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REVIEW ARTICLE

Considerations of mandibular angle fractures during and after surgery for removal of third molars: a review of the literature

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Abstract
Background Angle fractures are quite common considering that the angle of the mandible forms an area of lower resistance which contains a thicker upper border, a thin basilar bone, and the presence of an impacted mandibular third molar. Common complications of mandibular third molar surgery include alveolar osteitis (dry socket), secondary infection, nerve dysfunction, and hemorrhage. Reports of mandibular fracture during and after third molar removal are uncommon.
Purpose The purpose of this paper is to discuss the risk and predisposing factors that should be analyzed regarding the possibility of immediate and late mandibular angle fractures and their need for surgical treatment as a means through which to remove impacted molars. This study is based on a thorough review of the literature as well as on one immediate and one late mandibular angle fracture as described by the authors' own personal experience.
Conclusions The danger of an immediate jaw fracture can be avoided by means of proper instrumentation and by refraining from excessive force on the bone. The tooth should be sectioned in such a way as to minimize the extent of bone removal and force caused by instrumentation. The danger of a late jaw fracture can be avoided by precise diagnosis in cases of patients over 25 years of age, particularly men, whose tooth roots are superimposed on or adjacent to the inferior alveolar canal on a panoramic image, any local pathology and systemic disease or medications which may impair bone strength, and patients who present bruxism and are active athletes.

Keywords Third molar surgery · Complications · Mandibular fracture

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Introduction

The mandible contains a few mechanically weak portions, including the angle, the condylar process, and both sides of the mentum [1]. Several factors have been proposed that influence the location of mandible fractures, including the site, direction, and severity of the force and impact, as well as the bone's intrinsic attributes [2, 3]. Fracture of the mandible occurs when the strength of the bone and the forces acting on it are not equal. The reduction of bone strength may be caused by physiological atrophy, osteoporosis, pathological processes (i.e., cystic lesion, malignant lesion, inflammatory condition), or may be secondary to surgical intervention [4].

The angle is a unique anatomic subcomponent of the mandible. It serves as the transition zone between dentate and edentate regions and is commonly associated with impacted teeth. The mandibular angle and ramus are both suspended within the strong masticatory musculature. The term angle is

derived from the lateral view of the transition between the horizontal body and the vertical ramus [5]. However, an "angle" is also formed when the mandible is viewed from an axial perspective as the dentate body leads into the lateral flare of the ramus. These qualities may well be associated with an increased risk of fracture at the angle region [6].

Angle fractures are quite common [7] since the angle of the mandible forms an area of lower resistance which contains a thicker upper border, a thin basilar bone [8], and the presence of an impacted mandibular third molar (3 M). Biomechanical and epidemiological studies support the hypothesis that the presence of mandibular 3 Ms is associated with an increased risk for angle fractures [2, 9–14]. Risk of fracture was also dependent on the 3 M position [9, 12, 13].

Common complications of 3 M surgery include alveolar osteitis (dry socket), secondary infection, nerve dysfunction, and hemorrhage. The incidence of these complications varies from 0.2% to 6% [15, 16]. Reports of mandibular fracture during and after third molar removal are uncommon [4, 17–23].

The purpose of this paper is to discuss the risk and predisposing factors that should be analyzed regarding the possibility of immediate and late mandibular angle fractures and their need for surgical treatment as a means through which to remove impacted molars. This study is based on a thorough review of the literature as well as on one immediate and one late mandibular angle fracture as described by the authors' own personal experience.

Literature review

The removal of 3 Ms is one of the most common dentoalveolar surgical procedures. During the pre-penicillin period, prophylactic removal of wisdom teeth was the order of the day, due to morbidity rates associated with pathologies related to these teeth [24]. In recent times, prophylactic surgery has been justified on the basis that third molars have no role in the mouth, the need to minimize the risk of disease (cysts and tumors) development [25–27], the reduction of the risk of mandibular angle fracture [10, 12, 28–31], as well as an increased difficulty of surgery that is proportional to an increase in age [27, 32].

