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Mandibular fractures, diagnostics, postoperative complications

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ABSTRACT

Mandibular fractures usually happen among young males at the age of 16-30 years old. The mandible which has been rated as the second facial bone with the highest rate of injuries, tends to break much more often compared to any other bone of the cranium and represent up to 70% of the cases. This tendency to fracture may be explained by the protruded position, mobility and particular shape of it. The tendency for a mandibular fracture may also be explained by the common risk factors such as vehicle accidents and physical violence that are part of our daily life. There are many other risk factors according to the literature which differ between individuals due to the different socio-economic status, culture, technology and environment. Before the clinical examination of the fracture, it is obligatory to make sure that a clear airway path presents with no other fatal injuries. The examination may be supported by imaging methods which together will approve the diagnosis and method of treatment. Patients with a fracture of the mandible may suffer from post-operative complications which may occur after a short or long duration of the treatment. Those complications may be malocclusion, infections, trismus, damaged teeth and soft tissue, esthetic disfiguration, functional problems, pain and many more. In addition, those complications may be expressed as an unfavorable effect to the quality of life due to an unstable emotional state, an unpleasant feeling such as awkwardness to smile or laugh and difficulty to make social interactions.

Keywords: Mandibular fracture, Fracture imaging techniques, Facial fracture treatment, Facial fracture classification, Post-operative complications.

Abbreviations

Temporomandibular joint (TMJ), United States of America (USA), Orthopantomogram (OPG), Multidetector computed tomography (MDCT), Computed tomography (CT), Posteroanterior (PA), Ultrasonography (USG), Magnetic resonance imaging (MRI), Intermaxillary fixation (IMF), Open reduction with internal fixation (ORIF)

Introduction

The facial bones are immensely prone sites for injuries. The mandible specifically, has a higher tendency for maxillofacial injury compared to any other bone of the cranium. This tendency can be explained by the protruded position, mobility and particular shape of the mandible which eventually may lead to the loss of function and unreversed damage [4, 6]. The U-shape of the mandible has an important feature known as the 'ring bone rule', which states that in case of a fracture in one location, another fracture or displacement will most likely to appear over the opposite side [1].

The mandible considered as responsible for 15.5%-59% of the facial bones fractures and has been rated as the 2nd facial bone with the highest rate of injuries. Recent reports have shown that the usage of a seatbelt and automatic airbags within the vehicle have drastically reduces the chance for the passengers to suffer from fracture during a car accident. Due to a better and safer technologies in the last few years, the incidence and patterns of facial bones fractures among passengers in their vehicles have reduced [3].

Possible complications of a mandibular fracture may be a result of the surgery itself which in that case, they must be treated as soon as possible. The complications may occur directly after mandibular fracture such as airway obstruction, bleeding, broken teeth or bones. The complications may occur after a much longer duration such as nonunion, malunion, damage to the nerve, infections, temporomandibular joint (TMJ) dislocations and tearing [10]. Patients with a fracture of the mandible may also present symptoms such as, trismus, step

deformity pain, esthetic disfiguration and may be having a functional problem to chew and talk [1, 4]. The aim of this article is to present the available literature regarding fractures of the mandible with a

focus on the possible complications of treated or untreated cases.

Epidemiology

In 2007, out of 400,000 visits to the emergency departments in the United States of America (USA) as a result of fractures of to the facial bones, 23% of them were related to the mandible [9]. Mandibular fractures usually happen among young males at the age of 16-30 years old. The mandible, unlike other bones of the facial skeleton, tends to break much more and represent up to 70% of the cases [1].

The mandible may have fractures at different locations, in which the literature presents different statistics for each one of them. The most common location is the parasymphysis with 35-50%, body of the mandible with 21-36%, condyle with 20-26% and the angle of the mandible with 15-26% while the least common location is the ramus with 2-4% and the coronoid process with 1-2% [1]. A study which was conducted in Taiwan among 6013 patients has shown that the mandible is the 2nd most common site for a fracture with 24.7%, followed by fracture of the nasal bones with 22.8% but still remains less than the maxillary and malar bones with 48%. Another study which was conducted by the authors Christopher et al, has shown that the most common site for a fracture is the angle with 27%, followed by the symphysis with 21.3%, condyle 18.4% and the body of the mandible with 16.8%. A different study which was conducted by the authors Fridrich et al., has shown that the most common site for a fracture

is the angle with 28.5%, followed by the symphysis [5]. In addition, a group of studies which had investigate the fractures of the mandible have shown that the parasymphysis is the most common site whereas the least common was the coronoid process [2].

