

The influence of third molars in the line of mandibular angle fractures on wound and bone healing

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Abstract

Objectives The objective of this study was to evaluate postoperative complications after removal or retention of the third molar in the line of mandibular angle fractures.

Materials and methods This retrospective study included the data of 98 patients with a molar in the line of a mandibular angle fracture treated with internal reduction and mini-plate fixation at our department over 9 years. Patients were classified into two groups: tooth removal during osteosynthesis ($n=45$) and tooth retention ($n=55$). The primary target criterion was the incidence of minor (outpatient treatment, local measures) and major (surgical revision, rehospitalisation) complications. Time between trauma and surgery was 1.4 days (range 0 to 12), and the average follow-up 291 days (range 66 to 863).

Results Regarding the eruption status, 26 of 52 (50.0 %) impacted third molars, 11 of 19 (57.9 %) incompletely erupted and 8 of 27 (29.6 %) completely erupted molars had been removed during open reduction. Overall, 17 (17.3 %) patients had postoperative minor ($n=7$) or major ($n=10$) complications, in detail 10/45 (22.0 %) patients after tooth removal and 7/55 (13 %) patients after tooth retention ($p=0.286$). Complication rates between impacted and incompletely erupted third molars (impacted molars 15.0 %, incompletely

erupted molars 10.0 %) did not differ significantly, but completely erupted molars had a complication rate of 26.0 %.

Conclusions Mandibular angle fractures with a completely erupted third molar show the highest complication rate after open reduction and osteosynthesis. Retention of a non-infectious third molar facilitates open reduction and does not increase the complication risk.

Clinical relevance The study helps with the decision of removing or retention of a third molar during surgical treatment of a mandibular angle fracture.

Keywords Mandibular angle fracture · Third molar · Postoperative complication · Healing disorders · Infection · Mini-plate osteosynthesis

Introduction

The incidence rate of mandibular angle fractures is about 20 %; thus, the mandibular angle is the most common site for fractures of the lower jaw, particularly in violence-related fractures [1, 2]. Such injuries frequently present with a third molar in the fracture line, resulting in the highest complication rate of all fractures of the jaws [3–6]. The necessity to simultaneously remove molars in the fracture line during surgery is still controversially discussed in the literature. Consensus only exists concerning the recommendation to remove the tooth in case of additional pathological processes such as extended caries, apical inflammation or periodontitis [7].

Several factors may influence the postoperative healing process in mandibular angle fractures: method of treatment, health status and compliance of the patient and administration of postoperative antibiotics. Therefore, the reasons why some patients develop postoperative complications whilst others do not are difficult to determine. Treatment modalities have also

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changed essentially over the past 30 years. Nowadays, antibiotics are given perioperatively [8, 9], and mini-plates are used in open reduction techniques instead of wire sutures [10, 11]. According to the technique described by Champy [12], angle fractures are frequently treated with only one plate placed onto the tension site along the superior border of the mandible. For this reason, maintaining the third molar may be beneficial in fracture reduction and fixation because extensive osteotomy necessary for tooth removal can be avoided, particularly for judging the remaining fracture line and attaching the osteosynthesis plate in an adequate position [13, 14].

The objective of this study was to examine if the presence of a third molar within the line of a mandibular angle fracture treated by mini-plate fixation influences postoperative complications.

Material and methods

For this retrospective study, we investigated the records of all patients with a third molar in the line of a mandibular angle fracture, who had been treated at the Department of Cranio-Maxillofacial Surgery of the Regensburg University Medical Centre between August 2003 and July 2011.

All fractures had been treated with open internal reduction and osteosynthetic fixation with mini-plates via an intraoral approach. The molar in the line of the fracture was removed when loose or infected (caries and periodontitis) or when impeding adequate open reduction. Each patient had received perioperative and postoperative antibiotic treatment and was encouraged to practice dental hygiene by careful tooth brushing and additional daily mouth rinse with chlorhexidine gluconate. Only patients with adequate medical records describing surgical treatment and the postoperative course were included. Exclusion criteria were infected or comminuted fractures, treatment with other forms of osteosynthesis than mini-plates (e.g. lag screws or rigid osteosynthesis) or conservative treatment by means of intermaxillary fixation.

Each patient underwent adequate preoperative and postoperative imaging in terms of three-dimensional radiological diagnostics (computed tomography) or imaging in two planes (panoramic view and Clementschitsch [reversed Towne's] view or submentovertex view). Follow-up lasted until at least plate removal scheduled 6 to 12 months after surgery.