Mandibular fractures after the removal of impacted 3 Ms are rare [4, 17–23]. Nyul [33] reported one fracture in 29,000 cases (0.0034%). Alling and Alling [34] reported on the incidence of mandibular fractures associated with 3 M surgery, recorded by 74 respondents representing the practices of 108 oral and maxillofacial surgeons in a retrospective study of 365,170 patients. The intraoperative mandibular fracture rate was recorded as one in 30,583 patients (0.0033%). Postoperatively, this number rose to one in 23,714 (0.0042%). Findings from Libersa et al. [23], in which an incidence of 0.0049% was obtained, confirmed the conclusion of Perry and Goldberg [22], with a very similar incidence of 0.0046% over a 10-year period.

The present study identified 128 cases in the literature including two cases referent to the authors' own personal experience (Table 1). In the first case (Fig. 1), a 20-year-old healthy female patient heard a "cracking" sound in her jaw while eating 10 days after having had third molar surgery. An orthopantomograph was taken which revealed a non-displaced fracture with the fracture line extending from the apex of the mesiobuccal root socket to the lower border of the mandible. The minor trauma was most likely responsible for the lack of displacement of the fragments. The ratio indicating the space occupied by the third molar in the bone was 77.4% (the space which the third molars had occupied in the bone analyzed in relation to mandibular height). Possible treatment options, i.e., intermaxillary fixation (IMF) or open reduction and internal fixation (ORIF), were explained in detail to the patient. However, due to a lack of infection and dislocation between the segments, a good occlusion with all other teeth, and the patient's consent, only an IMF without ORIF was performed. Three months later, a bone union was radiologically observed.

Table 1 Reports of mandibular fractures during and after third molar removal

Author	Published	Reported cases
Nyul [33]	1959	1
Harnish [17]	1971	3
Haunfelder and Tetsch [18]	1972	4
De Carvalho et al. [88]	1977	1
Einrauch et al. [19]	1980	4
De Silva [20]	1984	1
Litwan and Götzfried [89]	1987	4
Härtel et al. [90]	1988	4
Guzmán et al. [91]	1990	2
Dunstan and Sugar [44]	1997	3
Iizuka et al. [21]	1997	13
Becktor and Schou [92]	1998	1
Krimmel and Reinert [4]	2000	6
Perry and Goldberg [22]	2000	28
Libersa et al. [23]	2002	27
Kunkel et al. [93]	2004	2
Wagner et al. [43]	2005	17
Komerik and Karaduman [45]	2006	1
Wagner et al. [94]	2007	1
Woldenberg et al. [35]	2008	1
Khan et al. [95]	2009	1
Valiati et al. [96]	2009	1
This study		2
Total		128

Fig. 1 Postoperative fracture. A non-displaced fracture with the fracture line extending from the apex of the mesiobuccal root socket to the inferior border of the mandible

In the second case (Fig. 2), a 26-year-old female patient underwent a third molar extraction by her orthodontist, who, without the expertise necessary for the extraction of impacted third molars, had applied excessive force on the bone. The patient felt a sudden and acute pain in the mandibular angle region when the tooth was released. Upon clinical examination, malocclusion with premature contact on the ipsilateral side could be observed. The unfavorable angulation of the fracture resulted in the displacement of the fractured proximal segment (containing the mandibular ramus) due to the traction force exerted by the masseter muscle. The ratio indicating the space occupied by the third molar in the bone was 62.4%. Under general anesthesia, the patient underwent open reduction and internal fixation of the fracture through a submandibular approach.

Fig. 2 Immediate fracture. Unfavorable angulation of the fracture resulted in the displacement of the fractured proximal segment

Iizuka et al. [21] stressed the fact that radiographic diagnosis may not be so simple. De Silva [20] reported a case in which no fracture line was visible on a radiograph taken when the fracture was first suspected. In this case, it was initially presumed that the symptoms were simply a manifestation of temporomandibuIar joint dysfunction caused by the manipulation of the jaw during surgery. In the study of Iizuka et al. [21], all fractures which occurred in the early postoperative stage were non-displaced. Since such hairline fractures are not always immediately apparent, a negative radiological finding immediately after such an episode does not exclude the possibility of a fracture. In such a situation, a soft diet should be prescribed and a follow-up radiograph should be taken several days later [21]. A cracking noise reported by the patient should be considered as an indication of a possible fracture even if the fracture initially appears to be radiologically undetectable [35].

In negative radiological findings of a fracture line in suspected cases of non-dislocated mandibular fracture, computed tomography (CT), digital volume tomography (DVT), or cone-beam computed tomography (CBCT) may add additional insight. Plain films are the least expensive and require less radiation, but they have been superseded by CT, DVT, and CBCT, which offer superior anatomic visualization [36]. Plain films may superimpose structures, thus frequently underestimating the extension of fractures [37]. Advanced imaging modalities, such as CT, DVT, and CBCT, are able to generate images easily on sagittal, coronal, and axial planes, in turn eliminating the superimposition of anatomic structures [38, 39].

