Original Article - Retrospective Study

Paediatric Mandibular Fracture Management - A Seven Year Retrospective Study

Rostyslav Yehorov, Lyudmila Yakovenko, Irina Primak

Department of Surgical Dentistry and Maxillofacial Surgery of Childhood, Bogomolets National Medical University, Kyiv, Ukraine

Abstract

Introduction: Mandibular fractures are one of the most frequent and complex types of traumatic injuries of the maxillofacial region in children. Given significant long-term sequelae of inappropriate healing, adequate diagnosis and choice of management, which takes into account the patient's age and fracture characteristics, are paramount. **Methods:** The data for this study were obtained from the medical records of patients treated in the Department of Surgical Dentistry and Paediatric Maxillofacial Surgery of the Bogomolets National Medical University from 2014 to 2020. Age, gender, fracture pattern and surgical treatment methods performed in these patients were recorded and analysed. **Results:** A total of 302 children with 376 traumatic fractures of the mandible were managed during the study period. The largest number of fractures was found in the condylar processes region, 42%, and in the body of the mandible, 40%. The majority of patients were males and in the 13–17 age group (147 [49%] cases). Tigerstedt's maxillary-mandibular fixation splint was used in the majority of cases, alone or in the combination with open or internal fixation. **Discussion:** Whilst the most common type of immobilisation in children in our series was Tigerstedt's maxillary-mandibular fixation splint, its use is limited to the variable bite period. Alternative fixation options are discussed.

Keywords: Condylar process, mandibular fractures, paediatric surgery

Introduction

Fractures of the lower jaw rank first amongst the fractures of the maxillofacial area (MFA) in children. Children's facial bones are more resistant to fractures, due to their anatomical and functional capacity and age.[1-3]

However, this is also the 'Achilles heel' as it creates conditions for the development of the inflammatory processes of the soft tissues and bones, secondary bone deformities and pathological occlusion. Therefore, the choice of the most informative methods of diagnosis, adequate and gentle type of immobilisation depending on the age, occlusion and fracture characteristics are the primary goals when providing care.

Materials and Methods

There were 302 children with 376 traumatic fractures of the mandible treated at the clinical base of the Department of Surgical Dentistry and Paediatric Maxillofacial Surgery of the Bogomolets National Medical University from January 2014 to July 2020. In the age of 13–17 years, mandibular fractures were in 147 (49%) cases, in the age of 7–12 years – 73 (24%), in the age of 3–6 years – 55 (18%) children and under 2 years in 26 (9%) cases. All children underwent radiological examinations: computed tomography (CT) examination – 206 (68%), orthopantomogram – 77 (26%) and plain radiographs of the mandible in direct projection – 19 (6%) persons. The criterion for inclusion in the study was the presence of at least one mandibular fracture in a patient with a traumatic injury of the MFA. The exclusion criteria were age older than 18 years, refusal of the patient's parents to participate in the study and lack of complete clinical and radiological documentation.

Access this article online

Quick Response Code:

Website: https://journals.lww.com/aoms

DOI: 10.4103/ams.ams_158_22

Address for correspondence: Dr. Rostyslav Yehorov, Department of Surgical Dentistry and Maxillofacial Surgery of Childhood, Bogomolets National Medical University, 13, T. Shevchenko Blvd., Kyiv, Ukraine.
E-mail: dr.egorovr@icloud.com

Received: 12-08-2022 **Last Revised:** 08-02-2023
Accepted: 18-04-2023 **Published:** 30-06-2023

How to cite this article: Yehorov R, Yakovenko L, Primak I. Paediatric mandibular fracture management - A seven year retrospective study. Ann Maxillofac Surg 2023;13:44-8.

The analysis of medical histories was performed according to the proposed survey map, which provided data on age, gender, additional research methods, characteristics, fracture location and type of immobilisation of the mandibular fragments.

The Chi-square test was used to determine statistical significance for categorical variables where applicable; the null hypothesis assumed that there is no correlation between the examined variables; the level of significance was set at $P < 0.05$.

The study was performed in accordance with the ethical standards of our Institution and International Standards (committee review #158 from 23/05/22). Records were anonymised at the data collection stage, and patients' confidentiality was protected. All procedures performed in the study were conducted in accordance with the ethics standards given in 1964 Declaration of Helsinki, as revised in 2013.

Results

The most commonly used systems for mandibular immobilisation in children were the dentogingival and the bony fixation systems. The dentogingival fixation systems used were: Tigerstedt's maxillary-mandibular fixation splint and the cap splints; and the bony fixation systems were the intraosseous screws and bone plates. These types of fragment fixation were used both in isolation and in their combinations.

The largest number of fractures was found in the condylar process (CP) region – 158 (42%) and in the body of the mandible – 152 (40%). Non-displaced fractures were found in 234 (62%) cases, whilst displaced fractures in 142 (38%). The latter was more common in boys, accounting for 72% of the total number of fractures in them (not statistically significant on the Chi-square test [Figure 1]).

CP fractures were prevalent in the age of 7–17 years and accounted for 70% of cases ($n = 110$). Those with and without the fragment displacement were found in a nearly identical proportion of cases. In the age group up to 2 years, CP fractures were found in 14 (9%) children, which accounted for 47% of the total number of fractures in this age group.

