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Inferior alveolar nerve function after open reduction and internal fixation of mandibular fractures

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ABSTRACT

Purpose: Mandibular fractures are amongst the most common facial fractures and are usually treated by open reduction and internal fixation (ORIF). Inferior alveolar nerve (IAN) injuries are seen frequently in mandibular fractures as well as after ORIF of these fractures due to the exposition and the close proximity of the nerve during fracture reduction. Therefore the continuity of the IAN can be disrupted. Permanent injury to the IAN can result in diminished quality of life. This retrospective study was designed to objectively analyse the incidence and the outcome of pre- and postoperative mental nerve hypoesthesia after ORIF of mandibular fractures.

Material and methods: Patients who were consecutively treated at the Department of Cranio-Maxillofacial and Oral Surgery of the University Hospital Zurich between 2004 and 2010 with mandibular fractures who underwent ORIF were included. Follow-up period was 12 months. Demographic, pre-, peri- and postsurgical data were tabulated and statistically evaluated using the χ^2 test and the Kruskall-Wallis-Test.

Results: 340 patients met the inclusion criteria. 27% of the study population presented with postinjury (preoperative) mental nerve hypoesthesia, 46% suffered from purely postoperative hypoesthesia and 27% showed no nerve damage. Complete recovery was seen in 70% of all cases, partial recovery in 20% of the cases and less than 10% suffered from a permanent (>12 months) IAN damage. Mandibular angle fractures were accompanied with significantly higher rates of hypoesthesia (79% vs. 68%). Recovery rate was significantly worse in older patients, when preoperative hypoesthesia was present (66% vs. 73%) and in patients with multiple fractures in proximity to the IAN (36% vs. 52%). Mandibular body fractures showed worse recovery rates than fractures that did not affect the body (44% vs. 52%).

Conclusion: The present study shows that IAN injury is seen frequently in mandibular fractures. Mental nerve hypoesthesia may influence quality of life. Nerve continuity may not be preserved due to the initial trauma or may result as a postoperative complication. Nevertheless the results of this study show a high potential for full recovery.

1. Introduction

Mandibular fractures are among the most common facial injuries (Boffano et al., 2015). As literature shows, aetiology is country as well as age dependent, but major causes include motor vehicle crashes, work-related injuries, assaults, or sports-related injuries (Gassner et al., 2004; Erdmann et al., 2008; Iatrou et al., 2010). Treatment options include ORIF (open reduction and internal fixation) by either the intraoral or the extraoral approach. Conservative treatment, consisting of closed reduction and mandibulo-maxillary fixation (MMF), may be indicated depending on the fracture site and the degree of fragmentation. Modern treatment principles for mandibular fractures in the symphyseal, the body, the angle and the ramus region evidently tend toward rigid internal fixation as fracture fragments can be reduced to re-establish the pretraumatic facial profile (Alpert et al., 2009; Chrcanovic, 2013).

Common complications after ORIF of mandibular fractures include nerve trauma, disturbed wound-healing, infection, malocclusion and non-union (Renton and Wiesenfeld, 1996; Seemann et al., 2010). One of the most common postoperative complications after ORIF of mandibular fractures is mental nerve

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hypoesthesia, which can be of transient or permanent nature. The inferior alveolar nerve (IAN) is at high risk in these fractures due to the exposition to bony fragments, which can cause compression, straining or tearing of the nerve. Therefore the continuity of the nerve may be partially or fully injured.

Risk factors for posttraumatic IAN dysfunction are highly displaced fractures, such as comminuted fractures, and fractures with close proximity to the inferior alveolar nerve (angle, ramus and body) (Bede et al., 2012; Boffano et al., 2014). Literature shows postinjury (preoperative) hypoesthesia rates of up to 81% (Halpern et al., 2004; Bede et al., 2012). When preoperative alveolar nerve function is intact, the literature demonstrates postoperative hypoesthesia rates around 30% (Schultze-Mosgau et al., 1999; Renzi et al., 2004) caused by intraoperative irritation during ORIF. Recovery rates of the inferior alveolar nerve between 33% (Marchena et al., 1998) and 100% (Mayrink et al., 2013) have been published, which suggests a high potential for recovery. Nevertheless disrupted continuity of the inferior alveolar nerve may cause trouble with chewing, eating, swallowing, smiling, or drooling (Lemke et al., 1998) due to diminished or complete loss of sensitivity of the skin and the mucous membranes.

IAN injury can result in severe reduction of quality of life and in chronic pain (Smith et al., 2013). In a study performed by Marchena et al., 1998, 55% of patients with persistent sensory deficit felt disturbed by the absence of nerve recovery.

