Frequency and risk factors for injury of the inferior alveolar nerve during surgical extraction of the impacted lower third molars

Učestalost i faktori rizika za povredu donjeg alveolarnog nerva u toku hirurške ekstrakcije impaktiranih donjih trećih molara

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Abstract

Background/Aim. The injury of inferior alveolar nerve during a surgical extraction of impacted lower third molars, followed by sensory disturbance, is, for the patient, an extremely unpleasant complication. The aim of this study was to determine the frequency of this complication after the third molar surgery and its frequency depending on a tooth position and tooth relation to the mandibular canal. Methods. In this study, 800 surgical extractions of the impacted lower third molar were performed. The position of the impacted tooth was recorded according to the Winter classification, as well as the ratio of their root tips to the mandibular canal using the Tanaka et al. and Rood and Shehab classifications. Results. The frequency of the recorded post extraction sensory disturbance was 2.25%, most frequently when teeth were in the mesioangular position. Concerning Tanaka and al. classification, the incidence of injuries was inversely proportional to the increase of distance between roots and mandibular canal with the statistical significance in cases where mandibular canal overlaps more than a half of the root of the tooth (p = 0.001). Considering the radiological signs recommended by Rood and Shehab, a higher frequency of the inferior alveolar nerve injury was recorded when illumination in the area of the root tips was present and when the loss of linear overshadowing characterized by the “roof” and the “bottom” of the mandibular canal were observed, or diversion of the canal and root deflection, but without a statistical significance. Conclusion. The superposition of the mandibular canal with the lower third molar roots at the panoramic radiographies may increase a possibility of the inferior alveolar nerve injury. The angulations of the impacted lower third molar as well as the vicinity of the tips of its roots to the content of the mandibular canal, do not significantly affect the frequency of the nerve injury.

Key words: molar, third; tooth, impacted; tooth extraction; mandibular nerve; oral surgical procedures; paresthesia.

Apstrakt

Uvod/Cilj. Povreda donjeg alveolarnog nerva prilikom hirurške ekstrakcije donjeg impaktiranog umnjaka, praćena poremećajem senzibiliteta, za pacijenta je izuzetno neprijatna komplikacija. Cilj ovog istraživanja je bio da se utvrdi učestalost ove komplikacije posle hirurške ekstrakcije impaktiranih donjih umnjaka. Metode. U studiju je bilo uključeno ukupno 800 hirurške ekstrakcije impaktiranih donjih umnjaka. Preoperativno je analizovana digitalna ortopantomografska snimka evidentirana položaj impaktiranih umnjaka prema Winter-ovoj klasifikaciji, kao i odnos njihovih vrhova korenova prema mandibularnom kanalu primenom klasifikacije Tanaka-e i saradnika. U studiju je bilo utvrđeno skretanje kanala i li defleksija korenova, ali bez statističke značajnosti. Završetak. Učestalost povrede donjeg alveolarnog nerva iznosila je 2,25%, najčešće kada je umnjak bio u mezoangularnom položaju. Prednosti radioloških znakova preporučenih od strane Rooda i Shehaba, veća učestalost povrede donjeg alveolarnog nerva zapažena je u slučajevima kada je postojalo rasvetljenje u predelu vrhova korenova i gubitak linijskog zasenčenja „krova“ i „poda“ mandibularnog kanala ili kada je zapaženo skretanje kanala ili defleksija korenova, ali bez statističke značajnosti. Zaključak. Superpozicija mandibularnog kanala sa korenovima donjeg trećeg molara na ortopantomografskom snimku može povećati mogućnost povrede donjeg alveolarnog nerva.

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Introduction

The injury of the inferior alveolar nerve during a surgical extraction of the impacted lower third molars is a relatively rare complication, but for the patient an extremely unpleasant one. It can occur indirectly (infection in the post-extraction area, pressure of postoperative hematoma and/or edema on the nerve), or directly (injuries due to intimate contact of the lower third molar roots and the nerve)\(^1\). This injury manifests by a permanent or transient sensitivity disturbance in the area of nerve innervation of varying intensity. Clinically, sensory deficits are classified as: paraesthesia (neuropraxia and axonotmesis) and anaesthesia (neurotmesis)\(^2\). Neuropraxia is the easiest degree of the sensitivity disturbance and presents the appearance of mild paraesthesia in the form of tingling, burning and numbness in the nervous distribution area\(^3\). It is usually due to ischemia or compression of the nerve, while its structure is still preserved\(^4\). Axonotmesis is a severe sensory disturbance that manifests itself as hyperalgesia (overstimulation on stimuli) or allodynia (pain caused by harmless stimuli)\(^5\). It occurs due to the interruption of certain axons in the structure of the nerve with consequent Wallerian degeneration, but still with the preserved myelin coating\(^6\). Neurotmesis is a permanent and complete absence of sensitivity caused by a complete breakdown of the morphological continuity of the nerve.