According to a recent study, CT presented higher values, surpassing panoramic images as the gold standard for the diagnosis of mandibular fractures because of its image enhancement tools, better image quality, equivalent sensitivity in the identification of fractures, decreased interpretation error, and greater interphysician agreement in the identification of mandible fractures [40]. Some studies support the contribution of CT findings for the surgical management of traumas [41, 42]. However, limiting factors, such as cost, availability, and radiation dosage, promotes CBCT as an acceptable alternative to evaluate maxillofacial fractures [37, 43].

Intraoperative fractures may occur with improper instrumentation and excessive force placed on the bone, as occurred in case 2 of the present study. This confirms the importance of tooth sectioning before extraction, but it cannot account for all of the complications [23]. In the early postoperative period, mastication seems to be the main precipitating factor where patients with a full dentition are able to produce peak levels of biting forces that can place

considerable stress on bones that have been weakened by surgery and that have not yet fully recovered or calcified [4, 21–23], as occurred in case 1 of the present study. Although mastication was the most commonly reported cause, late mandibular fracture after 3 M removal was also reported after yawning [22], a cry of fear, and postextraction osteitis [23], after tooth removal without bone removal [44], and after maxillofacial injury [45].

The risk and predisposing factors that should be analyzed regarding the possibility of fractures of the mandibular angle during and after the removal of third molars are summarized in Table 2. The main factors observed during third molar removal include: (1) the magnitude of tooth impaction, (2) type of tooth angulation, (3) long roots, (4) patient age, (5) age and experience of the surgeon, (6) presence of cyst or tumor around impacted third molar, (7) systemic disease or medications which may impair bone strength, (8) preoperative infections in the third molar site, and (9) inadequate preoperative examination. The main factors observed after third molar removal include: (1) the temporal point after surgery, (2) preoperative infections in the third molar site, (3) the patient´s gender, (4) presence of bruxism, and (5) patients which are active athletes.

Risk and predisposing factors of fracture during the third molar operation

1. Magnitude of tooth impaction

Some authors [4, 21–23] have found a greater incidence of mandibular fracture with full bony impactions presumably because a greater volume of bone is necessary for removal. A lower third molar already occupies a significant amount of space in the bone. The postoperative result is a smaller or weaker strut, or cortical shell of bone, which thus may be an important causative factor in late fractures [21, 46]. Weakening of the mandible is, therefore, always associated with third molar removal [21]. According to Iizuka et al. [21], from a practical point of view, only deep impactions with tooth roots that are superimposed on or adjacent to the inferior alveolar canal within a panoramic image appear to be important parameters which present a predisposition to a mandibular fracture.

In the study of Iizuka et al. [21], the ratio indicating the space occupied by the third molar in the bone greatly varied from 44% to 84% in panoramic images. In the only case of Komerik and Karaduman [46], the roots occupied 40% of the total mandibular height. The two cases in the present study demonstrated ratios of 62.4% and 77.4%. Although the present cases presented a thin cortical bone above their crowns, when this cortical portion was removed, a point of extreme fragility was created.

Popular theory has typically defended that the more impacted a tooth may be, the smaller the cross-sectional region of bone remaining in the angle region may be; hence, less bone is available to resist outside stress. The results of Fuselier et al. [47] challenge this and consider that partially impacted mandibular third molars result in the least cross-sectional region of bone remaining in the angle region. This emphasizes the significance of an intact superior border playing an important role in the structural stability of the angle region, just as it played an important role in the surgical treatment of angle fractures. In the study of Werkmeister et al. [48], a considerable percentage of partially impacted third molars were encountered in patients with mandibular angle fractures (39%). Surprisingly, a case of fracture after removal of fully erupted 3 Ms was also reported [46].