Patients were divided into two groups: tooth removal during osteosynthesis and tooth retention. Any complications were grouped according to the type and severity, and the type of complication was further differentiated according to the cause, i.e. infection (inflammation or abscess) or mechanical reasons (malocclusion, plate fracture or screw

loosening). Wound dehiscence and bone nonunion or pseudarthrosis were viewed separately in consideration of the fact that these conditions could have been caused by an infection or mechanical complication. Regarding severity, complications were classified into three groups:

No complications:

The postoperative course was inconspicuous with normal occlusion and no signs of infection.

Minor complications:

Minor postoperative complications included erythema, minor dehiscence and submucosal abscesses, which were treated on an outpatient basis (oral antibiotics or surgical intervention under local anaesthesia) and closely monitored afterwards. Such complications incurred minimal costs.

Major complications:

Major postoperative complications included significant dehiscence, spatial abscesses, loosening of plates or screws, nonunion or malocclusion, which required rehospitalisation for intravenous antibiotics administration or revision surgery under general anaesthesia. Such complications incurred major costs.

The following data were collected: gender, age, reason for the trauma, mandibular side affected, occurrence of postoperative complications, type of complication, time between surgery and occurrence of the complication, time between trauma and operation, length of clinical stay, type of antibiotics and length of treatment, time between trauma and plate removal, number and location of accompanying mandibular fractures and the location of the molar in relation to the occlusal plane.

Statistical analysis was conducted with SPSS software (SPSS Inc., Chicago, IL). All patient data variables are expressed as median or mean \pm standard deviation. Data were analysed using the chi-square test. A *p* value below 0.05 was considered significant and marked using an asterisk within the graph or table.

Results

Ninety-eight patients (90 men and 8 women) with 100 molars in the fracture line and a sufficient data set were included in this study. The mean age was 23 years (range 11 to 62 years). Fractures were caused by assaults (54.0 %), sports accidents (13.0 %), traffic accidents (11.0 %) and falls (11.0 %). One patient had been kicked by a horse. Fifty-six percent (56 of 100) of the patients had sustained the fracture in the right mandible, 44.0 % (44 of 100) in the left mandible.

Thirty-eight patients (39.0 %) had an isolated mandibular angle fracture, and 60 patients (61.0 %) had a second accompanying fracture (2 contralateral mandibular angle fractures,

10 median mandibular fractures, 43 contralateral paramedian mandibular fractures, 1 equilateral paramedian mandibular fracture as well as 3 contralateral mandibular corpus fractures and 1 equilateral mandibular corpus fracture). The overall complication rate in cases with isolated fractures was 15.8 % (6 of 38), in cases with accompanying fractures 18.3 % (11 of 60).

On average, time between trauma and surgery was 1.4 days (range 0 to 12 days). The average hospital stay was 6.7 days (range 3 to 34 days). Antibiotics were prescribed for an average of 7.8 days (range 1 to 14 days). On average, plates were removed 292 days (range 66 to 863 days) after trauma surgery. Twenty-four patients had the third molar removed together with the plate. The mean time from surgery to complication was 47 days (2 to 194 days, median value 20). The mean time from trauma surgery to minor complication was 33 days (range 2 to 177 days; median 10 days) and 56 days (range 3 to 194 days; median 46.5 days) to major complication.

Table 1 shows the minor and major complication rates of patients after removal or retention of a third molar in the fracture line. Forty-five patients had the third molar removed (group 1); 9.0 % (4 of 45) of them developed a minor complication and 13.0 % (6 of 45) a major complication. Altogether, 22.0 % (10 of 45) of the patients in group 1 developed a complication.

In 55 patients, the third molar in the line of the fracture was retained (group 2). 5.5 % (3 of 55) of the patients developed a minor and 7.5 % (4 of 55) a major complication. Altogether, 13.0 % (7 of 55) of the patients in group 2 developed complications, but this difference was not statistically significant (*p* value 0.286).

Overall, 7 minor and 10 major complications occurred, 7 infections, 3 mechanical complications, 9 cases of dehiscence and 3 of pseudarthrosis; 3 patients had two complications and 1 patient had three complications simultaneously.

Of the 100 molars examined, 54 were impacted, 19 incompletely erupted and 27 completely erupted (Table 2). After removal of the impacted molar, three patients developed a minor complication and three patients a major complication.

Two patients of the group who had retained the impacted molar developed a minor complication but none developed a major complication. After removal of the incompletely erupted molar, none of the patients developed any postoperative complication, but one minor and one major complication were observed in the group of patients who had retained the incompletely erupted molar. After removal of the completely erupted molar, one patient developed a minor complication and three patients a major complication. Of the group of patients who had retained the completely erupted molar, none developed a minor complication but three patients developed a major complication.