It is therefore important to analyse the preoperative as well as the postoperative IAN function and to inform patients about possible recovery rates. Different methods of assessing the IAN function have been suggested in the literature, such as the sharp/blunt discrimination, two point discrimination, temperature testing, and others (Poort et al., 2009). While the more elaborate tests are more accurate it can be difficult to incorporate them into a quick postoperative follow-up, which might explain why simple tests are used more routinely.

Nerve lesions can be categorized as neurapraxia, axonotmesis and neurotmesis according to the Seddon classification. Neurapraxia is the mildest nerve injury with intact axon anatomy and shows spontaneous recovery within a few weeks. In axonotmesis the axon is damaged to some degree but recovery without surgical intervention is still possible. In neurotmesis the nerve is completely divided and no spontaneous recovery is possible (Seddon, 1942; Chhabra et al., 2014). The Sunderland classification groups nerve injury into five different groups. A Sunderland first degree injury corresponds to neurapraxia. A Sunderland second degree damage describes axonal damage with full recovery. A Sunderland third degree injury usually recovers in months but surgical intervention may be needed. In Sunderland fourth degree injury recovery only occurs if surgery is performed. Sunderland fifth degree nerve damage corresponds to neurotmesis (Sunderland, 1951). These classifications can help to forecast a prognosis for nerve recovery.

This retrospective study was designed to objectively analyse the incidence and the outcome of mental nerve hypoesthesia after mandibular fractures and after ORIF of these injuries. It was hypothesized that mental nerve hypoesthesia is a common condition after mandibular fractures and that its recovery potential is generally high without special treatment executed.

2. Material and methods

This retrospective analysis was performed in concordance with the Swiss Ethical committee (ref.: # 2014-0341). Patients who were consecutively treated at the Department of Cranio-Maxillofacial and Oral Surgery between 2004 and 2010 with mandibular fractures who underwent ORIF by an intraoral approach were included. Inclusion criteria were defined as:

1) Patient presented between the years 2004 through 2010 with a mandibular fracture at the University Hospital Zurich
2) Only patients with at least one fracture site where the continuity of the IAN might have been injured were included (ramus, angle, body, parasymphyseal and symphyseal region). The anatomical regions for this study were defined as:
   - Symphyseal region: area between the lateral incisors
   - Parasymphyseal region: area between the lateral incisor and the second premolar
   - Body: between the second premolar and the third molar
   - Angle: distal of the third molar
   - Ramus: area between the mandibular angle and the mandibular notch
3) Treatment was performed by ORIF with an intraoral approach and in fractures of the angle and the ramus a transbuccal incision supported the intraoral approach.
4) Sufficient radiological and clinical documentation with 12 months of follow-up was available
5) IAN function was routinely assessed by sharp/blunt and two point discrimination of the mental nerve. However hypoesthesia of the mental nerve does not automatically mean that there is hypoesthesia of the IAN.

All patients were treated by the AO/ASIF (Arbeitsgemeinschaft für Osteosynthesefragen/Association for the Study of Internal Fixation) guidelines by an intraoral approach. A transbuccal incision to support the intraoral approach has been used for angle and ramus fractures. Fractures were anatomically reduced and internal fixation was performed with the Synthes Mandible or the Medartis osteosynthesis system. In general two mini-plates were used for each fracture, one at the inferior border of the mandible with bicortical screws and one at the superior crestal part with monocortical screws. Non-dislocated fractures of the mandibular angle were treated with a Champy plate on the oblique ridge. At least two screws on each side of the fracture gap were placed.

Demographic information was tabulated including the patients' age, gender and diagnosis. Fracture site, pre- and postoperative mental nerve function as well as period to recovery were extracted from the hospital information system and coded in Excel (Microsoft Excel, Microsoft Corp., Redmond, Washington, USA). The postoperative follow-up interval was 12 months.

Data were then analysed with the Statistical Package for the Social Sciences software (IBM Corp. SPSS Statistics Version 21.0, Chicago, Illinois, USA). Descriptive statistics such as mean, standard deviations, medians, IQRs as well as relative frequencies were computed. Associations between two discrete variables were investigated by means of a Chi-square test. Differences in medians between four groups with respect to continuous variables were analysed by means of a Kruskall-Wallis-Test. Results of statistical analysis with p-values smaller than 0.05 were considered statistically significant.

3. Results

3.1. Demographics

In total 340 patients met the study's inclusion criteria and could be evaluated. The majority of the patients (79%, n = 268) were of male gender. Patients were between 18 and 90 years old, with a mean and median age of 33 and 27 years, respectively and with an interquartile range of 21 years.

3.2. Fractures and nerve injuries

While every patient included into this study suffered from at least one fracture in close proximity to the IAN (defined in the inclusion