The degree of restoration of sensitivity depends on the extent of the damage. The outcome after neuropraxia is most often a complete recovery of sensitivity by the end of the fourth month at the latest\(^7\). Axonotmesis is usually accompanied by an incomplete recovery of sensitivity, especially if the disturbance lasts longer than six months\(^4\), while anaesthesia in neurotmesis, which lasts longer than a month, is usually permanent\(^7\). A higher degree of recovery can be expected in younger people, with a good general condition, with good vascularization of the tissue, without the presence of a foreign body and with a preserved epineural coat\(^8\).

The aim of this study was to determine the frequency of occurrence of sensory deficits in the innervation distribution of the lower alveolar nerve after surgical extraction of the impacted lower third molar, as well as the frequency of this complication, depending on a tooth position and its relation to the mandibular canal.

Methods

The research was conducted as a prospect clinical study in the period from 2009 to 2017 at the Department of Oral Surgery, Faculty of Medicine in Kosovska Mitrovica. The study included 687 people of both sexes from the northern part of Kosovo and Metohija, aged 17–60 years, who had 800 surgical extractions of the impacted lower third molars. The study excluded people with a history of some neurological disease. The preoperative plan involved an analysis of digital panoramic radiographs of each patient. The position and angulation of impacted teeth were analysed according to the Winter classification. The study included the teeth in the most common positions - mesioangular, vertical, horizontal and distoangular\(^9\). Also, the relationship of the root tips of the impacted teeth and the mandibular canal was analysed using the classification by Tanaka et al.\(^10\) and Rood and Shehab\(^11\) (Figures 1 and 2). The cases that were classified in the first three classes by Tanaka et al.\(^10\) were further analysed by the Rood and Shehab classification. According to this classification, seven X-ray signs or indications of a close contact between the tips of the roots of the lower third molar and the contents of the mandibular canal were proposed (Figure 2).

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In all patients included in this study, the surgical extractions of the impacted third molars were performed in local block anaesthesia for the inferior alveolar nerve (HCR 4% + Epinephrine 1:100,000, 1.7 mL), with the use of standard triangular flap and buccal approach to the impacted lower third molar. Osteotomy and, if necessary, a separation of crown and/or roots of the impacted teeth was performed using the round and fissure carbide drills with a minimal trauma to the surrounding jawbone and mandatory cooling with saline to prevent or reduce the surgical trauma of the mandibular canal. After the extraction, antibiotic and/or analgesic therapy was prescribed when needed.

The post-operative follow-ups were performed on the first and the seventh post-operative day. To the patients with the sensitivity disturbances registered in the innervated area of the lower alveolar nerve, the complex of vitamin B (Beviplex N, Galenika A.D. Serbia) was administered in the next four weeks, in a dose of one coated tablet daily, and, in the same period of time, infrared therapy was applied locally (Infrared lamp, Medisana IRL), three times a week, lasting 15 minutes, from a distance of 40 cm. The patients with persistent paraesthesia after this period were called for screening twice a month until the total absence of symptoms. Anamnesis and three types of clinical tests were used to determine the existence of the sensory deficiency:

Pin-prick test was performed with a dental probe placed on the surface of the skin or mucous membrane, and then used for a light prick of the tissue, with the simultaneous assessment of painful perception of the patient. Each area was examined three times consecutively, bilaterally, and the patient was asked to point to any difference in sensation between the two sides. The test was performed in the skin area of the corners of the lips and mucous membranes from the vestibular side in the area of the canines.

The light touch test was performed by a tactile stimulation of the patient's skin. A ball of cotton wool was used to gently touch the skin at the corners of the lips, concentrically, gradually spreading towards the periphery until the patient felt touch, which made it possible to map the area with a loss of sensation.

The two-point discrimination test – this test was performed using a ten-millimetre scale divider. The tips of the divider at a distance of 2 mm were placed on the skin at the corners of the mouth with continuous pressure, and the patient was asked whether he felt pressure in one or two points. Whenever the patient gave an incorrect response, the distance of the divider peaks for the next test would increase and whenever the patient gave the correct answer the distance of the divider peaks for the next test would be reduced until the smallest distance in which the patient could feel the pressure in two spots was defined. The distance obtained was compared with the reference values. With the preserved sensitivity in the corner of the lips, the pressure in two spots could be different at their distance from 2 mm to 4 mm and in the lower edge of the mandible at the distance of 8 mm to 10 mm. The minimum distance of two spots where the pressure might vary was usually greater on the side of the damage.

