70	6	30	15	75	5	25	-	-	-	-	20

FIGURE 1. DISLOCATION OF THE FRACTURED MANDIBLE



The fractures of mandibular angle were divided into two groups: fractures with minimal dislocation and fractures with significant dislocation (Figure 1).

Lesion of inferior alveolar nerve was diagnosed by comparing the cutaneous sensation of pain to sharp needle prick at innervation point of injured side with the sensation of pain at innervation point of infraorbital nerve. When mandibular fracture was double and post-traumatic edema of soft tissues was present, the pain threshold of infraorbital nerve was measured in the side where post-traumatic outcomes at infraorbital zone were minimal and there were any subcutaneous bruising and scrapes.

The lesion degree of inferior alveolar nerve and recovery dynamics was estimated according to pain threshold. For measurement of pain threshold we used Pulptester Pt 1 device generating electric impulses of negative polarity. Measurements were performed on face skin, at mental foramen projection. Before measurement the skin was cleaned with 70° alcohol, and measuring was made on dry skin. Then it was calculated the lesion index of neural function by dividing pain thresholds of inferior alveolar nerve and infraorbital nerve. Measurements were performed 1-3 days before treatment and then 7, 14, 21, 28, 45, 60, and 90 days after stump reposition and fixation.

Statistical data analysis was executed using the program for Windows “Statistical Package for Social Sciences” (SPSS).

Results and discussion

The pain threshold of right side inferior alveolar nerve in control group was $47.2 \pm 3.5 \mu\text{A}$, left side - $47.4 \pm 3.3 \mu\text{A}$, right side infraorbital nerve $46.7 \pm 3.1 \mu\text{A}$, and left side - $46.9 \pm 3.3 \mu\text{A}$ (Table 2). The pain threshold differences at innervation point of inferior alveolar nerve and infraorbital nerve in control group did not reach the statistical significance ($p > 0.05$). This means, that for patients, who have bilateral inferior alveolar nerve lesions, the pain threshold can be compared with the pain threshold of infraorbital nerve.

By examining sensation disorders on patients’ skin at innervation zone of inferior alveolar nerve, hyperalgesia was identified in 34 patients (17.3%), and hypoalgesia - in 161 patients (82.4%). In 31 patients (15.8%) hyperalgesia was diagnosed with minimal stump dislocation (Table 3); in 3 patients (1.5%) it was indicated with significant stump dislocation. When significant stump dislocation was present, hypoalgesia was identified in 146 patients (74.8%) and in 15 patients (7.69%) it was diagnosed with minimal stump dislocation.

TABLE 2. PAIN THRESHOLD DATA OF CONTROL GROUP

Location of measurement	Pain threshold μA	
	Right side	Left side
Foramen mental projection on skin	47.2 ± 3.5	47.4 ± 3.3
Foramen infraorbitale projection on skin	46.7 ± 3.1	46.9 ± 3.3

TABLE 3. RELATIONSHIP BETWEEN SENSATION DISORDER AND STUMP DISLOCATION

Stump dislocation	Hyperalgesia		Hypoalgesia	
	n	%	n	%
Minimal	31	15.8	15	7.69
Significant	3	1.5	146	74.8

TABLE 4. PAIN THRESHOLD BEFORE STUMP FIXATION

Sensation disorder	Patients	Pain threshold		Lesion index of neural function	Degree of lesion severity	Cases	
		Intact side	Fracture side			n	%
Hyperalgesia	34	47.2±3.5	26.9±2.1	0.56±0.28	minor	34	17.4
Hypoalgesia	161	47.4±3.3	59.5±3.2	1.25±0.12	moderate	109	55.8
		47.3±3.4	99.6±5.5	2.10±0.11	severe	52	26.6
Total						195	

The pain threshold at fracture side before treatment depended on the type of cutaneous sensation disorder. By hyperalgesia, the pain threshold of inferior alveolar nerve at fracture side was significantly ($p < 0.05$) lower comparing with the pain threshold of infraorbital nerve at opposite side (Table 4). Lesion indexes of neural function by those patients were less than 1.0, with mean value of 0.56 ± 0.28 . Such neural lesion was considered as minor.