Table 2 Risk and predisposing factors that should be analyzed regarding the possibility of mandibular angle fractures during and after the removal of third molars

During the operation	
1	Magnitude of tooth impaction
2	Type of tooth angulation
3	Long roots
4	Patient age
5	Age and experience of the surgeon
6	Presence of cysts or tumors around the impacted third molar
7	Systemic disease or medications which may impair bone strength
8	Preoperative infections in the third molar site
9	Inadequate preoperative examination
After the operation	
1	Temporal point after surgery
2	Preoperative infections in the third molar site
3	Patient gender
4	Bruxism
5	Active athletes

Mandibular angle fractures contain an area of tension at the upper border and an area of compression at the lower border. These areas of tension and compression are demonstrated by muscle insertion, muscle force, and bite force positioned on the proximal and distal segments of the fracture [49]. Impacted 3 Ms that disrupt the cortical bridge of the upper border can cause an inherent weakness in the mandibular angle. Thus, less force and muscle tension are needed to cause an angle fracture. This could explain why the highest risk of angle fractures was observed by Duan and Zhang [50] for class II and class B positions of 3 Ms (classification of Pell and Gregory [51]), in which the upper border was interrupted, as compared to class III and class C which presented intact upper borders.

2. Type of tooth angulation

Distoangular impacted teeth are commonly considered to be more difficult to remove than others and require more extensive bone removal [11, 52]. It has also been stated that a distoangular position is often associated with a lingual position. The lingual cortex in such cases is correspondingly thin. Upon bone removal at the buccal cortex, such tooth positioning would be more predisposed to fracture [53]. In the study of Iizuka et al. [21], however, no relationship between the type of tooth angulation and the likelihood of fracture could be observed.

3. Long roots

The mechanism by which third molars with long roots have been hypothesized to increase the risk of angle fractures is by occupying osseous space, thereby weakening the angle region by decreasing the cross-sectional area of bone [29]. The same is valid for the presence of cysts or tumors around impacted third molars (see later in this paper).

4. The patient age

Patient age is also an important factor in fracture risk [4, 21–23, 54]. In the study of Libersa et al. [23], 85% of the patients were over 25 years of age, with a mean age of 40. In a similar study [22], 22 of 28 (78.6%) patients were 26 years of age or older. Iizuka et al. [21] found a mean age of 53 (range 34-78), and 67% were more than 40 years of age. Krimmel and Reinert [4] found a mean age at fracture of 45, whereas Wagner et al. [44] reported a mean age of 49 years. The decrease in elasticity of the bone and occurrence of osteoporosis in aging are likely explanations for an increase in the fracture rate at age [21]. Likewise, narrowing of the periodontal ligament also increases with age [4], and increased ankylosis of third molars in older patients may also complicate tooth removal, thus producing a need for extensive osteotomy [44]. In comparison to young patients, the impacted tooth must be more extensively freed from the surrounding bone, and the jaw is further weakened [21]. This knowledge should influence the decision to remove impacted third molars in the elderly patient [4]. This finding is in agreement with previous reports [16, 52, 54–57] that showed increased numbers of intra- and postsurgical complications with the removal of impacted third molars in older patients. These complications include increased pain, swelling, trismus, bleeding, incidence of fractured roots, lingual plate fracture, lingual and inferior alveolar nerve injury, dry sockets, and prolonged healing. Moreover, a univariate analysis based on the removal of 354 mandibular 3 Ms identified increased age as a factor that predicts the surgical difficulty of 3 M extractions [58].

5. The age and the experience of the surgeon

The age and the experience of the surgeon seem to have little, if any, bearing on the incidence of fracture. Only four of the 28 fractures were reported by surgeons who had been in practice 5 years or less [59]. Sisk et al. [59] reported a higher rate of other complications, such as alveolar oseitis and nerve dysesthesia, when the surgery was performed by residents as compared to hospital staff.

6. Presence of cysts or tumors around the impacted third molar

Although the proponents of prophylactic removal of impacted third molars have based their arguments on the likelihood of cyst and tumor development if these teeth are retained, a closer look at the literature shows that the incidence of cyst and tumor development from impacted third molars is apparently low [60]. Güven et al. [26] reported that the incidence of cysts and tumors around impacted third molars was 3.1%. Bruce et al. [54] reported an incidence of 6.2% of cysts and tumors developing around impacted third molars. In their report, the incidence was notably highest (13.3%) in the oldest age group (mean age of 46.5 years) and lowest (1.5%) in the youngest age group (mean age of 20 years). Girod et al. [61] reported that the development of large cysts around impacted third molars took 2-13 years. It seems, therefore, that the longer an impaction exists, the greater the risk of development of cysts and tumors. This fact may act as synergism in an increased risk of angle fractures in 3 Ms surgery, as the decrease in the elasticity of the bone and the occurrence of osteoporosis in aging are likely explanations of an increase in fracture rate with age [21], as aforementioned.