Discussion

There are several reasons for and against molar retention in the fracture line. Since fractures in the tooth-bearing area of the mandible are open fractures by definition, molar retention in the line of a fracture may cause an infection of the lower jaw along the periodontal ligament [15, 16]. Many studies have described the complication rate of molars in the line of mandibular fractures in general [5, 17, 18], but only a few of them have presented data on mandibular angle fractures and a third molar in the fracture line. Complication rates vary between 8.2 and 25.0 % in this region [4–6, 19]. This wide range may be attributed to advanced surgical techniques such as the introduction of internal fixation by means of mini-plates or the use of modern antibiotics. The results of our retrospective study showed an overall complication rate for mandibular angle fractures with a third molar of 17.0 %.

Does the retention of a molar in the fracture line influence the infection rate? Our study showed postoperative complication rates for patients after tooth removal and tooth retention of 22.0 and 13.0 % and infection rates of 4.0 and 9.0 %, respectively. The differences were not statistically significant. Ramakrishnan et al. [20] did also not observe any significant difference in the rate of revision surgery between patients after tooth removal (25.0 %) and tooth retention (30.0 %).

Table 1 Minor and major complication rates of patients after removal or retention of a third molar in the fracture line. Multiple complications per patient are possible

	Third molar removed 45.0 % (45 of 100)	Third molar retained 55 % (55 of 100)	Total	<i>p</i> value (<i>p</i> <0.05)
Minor complication	9.0 % (4 of 45)	5.5 % (3 of 55)	7.0 % (7 of 100)	<i>p</i> =0.932
Major complication	13.0 % (6 of 45)	7.5 % (4 of 55)	10.0 % (10 of 100)	<i>p</i> =0.932
Total	22.0 % (10 of 45)	13.0 % (7 of 55)	17.0 % (17 of 100)	<i>p</i> =0.286
Infectious complication	4.0 % (2 of 45)	9.0 % (1 of 55)	7.0 % (7 of 100)	<i>p</i> =0.926
Mechanical complication	4.0 % (3 of 45)	2.0 % (0 of 55)	3.0 % (3 of 100)	<i>p</i> =0.972
Pseudarthrosis	7.0 % (3 of 45)	0 % (0 of 55)	3.0 % (3 of 100)	<i>p</i> =0.936
Dehiscence	16.0 % (7 of 45)	4.0 % (2 of 55)	9.0 % (9 of 100)	<i>p</i> =1.000

Table 2 Complication rates of removed and retained molars in the fracture line related to the position of the molar in relation to the occlusal plane; values are given in percent and in absolute numbers. Multiple complications per patient are possible

	Removed teeth, 45 patients			Retained teeth, 55 patients		
	Impacted (26 of 45)	Incompletely erupted (11 of 45)	Erupted (8 of 45)	Impacted (28 of 55)	Incompletely erupted (8 of 55)	Erupted (19 of 55)
Minor complication	11.5 % (3 of 26)	0 % (0 of 11)	12.5 % (1 of 8)	7.1 % (2 of 28)	12.5 % (1 of 8)	0 % (0 of 19)
Major complication	11.5 % (3 of 26)	0 % (0 of 11)	37.5 % (3 of 8)	0 % (0 of 28)	12.5 % (1 of 8)	15.7 % (3 of 19)
Total complication rate	23.0 % (6 of 26)	0 % (0 of 11)	50.0 % (4 of 8)	7.1 % (2 of 28)	25.0 % (2 of 8)	15.7 % (3 of 19)
Type of complication:						
Infectious complication	3.8 % (1 of 26)	0 % (0 of 11)	12.5 % (1 of 8)	0 % (0 of 28)	25.0 % (2 of 8)	15.7 % (3 of 19)
Mechanical complication	3.8 % (1 of 26)	0 % (0 of 11)	12.5 % (1 of 8)	3.5 % (1 of 28)	0 % (0 of 8)	0 % (0 of 19)
Pseudarthrosis	3.8 % (1 of 26)	0 % (0 of 11)	25.0 % (2 of 8)	0 % (0 of 28)	0 % (0 of 8)	0 % (0 of 19)
Dehiscence	15.4 % (4 of 26)	0 % (0 of 11)	37.5 % (3 of 8)	3.5 % (1 of 28)	12.5 % (1 of 8)	0 % (0 of 19)

Interestingly, their study showed a higher percentage of complications, although their criteria for tooth removal and fracture treatment were similar to ours. Such a higher percentage may be explained by possible differences in the study population, for instance, due to the socioeconomic or nutritional status as well as possible abusive habits. Ramakrishnan et al. included patients with exposed hardware, loose hardware and nonunion in their ‘revision surgery’ group but did not differentiate between infectious or mechanical causes.