Risk factors

Maxillofacial injuries depend on numbers of causes which determined by the geographic areas, socio-economic status, culture, demography, technology and environment of the individuals. The fractures of the mandible do not have a specific etiological factor in the literature [6, 7]. Epidemiological researches from the past have suggested that each risk factor is a bit more common for a specific age group. For instant, in countries at the region of North-America, North Europe, Australia and New Zealand the number one cause for fractures of the mandible is violence between people. In countries with new industry and less development like Nigeria and Jordan, the number one cause for fractures of the mandible is vehicle accidents [7]. Most of the mandibular fractures in the USA are caused by violence between men at the age 18-24 years old. A study which was conducted between 13,142 patients have shown that men have a 4 times higher chance to suffer from fractures of the mandible. This study has also shown that more than 50% of the fractures related to men are from violence, compare to women which most of their fractures are a result of vehicle accidents and falls [3].

At the present days in contrast with the past, the main cause of fractures to the mandible is vehicle accidents. That cause may be explained by the constant growing number of vehicles and the lack of speed limitations which have led to a higher number of high-speed traumas. The 2nd cause by its rating is the physical violence, which was the leading cause 30 years ago when the number of vehicles were

much smaller. In addition, fractures of a mandible are more common in societies with a low socioeconomic status due to their frequent use of alcohol and tendency for a loud and violent arguments [1].

Classification

In the broad field of facial trauma, the specific fracture of a mandible should not be included in the classification because of the protruded and fragile position of the mandible compare to the rest of the facial skeleton [1]. The classification that will be use clinically to evaluate the fractures must be easy and convenient. It must contain few specific characteristics, such as the anatomical position and displacement level of the fracture [15].

Fractures of the mandible may be classified according to the anatomy, dentition, severity and action of the muscles. The fractures may also be open, close, displaced, pathological and comminuted. Kazanjian and Converse have classified the fractures of the mandible according to 3 types of dentition and their proximity to the fracture line. In class 1, teeth located on each side of the fracture line. In class 2, teeth located only on one side of the fracture line. In class 3, there are no teeth on either side of the fracture line. This classification is relevant for cases which may require the teeth to be used for fragmental reduction and attachment by wires or other means to keep the alignment. Classification by the action of the muscle, can by apply for the angle and body of the mandible. Fractures of those anatomical areas may be held in a position which may improve or worsen the healing process due to the surrounding muscles and their directions of action. The position of the fracture may be improved and considered as favorable, in situations which include opposite directions between the bone fragments and the direction of the muscle's actions. The position of the fracture may be worsened and considered as unfavorable, in

situations which include the same directions between the bone fragments and the direction of action of the muscle which eventually leads to a bigger displacement. Fractures of the mandible may also be classified according to their severity. The F-F4 system grades the severity as F - not visible fracture line, F1 – single fracture line at the alveolar area, F2- single and continuous line which separate the bone completely, F3- two continuous lines which separate the bone completely, F4- more than three continuous lines which separate the bone completely. As the grade of the classification is higher, the risk is higher for inferior alveolar nerve impairment and complications after the surgery [1]. Fractures may be also classified into 3 classes according to their diagnostic imaging methods, such as townes view and orthopantomogram (OPG). Class 1 represents fracture with a reduction of the ramus height which is smaller than 2mm or fracture which have been displaced less than 10 degrees. Class 2 represents fracture with a reduction of the ramus height which is between 2-15mm or fracture which have been displaced between 10-35 degrees. Class 3 represents fracture with a reduction of the ramus height which is bigger than 15mm or fracture which have been displaced more than 10-35 degrees. Treatment by open reduction should be apply for classes 2 and 3 while close reduction for class 1 [10].

Examination

The first tasks to do before the assessment of a facial bone fracture is to make sure that there is a clear airway path and no other injuries which may jeopardize the life of the patient [1]. The occlusion state of the patient is one of the most important diagnostic characteristics for proper evaluation of mandibular fractures. In cases which have recently occur, it provides a lot of information to ask the patient if his bite is balanced and normal. Any complain from the patient side such as malocclusion, must be properly evaluated and