The incidence of large cystic lesions associated with impacted third molars which required hospitalization was 0.038 $year^{-1}$ 1,000 $patients^{-1}$ in the study of Berge [62]. In this Norwegian study, the greatest diameter of the lesion was 47.6 mm (range 26–72 mm). Moreover, severe impaction of a mandibular third molar seems to indicate a predisposition for cyst development [48].

One mechanism by which third molars have been hypothesized to increase the risk of angle fractures is by occupying osseous space, thereby, weakening the angle region by decreasing the cross-sectional area of bone [29], which may be also attributed to local pathologies. In findings from

Krimmel and Reinert [4], three cases of mandibular fractures after 3 M removal showed that the mandible had already been preoperatively weakened by cystic lesions.

7. Systemic disease or medications which may impair bone strength

Because of their anti-inflammatory and immunosuppressive action, glucocorticosteroids (GC) are used in the treatment of various symptoms and diseases, including rheumatoid arthritis and related diseases, asthma bronchiale, and neurodermitis, as well as, in high doses, after organ transplantation [63, 64]. One of the side effects of GC treatment is an accelerated bone loss and an increased risk for bone fracture, especially after prolonged exposure [65, 66]. GC-treated patients, as compared to controls, are at a two times higher risk of suffering a fracture, regardless of their bone mineral density [67].

Osteoporosis can play a significant role in the impairment of bone strength. Bone mass is largely genetically determined, but environmental factors may also contribute. Greater muscle strength and physical activity are associated with higher bone mass, while radial bone loss is greater in cigarette smokers or those with a moderate alcohol intake. Sex hormones have important effects on bone physiology. In men, there is no abrupt cessation of testicular function or 'andropause' comparable with the menopause in women; however, both total and free testosterone levels decline with age. A common secondary cause of osteoporosis in men is hypogonadism. There is increasing evidence that estrogens are important in skeletal maintenance in men as well as in women. In men aged >65 years, there is a positive association between bone mineral density (BMD) and greater serum estradiol levels at all skeletal sites as well as a negative association between BMD and testosterone at some sites. It is crucial to exclude pathological causes of osteoporosis, given that 30-60% of men with vertebral fractures actually have another illness contributing to bone disease. Glucocorticoid excess (predominantly exogenous) is common. Gastrointestinal disease predisposes patients to bone disease as a result of intestinal malabsorption of calcium and colecalciferol (vitamin D). Hypercalciuria and nephrolithiasis, anticonvulsant drug use, thyrotoxicosis, immobilization, liver and renal disease, multiple myeloma and systemic mastocytosis have all been associated with osteoporosis in men [68]. Osteoporosis is also common in patients with systemic lupus erythematosus. Risk factors for osteoporosis include prolonged use of glucocorticoids, cyclophosphamide, and possibly gonadotropinreleasing-hormone agonists [69].

Juvenile idiopathic arthritis is the most common pediatric rheumatic disease. Studies have demonstrated significant deficits in trabecular volumetric bone mineral density and cortical bone mass [70, 71].

Chronic kidney disease (CKD) is a worldwide public health problem that affects 5-10% of the world population [72]. Disorders of bone and mineral metabolism and vascular calcification associated with CKD have been identified. Bones are likely to be more severely affected by CKD than might be expected from normal aging. Increased bone fragility observed with aging (senile or postmenopausal osteoporosis) and atherosclerotic disease with calcification that develop with or without of CKD can be present in patients with CKD who have a normal or only slightly reduced kidney function and can coexist with CKD-mineral and bone disorder after its onset [73].

Although mandibular fracture in connection with third molar surgery is uncommon, it may give rise to serious problems. When a fracture occurs, it should be reduced and managed in a standard fashion, using IMF or ORIF techniques. If the practitioner is not skilled in fracture management, the patient should be referred to an oral and maxillofacial surgeon [21].

8. Preoperative infections in the third molar site

Perry and Goldberg [22] found that 64% of the patients (18 of 28) with a history of mandibular angle fracture due to third molar surgery presented a medical history of previous preoperative infections in the third molar site. Goldberg et al. [15] reported a 21% preoperative infection rate in a series of 500 third molar patients. Iizuka et al. [21] observed that six of their 12 cases had pericoronitis and/or infected periodontal pockets within the distal aspect of the second molar before extraction.