In a similar study, Ellis did also not find any statistical difference in complication rates [5]. He distinguished between the infection rate and the removal rate of the implanted bone plate(s). In the case of tooth retention, the incidence of infection was 19.5 % and the rate of hardware removal 19.5 %; in the case of tooth removal, these rates were 19.0 and 18.6 %, respectively.

Bui et al. recommended only removing the third molar if one of the following criteria is met: fracture of the involved molar, gross dental caries, exposure of 50.0 % or more of teeth roots, pericoronitis, periodontal infection or impediment of adequate fracture reduction. Interestingly, their results showed a higher infection rate after tooth retention (14.0 %) than after tooth removal (5.6 %), even if the difference was not statistically significant because of the small sample size [6].

Bobrowski et al. conducted a systemic literature review and meta-analysis on postoperative infections associated with the treatment of mandibular angle fractures in the presence of molars in the fracture line [21]. The authors found 13 articles involving 1542 mandibular angle fractures that met their inclusion criteria and also included the studies mentioned previously. The study by Ramakrishnan et al. may be biased because only the data of the group with minor complications were included but not the data of the larger second group who required revision surgery. Overall, Ramakrishnan et al. could not find any statistically significant differences in the infection rates between the groups

of patients after tooth removal (10.7 %) and tooth retention (11.1 %).

Most of the abovementioned studies focused on the infection rate, which is difficult to define and not the same as the complication rate. The latter, for example, also includes mechanical complications, which may play an essential role in revision surgery including removal of the third molar. Removal of a molar in the fracture line causes additional trauma to the bone tissue [7]. Particularly in impacted, incompletely erupted or fractured teeth, the possibility of reconnecting the fracture ends is limited because of often necessary and extended osteotomy procedures. Reduction is frequently impeded, particularly in the case of highly mobile fragments [10]. Furthermore, the reduced bone apposition surface due to the loss of the bony support precludes the application of the tension band principle [22] and thus the use of the technique described by Champy with one mini-plate on the superior border of the mandibular angle [12, 23].

Particularly, retrospective studies often lack any explanation for the true reason for removing a third molar [5, 20]. If a molar was removed because of infection (caries or apical periodontitis), the infection rate of this group of patients could also be influenced by the original infection. This bias also applies to the present study, and such bias can only be addressed in a prospective study.

It must be noted that other factors may influence the rate of complications in addition to the location and removal or preservation of the third molar. These include, for example, comorbidities or an addictive behaviour. Especially, the correlation between smoking and postsurgical complications in patients with mandibular fractures is well documented in literature [24, 25]. Due to the frequent lack of information on smoking behaviour in the patient data sheets, we are not able to make a reliable statement on this issue in our series.

Another factor that possibly influences the complication rate is the presence of one isolated fracture of the mandibular

angle or accompanying fracture(s) of the mandible. Ellis stated in a study of 2013 that the fixation requirements of patients treated with double fractures of the mandible are different than when treating isolated fractures of the mandible. Double fractures require that at least one of the fractures undergoes rigid fixation to decrease the incidence of complications [26]. Using these recommendations, we could not find a significant difference in these groups regarding the complications in the observed area of the mandibular angle.

Finally, it is worth mentioning that the removal of third molars is one of the most commonly conducted surgical procedures worldwide [26, 27]. Therefore, the question is not whether this molar has to be removed or not but whether the removal or retention of the molar together with fracture treatment influences postoperative complication rates, reducibility of the fracture and postoperative bone healing.

In accordance with many other authors [5, 6, 28, 29], we agree on the necessity to remove a third molar in the fracture line of patients with an infection or a fracture of the molar or the alveolus, in case of a comminuted fracture, in the presence of cysts or if reduction is complicated by the molar. In our opinion, the advantage of retaining the molar lies in avoiding osteotomy, thus allowing more controlled open reduction, internal fixation and consecutive bone healing [17, 30].

After successful fracture healing, the corresponding guideline-based indications for removing third molars [31] can be used as a basis for the necessity of later molar removal, possibly in connection with plate removal.

Conclusion

Statistically, no significant difference in postoperative complications was found after removal or retention of the molar in the fracture line, but the percentage of developing a postoperative complication in this study was about 10 % less for patients after retention of the third molar.

Our results and the findings of the abovementioned studies indicate that retention of the third molar in the fracture line seems advisable, unless the molar is fractured, decayed, affected by periodontal disease or has any other sign of infection. Nevertheless, the benefit of retaining a third molar should be reconsidered for each individual patient. In this respect, molar removal in combination with plate removal after fracture healing may be appropriate.

Compliance with ethical standards

Conflict of interest The authors declare that they have no competing interests.

Ethical approval This article does not contain any studies with human participants performed by any of the authors.

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