The results were presented in percentages and ratios. A binomial test was used to analyse the frequency of events of interest. For the multiple variables testing, Bonferroni correction was applied. All p values less than 0.05 were considered significant. All analyses were performed in the R programming language and environment (R Core Team, 2014).

Results

Of the total number of surgically extracted the impacted lower third molars, the occurrence of sensory disturbances was recorded at 18/800 or 2.25%. In all patients, in the observed period of 6 months, full recovery of sensitivity occurred.

Of all recorded cases with the injuries of the lower alveolar nerve, the largest number occurred after the surgical extraction of the impacted lower third molars in the mesioangular position, and the least was registered at distoangular position (Table 1). The statistical analysis of the obtained results showed no statistically significant difference in the incidence of lower alveolar nerve injuries compared to the position of the impacted third molar.

By monitoring a percentage of the sensitivity outbreak in the innervated zone of the inferior alveolar nerve, depending on the relationship of the molar roots and the mandibular canal, the highest percentage of sensitivity disturbance was registered in Class I, then in Class II and the smallest in Class III, according to the Tanaka et al. classification (Table 2). The statistically significant difference was observed in Class I, in the cases where mandibular canal overlapped more than a half of the root of the tooth (p = 0.001).

After additional analysis of all registered cases of sensitivity outbreaks in the innervated zone of the inferior alveolar nerve in different classes (Tanaka et al. 10), to which the classification by Rood and Shehab 11 was applied, it was concluded that the nerve injuries were more frequently met when the „white“ line of the root canal and canal diversion was interrupted and when the root deflection and narrowing of the canal were previously radiographically observed (Table 3), but without a statistical significance.

Table 1

| Position of impacted lower third molar | n   | Sensitivity disturbance, n (%) | p – value |
|--------------------------------------|-----|-------------------------------|----------|
|                                      |     | with                          | without  |          |
| Mesioangular                         | 336 | 11 (3.3)                      | 325 (96.7)| 0.196    |
| Vertical                             | 242 | 4 (1.7)                       | 238 (98.3)| 0.826    |
| Horizontal                           | 118 | 2 (1.7)                       | 116 (98.3)| 1.000    |
| Distoangular                         | 104 | 1 (1.0)                       | 103 (99.0)| 0.734    |
| Total                                | 800 | 18 (2.3)                      | 782 (97.7)|          |

p – values were calculated by comparing each ratio with the ratio 18:782.

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Table 2
Nerve injury in regard to the relationship of the molar roots and the mandibular canal (Tanaka et al. classification)

| Class* | n   | Sensitivity disturbance, n (%) | p – value |
|--------|-----|--------------------------------|-----------|
|        |     | with                           | without   |           |
| I      | 264 | 13 (4.9)                       | 251 (95.1)| 0.001†    |
| II     | 157 | 4 (2.6)                        | 153 (97.4)| 0.783     |
| III    | 188 | 1 (0.5)                        | 187 (99.5)| 0.138     |
| IV     | 106 | 0                              | 106 (100)| 0.181     |
| V      | 85  | 0                              | 85 (100)  | 0.270     |
| Total  | 800 | 18 (2.3)                       | 782 (97.7)|           |

* – Description of particular class see under Fig. 1.
p – values were calculated by comparing each ratio with the ratio 18:782; † – statistically significant.

Table 3
Nerve injury in regard to the relationship of the molar roots and the mandibular canal (Rood and Shehab classification)

| Parameters                        | n   | Sensitivity disturbance, n (%) | p – value |
|-----------------------------------|-----|--------------------------------|-----------|
|                                  |     | with                           | without   |           |
| Illumination of root             | 172 | 7 (4.1)                        | 165 (95.9)| 0.362     |
| Deflection of root               | 174 | 3 (1.7)                        | 171 (98.3)| 0.498     |
| Narrowing of root                | 0   | 0                              | 0         | -         |
| Lightness and bifid root apex    | 12  | 0                              | 12 (100)  | 1.000     |
| Interruption of white line of canal | 140 | 5 (3.6)                        | 135 (96.4)| 0.612     |
| Diversion of canal               | 67  | 2 (3.0)                        | 65 (97.0)| 1.000     |
| Narrowing of canal               | 44  | 1 (2.3)                        | 43 (97.7)| 1.000     |
| Total                            | 609 | 18 (3.0)                       | 591 (97.0)|           |
p – values were calculated by comparing each ratio with the ratio 18:591.