Indresano et al. [74] pointed out that the formation of deep abscesses associated with lower wisdom teeth was more frequent in cases of partial impaction. This is in accordance with an increased risk of acute pericoronitis in fully erupted, vertically positioned third molars at or above the occlusal plane which have only partially been encapsulated by soft or hard tissues [75]. The study of Werkmeister et al. [48] confirmed the increased risk of developing an infection around partially impacted third molars. This fact, together with the consideration of Fuselier et al. [47] that a partially impacted mandibular third molar results in the least cross-sectional region of bone remaining in the angle region, may act as synergism in an increased risk of angle fractures in 3 M surgery.

Although no description of the severity or duration of the infections was collected, it is reasonable to assume that chronic or deep infection will decalcify or destroy the bone, thereby contributing to the likelihood of fracture both during and after third molar surgery. Periodontitis of the second molar may be the cause of the infection around the impacted third molar. In these cases, the alveolar bone between the impacted third molar and the second molar is usually destroyed by chronic periodontitis [76].

The results of the study of Osaki et al. [76] in elderly patients suggest that bone-perforating impacted third molars with bone resorption around the crown, denture irritation, as

well as impacted third molars that are connected to the enlarged periodontal space of the second molar, are likely to cause infections. The study of Werkmeister et al. [48] showed that when deep abscesses around impacted third molars formed, 97.2% of the teeth were partially impacted. Chronic infection not only weakens the bone, but also frequently causes an inflammation of the masseter and medial pterygoid muscles, resulting in trismus [77]. This inflammation results in an immobile ramus and increases the potential for mandibular fractures. When healing is prolonged, the possibility of fracture should always be considered. Repeated radiological examinations are recommended.

9. Inadequate preoperative examination

Identifying the teeth that present a higher risk of complications related to third molar surgery is the key to developing prophylactic measures to avoid mandibular fractures. All aforementioned risk and predisposing factors should also be carefully analyzed.

Risk and predisposing factors of fracture after the third molar operation

1. The temporal point after surgery

One study found that fractures had occurred most frequently within the first week after surgery [21], whereas other studies only found fractures within the third week [23]. However, according to Perry and Goldberg [22], the greatest risk period seems to be during postoperative weeks 2 and 3, during which granulation tissue is being replaced by connective tissue in the alveolar socket [78]. In older patients, a lag phase in healing occurs during this period. Two-thirds of the socket is not filled with osteoid or bone until the 38th day [56, 78, 79]. Moreover, at the end of the second week, patients are feeling better, the pain has disappeared, and they can chew normally. When the patients have a full dentition, the occlusal forces are at their peak and the risk of fracture in non-fully calcified mandibles is quite high [23]. Our second case confirms the findings from Perry and Goldberg [22], especially considering that the patients reported a cracking sound during eating that was accompanied by great pain. From our second case, it can be concluded that the masticatory forces may be sufficient enough to cause fracture in the susceptible bone but are not strong enough to cause a displacement of the segments.

In contrast, the recent study of Al-Belasy et al. [80] contradicted this hypothesis in all cases. To see whether counseling patients or limiting their diet has any value in the possible risk of late mandibular fracture, patients were randomly assigned into two groups for non-routine (NR) and routine (R) postoperative instructions. Patients in the NR group were postoperatively informed of the potential of a mandibular fracture and were given an unambiguous emphasis on the necessity of limiting chewing to a soft diet for 4 weeks. The quality of the soft diet was also emphasized. Patients in the R group were given no such information or emphasis. The authors therefore concluded that in patients who were fully dentate or with one or two teeth missing and older than 25 years of age, who have no jawbone atrophy and no systemic problems that may impair bone strength, mastication seems not to affect late mandibular fracture after surgical removal of impacted 3 Ms that not were associated with gross pathology.