recorded in written or in any other form and must be compared to the occlusion state prior to the trauma. If the patient is incapable to provide the needed information due to medical situation such as sedation, intubation or any other reason, the information should be taken from previous dental records. During the clinical evaluation, the practitioner will have to palpate the exact location of the fracture from both sides while looking for any mobility. No mobility at all will suggest that conservative treatment will be very responsive due to the high stability and proper occlusal alignment of the fracture. Any intraoral tearing of soft tissues and hematomas with proximity to the fracture must be recorded due to the higher risk for infection. A very clear sign for fracture of the mandible is a big ecchymosis at the floor of the mouth. In addition, clinical evaluation of the dentition must be done during the primary evaluation and in case of any mobile, carious, broken teeth especially near the fracture line, it should be recorded as well and to take into an account of a possible extraction. Extraction would be advised in case the tooth is severely broken, prevent proper reduction of the segments, displaced out of the socket, has a deep caries with possibility for future abscess, very mobile with widespread periodontal disease and has certain pathologies such as cyst or pericoronitis [3]. Inability to identify the specific size, structure and severity of a certain fracture may result an insufficient surgical treatment. Therefore, an increasing number of treatment management considerations are based on the accurate and informative Multidetector computed tomography (MDCT). MDCT has become the primal tool of diagnostic for orbital and facial structures. There is an antagonism for primary examination of doubtful mandibular fractures with MDCT, due to the fact that mandibular fractures frequency is much higher than midface fractures and the total cost as a result

will be higher. On the other hand, the popularity of regular dental radiography and OPG have drastically reduced in the emergency care as the availability of the MDCT has increased [9].

Diagnostic methods

The use of imaging methods would be advised in case of a suspicious fracture of the mandible. Early identification of a mandibular fracture is highly important in order to prevent harmful consequences such as malunion, nonunion and delayed union. Fracture of the mandible usually presents certain clinical characteristics such as malocclusion, spasm of the jaw muscles, constant pain, damaged teeth and step deformity. In case of any of these facial characteristics, the patient would be advised to undergo radiographic imaging [1].

Fractures of the mandible may be evaluated by a number of radiographic imaging from 3 different positions, such as the lateral, oblique and the posteroanterior (PA). The PA and the oblique positions may provide a comprehensive view of the ramus, angle and body of the mandible. The lateral position is especially beneficial for the evaluation of the TMJ and possible dislocations. Different positions of radiographic imaging are necessary in order to recognize the lines of the fracture and displacement [1].

In order to achieve an adequate treatment for a fracture of the mandible, the diagnosis must be accurate. An extensive and accurate diagnosis may be achieved by the use of an OPG, which may clearly present the different areas of the mandible [10].

Nowadays, computed tomography (CT) can presents the most extensive and particularized information regarding the facial bones [10]. There are a few indications which advise the use of a CT for the mandible. The first indication is in case of an

unsteady patient with conjecture for a present fracture of the mandible. The second indication is in case of a concern of a fracture which is not illustrated in the radiographic imaging. The 3rd indication would be advised if the radiographic evaluation of a mandibular fracture would help to prepare a treatment plan for cases which may require an open or close reduction and the improved information given by the CT might assist [1].

Known as Ultrasonography (USG), has been proven as beneficial imaging technique for the identification of fractures of the mandible. The USG is beneficial due to the non-ionizing radiation emission, cheap technique and fast imaging. On the other hand, the USG is unable to present the specific severity of the mandibular fracture due to the lack of spatial information which is provided from different angles, as possible in other imaging technique. This technique would be recommended in cases which include patients that are not able to undergo CT as a result of a certain trauma, pregnancy and would prefer to reduce the level of ionizing radiation [1].

Magnetic resonance imaging (MRI) holds the advantage of not applying ionizing radiation to the patient, but in case that a very informative and fast imaging under 24 hours is required, the preferable imaging technique would be CT. This specific technique would be advised in case of a suspicion for trauma to the soft tissues. For instant, in case of a condylar fracture, the disc of the TMJ would require evaluation for a dislocation or any capsular rupture [1].

Management

The expertise of the oral and maxillofacial surgeons regarding the anatomical, functional and occlusal aspects of the mandible is obligatory for an accurate initial diagnosis, therapeutic planning and accomplishment of a positive outcome for the patient [9]. The predilection of the surgeon to a certain type of treatment for the mandibular fracture

may be depend on the features of the fracture itself [8] such as the location [3]. Treatment may include soft diet, close reduction with intermaxillary fixation (IMF) and open reduction with internal fixation (ORIF) [8]. As most of the mandibular fractures demands a certain type of fixation for a better healing process in order to restore the position of the jaws before the trauma, a minor percentage of the mandibular fractures do not present any occlusal alterations, such as displacement, and do not require surgical treatment [3].

The specific treatment of a fracture will be depending on the specific location. In case of an isolated fracture at the body of the mandible which is not or barely displaced and have an adequate number of surrounding teeth, the most proper way of treatment will be to use an IMF. ORIF would be more suitable for older patients, in order to prevent the inconvenience and obstruction of the long-term use of IMF. In case of fracture at the symphysis and or the parasymphysis, the most common way of treatment is ORIF. Close reduction would be advice for those with a fracture which is not dislodge. In case of fracture at the angle, the most common way of treatment is ORIF as a result of the strong inclination toward displacement. In case of fracture at the condyle, the consensus is to reconstruct the range of motion soon as possible in order to restore the activity of the TMJ. Those patients usually suffer from a pain near the ear, malocclusion and deviated chin during movements of the mandible [3].