Discussion

Surgical extraction of impacted lower third molars is a common therapeutic procedure in everyday oral surgery. Indications for it are numerous, although it might be followed by several possible complications with the injury of the inferior alveolar nerve being one of the most serious and unpleasant. According to relevant literature, the frequency of this complication ranges from 0.5% to 8% in our study, the recorded frequency was 2.25%, which is roughly the registered value reported by Rood and Shehab. Some authors state that the frequency of permanent sensory deficit is between 0.35% and 1.1%, but there are also those ones who do not record it, which is in correlation with the results of this study.

Some authors considered the possible risk factors that could predict a possibility of occurrence of this complication. In this respect, the incidence of injuries of the inferior alveolar nerve was monitored in relation to a number of factors, such as: gender and age of respondents, experience of a surgeon and a degree of tooth impaction. However, as the most commonly cited factors are angulation of the impacted third molar and the relationship of its roots to the mandibular canal.

According to our results, the favourable position for the injury of the lower alveolar nerve was the mesioangular position of the tooth, but it was not significant. The lowest frequency of the occurrence of this complication was recorded with lower third molars in the distoangular position. Selvi et al., Hasegawa et al., and Nguyen et al. recorded similar results to ours. However, there are authors who reported different results. Thus, Jerjes et al., showed that the most risky situation for the emergence of a nerve injury is a vertical position and the least risky is horizontal position. The results of our study, however, indicate the importance of careful preoperative planning as well as using an adequate surgical approach in order to prevent the development of this complication.

The relationship between the tips of the roots of the impacted lower third molars and the content of the mandibular canal was also analysed according to their mutual distance, on the panoramic radiographs, using the X-ray classification by Tanaka et al. and the classification by Rood and Shehab. The results showed that the incidence of injuries was inversely proportional to the increase of a distance between the tip of the tooth roots and the canal. Such results suggest that the presence of a superimposition of roots with a mandibular canal on standard radiographs requires the additional three-dimensional imaging techniques in order to perceive more accurately the relationship of the root tips of the impacted lower third molar to the content of the mandibular canal. Observation of the radiological signs in this study, recommended by Rood and Shehab, showed a higher possibility of the inferior alveolar nerve injury during the extraction if the illumination in the area of the root tips was present, or the loss of linear overshadowing characterized by the “roof”, i.e., “bottom” of the mandibular canal, as well as when the canal diversion, root deflection and narrowing of the canal were present, which is in accordance with the results of Rood and Shehab. Valmaseda-Castellón et al. state that only the canal diversion can predict a possible injury of the nerve, while Blaeser et al. point out the illumi-
nation of the roots, the loss of the “white” line and the canal diversion as the most risky x-rays indicators. However, in contrast to these studies, in our research, in spite of the greater interrelation of these radiographic signs with the frequency of the occurrence of sensory disturbances, no statistical significance was recorded with any of the mentioned parameters.

It should be noted that in this study articaine was used as local anaesthetic. Some authors state that articaine can induce paraesthesia after the inferior alveolar nerve block. The reason for that, as they state, is the higher concentration of anaesthetic (4%) compared to lidocaine (2%) and, eventually, a greater potential to cause neurotoxicity. However, it is the lingual nerve that is more often affected with this complication (about 89% of all cases) 26.

Conclusion

The incidence of the inferior alveolar nerve injury during a surgical extraction of impacted lower molars is approximately 2.25%. The superimposition of the mandibular canal with the lower third molar roots at the panoramic radiography significantly increases a possibility of nerve injury. The angulation of the impacted tooth does not significantly affect the incidence of nerve injury after the surgical extraction, nor does the relationship of the tips of tooth roots to the content of the mandibular canal.