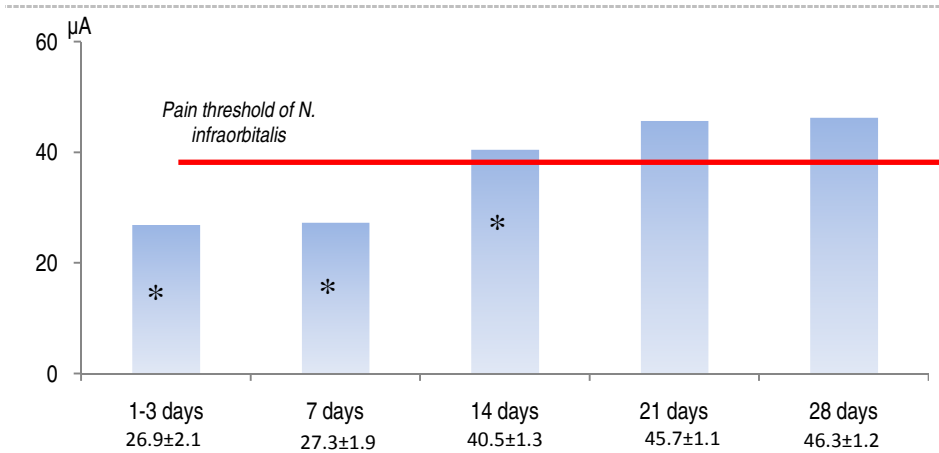
Pain thresholds differences in patients with hypoalgesia were statistically significant: threshold of inferior alveolar nerve at fracture side was higher than threshold of infraorbital nerve ($p < 0.05$), though they significantly differed among patients of this group. One subgroup (109 patients) had lesion indexes of neural function at interval from 1.0 to 2.0 (with mean 1.25 ± 0.12), and these lesions were considered as moderate. Other subgroup (52 patients) had lesion indexes of neural function more than 2.0 (with mean value of 2.10 ± 0.11) and these lesions were considered as severe.

After analysis of neural function recovery of inferior alveolar nerve it was established that the dynamics of neural function recovery mainly depends upon degree of lesion severity. When neural lesion was minor, after treatment and stump reposition and fixation, pain threshold increased at fracture side (Figure 2). After 21 days the mean of pain threshold did not differ significantly comparing with the one of infraorbital nerve. In case of moderate lesion (Figure 3), increase of pain threshold was registered after 7 days. Statistically significant difference of means continued until the 21st day after stump reposition and fixation. After 28 days the pain threshold of inferior alveolar nerve declined and did not differ significantly from the pain threshold of infraorbital nerve. The increase of pain threshold, in patients with severe lesion of inferior alveolar nerve, also was registered after 7 days (Figure 4), after 14 days pain threshold declined until the 45th day. 90 days after stump fixation, pain threshold of inferior alveolar nerve was statistically significant and higher comparing with pain threshold of infraorbital nerve, and lesion index of neural function was 1.73 ± 0.12 .

By summarizing the results it can be stated, that the estimations of pain threshold of inferior alveolar nerve and setting of lesion index of neural function (comparing those thresholds at fracture side with the ones of infraorbital nerve), enables objective evaluating the degree of lesion and functional recovery dynamics. Three lesion degrees of inferior alveolar nerve were studied: minor, moderate, and severe. Every degree includes corresponding neural functional condition, which can be characterized by pain thresholds and lesion index of neural function. Besides, those three degrees differ by dynamics of neural function recovery and by outcomes.

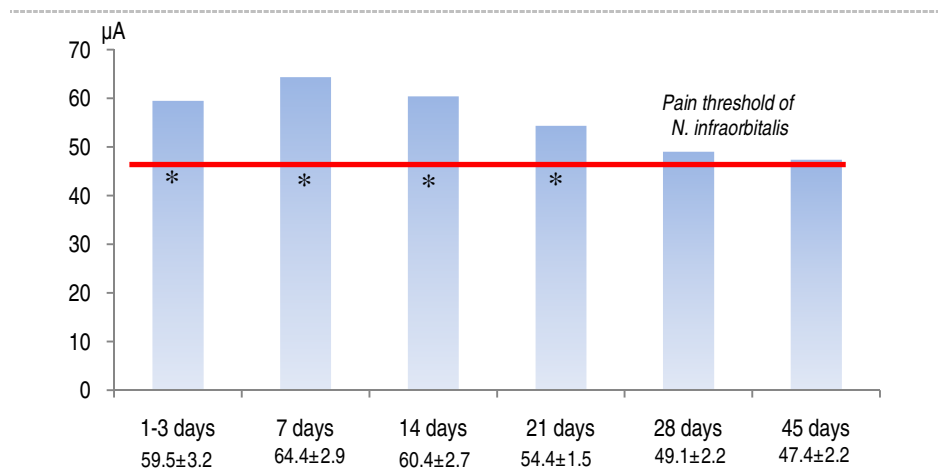
Minor lesion of nerve shows sensation increase that can be characterized by decline of pain threshold. Our results indicate that the function of nerve in this case recovers with time. Davis (2000), Schultze-Mosgau et al. (1999), investigated the reaction of peripheral nerves to injury, call such condition of neural function as “metabolic block”, and the type of neural lesion - neurapraxia.