After the reduction of the separated segments, the teeth at the area may act as an anchor one to the other with the reinforcement of a wire. The teeth near the fracture site are a significant anatomical promoter which does not present anywhere else in the body [14]. The result of the various treatments should be a healed fracture with correct occlusion and without any malocclusion such as nonunion, malunion and/or delayed union [1].

Complications

The outcomes of trauma to the face may be expressed as an unfavorable effect to the quality of life due to an unstable emotional state, an unpleasant feeling such as awkwardness to smile or laugh and difficulty to make social interactions [2]. Many of the patients who suffer from a certain trauma, will likely to present with a facial injury that may be specific to the face or combined with other bony fractures in different locations over the body. Those injuries demand a fast diagnosis and treatment in order to prevent any aesthetic and functional complications later on [11].

The mandible undergoes almost twice as much repairs compared to any other bone of the face as a result of fractures. The initial purposes in the management of mandibular fractures should be to reform the original shape and function of the traumatized bone and surrounding structures in order to obtain a bony union of the separated segments [16]. A study by Giroto in 2001, have investigated the consequences of injury to the face from the functional point of view and have claimed that those cases cannot be forsaken and have to be managed as soon as possible, due to the relation between the gravity of the injury to the physical limitations such as malocclusion, difficulty to chew, sense any odor and feel physical stimulation [11].

There are many complications which may happen after a surgery of maxillofacial area. Those complications may be related to soft tissues, TMJ, various nerves, bones, osteonecrosis, malocclusions, malunion or nonunion and infections. Those complications may be related to teeth such as necrosis to the pulp, broken teeth, teeth displacement which may occur during the surgery or postoperative [10]. The rates of postoperative complications as a result of mandibular fractures are between 7-29%. Those rates are influenced by the

severity, location and the number of involved areas of the fracture. Patients who smoke, have a systemic disease or expose to any physical mistreatment behavior will present with higher rates of the complications [3]. The most prevalent complications are infection of the site, technical equipment failure, osteomyelitis, lack of a proper healing such as nonunion or malunion and the most common of all is malocclusion which most likely to occur as a result of wrong placement of the fixation [3].

Another possible postoperative complication is a symmetrical face, which may occur due to an incorrect reduction of the mandible at the necessary time of healing. The incorrect reduction of the mandible and as a result an incorrect position of the condyle, has a direct effect on the TMJ which in the long term would lead to TMJ disorders [13].

The most common complication of mandibular fractures, particularly at the angle of the mandible is infection. After the treatment of a mandibular fracture, the area is more subjected to infection and other circumstances which may reduce the blood flow to the area and eventually lead to nonunion and/or malunion. The prevalence of nonunion and/or malunion in the literature is approximately 1-2% [12]. The mouth provides a shelter for a substantial number of microscopic organisms which may postpone the regular healing process of wounds and might lead to infections in the area of the surgery. A recent research has suggested that proper mouth health care prior to the surgery, may decrease the possibility for infection and its important value to minimize the chance for complications after the surgery. Proper mouth health care after the surgery is recommended for patients who are having a trouble to keep a satisfying level of oral hygiene as a result of a damage to the surgical site, such as microflora habitat which have been filled with pathogens. Complications after the surgery

frequently leads to sustained hospitalization and decreased quality of life among the involved patients [17].

Complications after surgery cannot be avoided from happening but can definitely be reduced by taking into account the specific causing factor while making a treatment plan. For instance, the first treatment of choice for complications such as TMJ disorders and malocclusion which occurred due to malunion is to do a surgery again [13].

Conclusion

In conclusion, the high prevalence and tendency of the specific mandibular fractures will always open a door to the post-operative complications. Those complications cannot be completely avoided from happening but can definitely be reduced by an earlier and more accurate identification which will assist to select the proper method of treatment and will minimize the harmful consequences.

In conclusion, the fractures of the mandible may differ from one geographical region to the other due to variant risk factors and individual's circumstances.

In conclusion, fractures of the mandible may differ from one geographical region to the other due to variant risk factors and individual's circumstances but the high prevalence and tendency remains high worldwide. The amount of mandibular fractures cannot be completely avoided from happening but can definitely be reduced by an earlier identification which will assist to select the proper method of treatment and will minimize the harmful consequences.

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Conflicts of interest

The authors have no conflicts of interest to declare.

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