REFERENCES

1. Cade TA. Paresthiesia of the inferior alveolar nerve following the extraction of the mandibular third molars: a literature review of its causes, treatment, and prognosis. Mil Med 1992; 157(8): 389–92.
2. Renton T. Prevention of iatrogenic inferior alveolar nerve injuries in relation to dental procedures. Dent Update 2010; 37(6): 350–2, 354–6, 358–60 passim.
3. Seo K, Tanaka Y, Termitius M, Soneya G. Characterization of different paresthesias following orthognathic surgery of the mandible. J Oral Maxillofac Surg 2005; 63(3): 298–303.
4. Donoff RB. Surgical management of inferior alveolar nerve injuries (Part I): The case for early repair. J Oral Maxillofac Surg 1995; 53(11): 1327–9.
5. Hillenep S, Jansen R. Nerve injury caused by mandibular block analgesia. Int J Oral Maxillofac Surg 2006; 35(5): 437–43.
6. Pogrel MA. Complications of third molar surgery. In: Kaban LB, Pogrel MA, Perrott DH, editors. Complications of oral and maxillofacial surgery. Philadelphia: WB Saunders Co; 1997. p. 59–68.
7. Querat-Galob E, Valmasala-Castellón E, Bertini-Aytes L, Gay-Escoda C. Incidence and evolution of inferior alveolar nerve lesions following lower third molar extraction. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2005; 99(3): 259–64.
8. Gregg JM. Surgical management of inferior alveolar nerve injuries (part II): The case for delayed management. J Oral Maxillofac Surg 1995; 53(11): 1300–3.
9. Winter GB. Impacted mandibular third molar. St. Louis: American Medical Book Co; 1926. p. 241–79.
10. Tanaka T, Murakami K, Kishida T, Ishib T, Morita Y, Nukura T. Relation between mandibular third molar and mandibular canal as assessed by three dimensional computed tomography reconstruction. J Jpn Oral Maxillofac Surg 2000; 46(5): 256–61.
11. Renton JP, Shehab BA. The radiological prediction of inferior alveolar nerve injury during third molar surgery. Br J Oral Maxillofac Surg 1990; 28(1): 20–5.
12. Masbroom VS, Masbroom PV, Lambodu P. Assessment of Nerve Injuries after Surgical Removal of Mandibular Third Molar: A Prospective Study. Asian J Neurosci 2013; 13(2): 433–51.
13. Robinson PP, Smith KG, Johnson FP, Cottington DJ. Equipment and methods for simple sensory testing. Br J Oral Maxillofac Surg 1992; 30(6): 387–9.
14. Hillenep S. Iatrogenic injury to the inferior alveolar nerve: etiology, signs and symptoms, and observations on recovery. Int J Oral Maxillofac Surg 2008; 37(8): 704–9.
15. Sisk AL, Hammer WB, Shelton DW, Joy ED. Complications following removal of impacted third molars: The role of the experience of the surgeon. J Oral Maxillofac Surg 1986; 44(11): 855–9.
16. Blóndeau F. Paresthésie: Résultat suite à l’extraction de 455 3e molaires incluses mandibulaires. J Can Dent Assoc 1994; 60: 991–4.
17. Renton JP. Permanent damage to inferior alveolar and lingual nerves during the removal of impacted mandibular third molars. Comparison of two methods of bone removal. Br Dent J 1992; 172(3): 108–10.
18. Bruce RA, Frederickson GC, Small GV. Age of patients and morbidity associated with mandibular third molar surgery. J Am Dent Assoc 1980; 101(2): 240–5.
19. Valmasala-Castellón E, Bertini-Aytes L, Gay-Escoda C. Inferior alveolar nerve damage after lower third molar surgical extraction: a prospective study of 1117 surgical extractions. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2001; 92(4): 377–83.
20. Jerjes W, Uptale T, Shah P, Nhembe V, Guntha D, Kafar P, et al. Risk factors associated with injury to the inferior alveolar and lingual nerves following third molar surgery-revisited. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2010; 109(3): 335–45.
21. Kipp DP, Goldstein BH, Weiss WW Jr. Dyssyesthesia after mandibular third molar surgery: a retrospective study and analysis of 1,377 surgical procedures. J Am Dent Assoc 1980; 100(2): 185–92.
22. Seker F, Dedem TN, Nattestad A, Robertson K, Teltschun L. Factors that are associated with injury to the inferior alveolar nerve in high-risk patients after removal of third molars. Br J Oral Maxillofac Surg 2013; 51(8): 868–73.
23. Hanagawa T, Ri S, Shigeta T, Akaishi M, Imai Y, Kakai Y, et al. Risk factors associated with inferior alveolar nerve injury after extraction of the mandibular third molar: a comparative study of preoperative images by panoramic radiography and computed tomography. Int J Oral Maxillofac Surg 2013; 42(7): 843–51.
24. Nguyen E, Cenob D, Chandu A. Risk factors for permanent injury of inferior alveolar and lingual nerves during third molar surgery. J Oral Maxillofac Surg 2014; 72(12): 2394–401.
25. Blaessor BF, Augst MA, Donoff R, Kaban LB, Dedem TN. Panoramic radiographic risk factors for inferior alveolar nerve injury after third molar extraction. J Oral Maxillofac Surg 2003; 61(4): 417–21.
26. Gauthier GA, Gaffin AS, Lawrence HP, Townshend HC, Haas DA. Occurrence of paresthesia after dental local anesthetic administration in the United States. J Am Dent Assoc 2010; 141(7): 836–44.

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