FIGURE 2. DYNAMICS OF PAIN THRESHOLD OF N. ALVEOLARIS INFERIOR: MINOR LESION



Note: * Statistically significant, comparing with pain threshold of N. infraorbitalis

FIGURE 3. DYNAMICS OF PAIN THRESHOLD OF N. ALVEOLARIS INFERIOR: MODERATE LESION



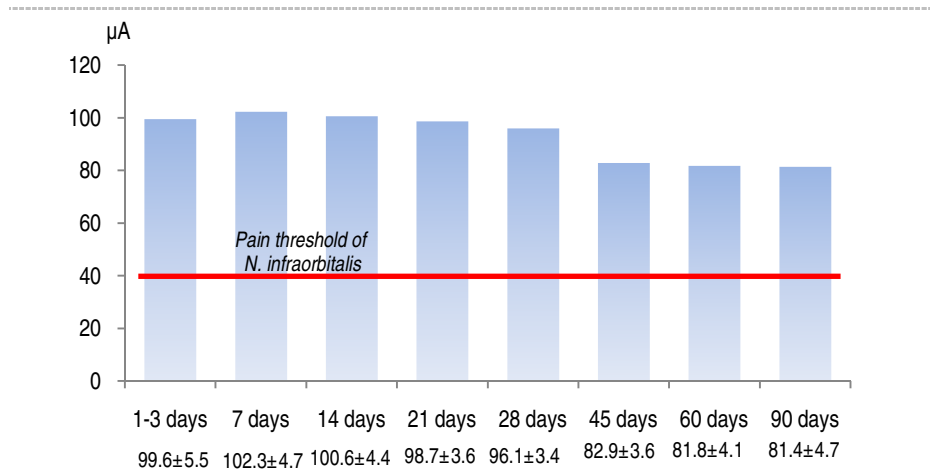
Note: * statistically significant, comparing with pain threshold of N. infraorbitalis

Moderate lesion of nerve is characterized by symptoms of neural function “disappearance” (hypoalgesia), which points on reversible structural changes characterized by increase of pain threshold. Such condition of neural function is called “demyelization block”, and the type - axonotmesis (Schultze-Mosgau et al., 1999).

Severe lesion of nerve is characterized by lesion of axon integrity. Davis (2000) calls it neurotmesis.

What determines the degree of lesion of inferior alveolar nerve in case of fractures of mandibular angle? Our results show that minor neural lesion occurs more frequently when minimal stump dislocation takes place (15.8%) rather than significant dislocation (1.5%).

FIGURE 4. DYNAMICS OF PAIN THRESHOLD OF N. ALVEOLARIS INFERIOR: SEVERE LESION



Note: * statistically significant, comparing with pain threshold of N. infraorbitalis

Researchers are still discussing how much influence on neural lesion has the stump dislocation. For instance, Shultze-Mosgau et al. (1999) state that by mandibular fractures when dislocation is more than 1 mm, sensory recovery is longer; and when dislocation is more than 5 mm, anesthesia or hypoaesthesia lasts for more than 6 months.

Conclusion

Lesion of inferior alveolar nerve always occurs in the case of mandibular angle fracture. This lesion can be minor, moderate or severe. The extent of stump dislocation has influence on this neural lesion: the more expressed dislocation, the higher likelihood of severe lesion of inferior alveolar nerve. The degree of lesion and recovery dynamics can be estimated using non-invasive and non-traumatic methods, i.e. by measuring pain threshold of inferior alveolar nerve and comparing it with corresponding infraorbital nerve data, and by estimating lesion index of neural function. The recovery dynamics of neural function depends on lesion degree. Sensory recoveries take place after stump reposition and fixation: in case of minor lesion of nerve - in 21 days, in case of moderate lesion - in 28 days. In severe lesion of inferior alveolar nerve the function still does not recover even in 90 days after stump reposition and fixation.

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