2. Preoperative infections in the third molar site (previously described in this article)
3. The patient´s gender

According to Libersa et al. [23], gender seems to be particularly important in postoperative fractures. Only two women, as compared to eight men, actually sustained postoperative fractures. Perry and Goldberg [22] found late fractures in six women and 22 men, while Iizuka et al. [21] found late fractures in seven men and five women. This may well be due to the greater masticatory force in men as compared to women [81]. In the present study, only women presented angle fractures, but this may be significant as the total sample size was small (only two cases). Libersa et al. [23] observed that the main cause was mastication, as also noted in our first case. Moreover, the biting force correlates with the number of teeth and functional pairs of teeth [81]. The first case of the present study was fully dentulous. The masticatory force required to break down food before deglutition can place considerable stress on bones that have been weakened by surgery and have not yet fully recovered or calcified [22]. Eating bagels, nuts, steak, spareribs, bacon, and frozen candy bars requires considerable masticatory force and hardly constitutes a soft diet. Even assuming that all third molar surgery patients received postoperative dietary instructions, perhaps inadequate emphasis was placed on the quality and duration of the soft diet. Also, noncompliance may be a greater problem than has been previously recognized as a cause of this late complication [22].

4. Bruxism

It is understood that clenching, bruxism, and masseter muscle hypertrophy may contribute to the late mandibular fracture after 3 M surgery, as these problems can positively affect the bite force [82, 83]. However, this is still a controversial subject. Al-Belasy et al. [80] undertook a recent study with the null hypothesis that in patients, fully dentate or with one or two teeth missing and older than 25 years of age, mastication does not affect late mandibular fracture after the surgical removal of impacted third molars. Seven patients who had masseter muscle hypertrophy and 11 who had clenching or/and bruxism presented no mandibular fracture.

5. Active athletes

Maxillofacial injuries are an increasing risk in sports, and fractures represent common sequelae. The intense physical nature and growing popularity of sports are believed to be the key factors responsible for the increased prevalence of such traumas [84]. At the end of the second week, patients who underwent 3 M surgical removal were normally feeling better because the pain had disappeared [23]. This false sense of security, due to the disappearance of post-surgical discomfort, can lead patients who are active athletes to return to their sporting activities, thus increasing the risk of a later mandibular fracture in a weakened mandibular angle region. This risk of sports-related maxillofacial fractures is considerably higher in contact sports that are both popular and lacking in facial protection [84].

Conclusions

Contemporary oral and maxillofacial surgery practices include the use of a detailed informed consent designed to educate the patient about risks and complications, enable them to contribute in the decision-making process regarding surgery, as well as prevent malpractice litigation. Discussions of late risks and complications, although relatively uncommon, should be included both in the preoperative risk/benefit discussions as well as in the postoperative instructions [22].

For those who frequently perform third molar surgery, it is important to understand the nature of this complication. One must consider if prophylactic removal of partially impacted 3 Ms is truly recommended as 3 Ms are commonly associated with the highest relative risk of angle fractures. There is a great variation among surgeons in their judgment on the need for prophylactic removal of third molars [60, 85, 86]. The decision to extract or not to extract impacted third molars should be individualized, rather than generalized [60]. The decision, however, should reflect knowledge on how the aging process affects difficulty and morbidity [21] and should be limited to those teeth with well-defined medical, surgical, or pathologic indications [60]. Identifying the teeth presenting a higher risk of complications related to third molar preservation is key to developing recommendations for prophylactic third molar surgery [48].

In cases in which the extraction of the impacted mandibular third molars is recommended, the danger of an immediate jaw fracture can be avoided by:

1. Adequate surgical expertise, good visualization, proper instrumentation, guided force application, and adoption of conservative necessary bone removal and tooth sectioning [80];
2. Excessive force should not be placed on the bone, and necessary bone removal should be conservative during removal. This confirms the importance of tooth sectioning before extraction [23];
3. Prophylactic third molar removal should be performed before 20 years of age [23];

The danger of an immediate as well as a late jaw fracture can be avoided by precise diagnosis in the following cases:

1. Patients over 25 years of age, particularly men [23];
2. Patients with bruxism [82, 83];
3. Active athletes [84];
4. Tooth roots superimposed on or adjacent to the inferior alveolar canal on a panoramic image [21];
5. Any local pathology and systemic disease [45] or medications which may impair bone strength.

Many empirical studies have identified the quality and communication of patient information as a major weak point in the treatment process [87]. Such patients need to be warned before operation about the possibility of fracture. A soft diet and a masticatory-limiting force are recommended for 4 weeks [35, 44]. These instructions should be stressed. Prophylactic third molar removal before 20 years of age should mitigate nearly all risks of fracture [23]. A cracking noise reported by the patient should be an obvious indication of a possible fracture, even if the fracture is initially radiologically undetectable [35].

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