In the ramus region, the fractures were mostly seen in the age group of 7–17 years ($n = 11$) with a predominance of boys. In contrast to the CP fractures, the ramus fractures without fragment displacement were seen in 82% of cases.

At the age of 13–17 years, fractures of the mandibular angle were diagnosed in 47 (12%) patients, in whom fractures without fragment displacement were 2.3 times more common.

The fractures of the mandibular body were detected in 70 (19%) individuals, with the localisation in the mental region – 56 (15%) and in the medial region – in 18 (5%) children. The fractures in the mental region without displacement were 1.5 times more common than those with displacement. Of note, in the age group of 7–17 years, this region was fractured in 80% ($n = 45$) of cases; but in the up to 2 years age group, only in 4 (7%).

Medial region fractures in 2/3 of cases ($n = 12$) were observed before the age of 6 years, half of which ($n = 6$) were in under 2 years. Medial mandibular fractures without displacement were twice more common.

Anterior cell fractures were diagnosed in 8 (2%) children, 2/3 of whom were boys. Only one patient had a displacement. According to age, in five (63%) cases, the patients were under 6, two cases were 13–17 years old and one child was in the 7–12 age group.

The immobilisation of mandibular fragments was performed in 97.4% ($n = 294$) of cases by different types of immobilisation systems, in 2% ($n = 6$), no fixation was required and 0.6% ($n = 2$) of children refused treatment.

The immobilisation of mandibular fragments in most cases was performed using the Tigerstedt's maxillary-mandibular fixation splint in 220 (73%) cases, in combination with osteosynthesis (open reduction and internal fixation [ORIF]) – 50 (14%), ORIF alone – 15 (5%), ORIF in combination with intraosseous screws – 4 (1.3%), ORIF with orthodontic buttons – 1 (0.3%), orthodontic buttons – 3 (1%) and intraosseous screws alone – 1 (0.3%) [Figure 2].

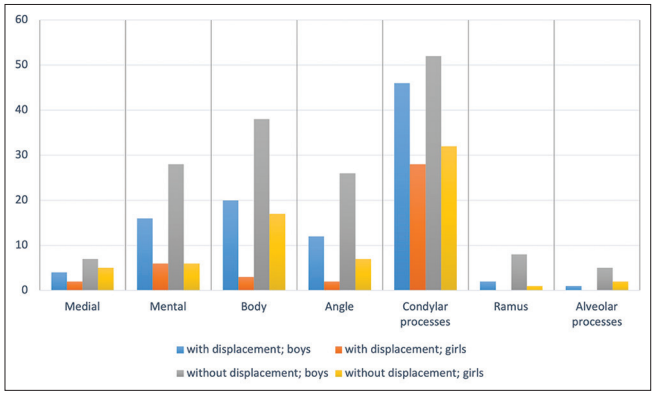

Figure 1: Distribution of mandibular fractures depending on the location, displacement and gender

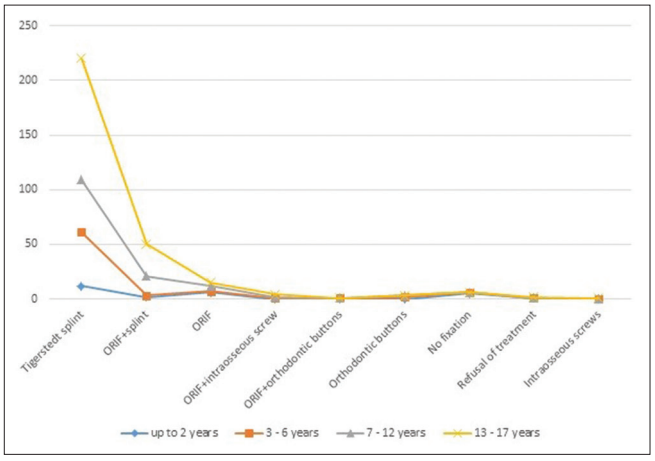

Figure 2: Types of immobilisation in fractures of the mandible depending on age

Tigerstedt splints were used for jaw fractures with different localisation and with a slight fragment displacement, the repositioning of which was performed in a closed fashion. This type of splint was used in 111 (50%) cases for children aged 13–17 years, 97 (44%) – from 3 to 12 years and 14 (6%) – up to 2 years. That is, in the period of temporary and variable occlusion, the fragment fixation was carried out with trauma to the periodontal tissues and the dentogingival attachment and with the presence of mobility of the teeth in which the roots were resorbed or not yet formed.

According to location, this immobilisation method was used for undisplaced fractures in the CP region – 57 (26%), the mandibular body – 47 (21%) and the mental region – 34 (15%) cases. In displaced fractures, it was more often used in the CP region – 38 (17%) and equally in the mandibular body and mental region – 16 (7%) cases.

Tigerstedt splints were supplemented by osteosynthesis in those cases when it was not possible to restore the position of mandibular fragments with closed reduction alone, usually in displaced fractures in the area of the angle and CP. This combination method of treatment was used in most cases in the older age groups: 7–12 – 18 (36%) and 13–17 years – 29 (58%) cases.

ORIF was used in isolation for 15 (7%) patients during the period of temporary and variable occlusion, with localisation of fractures in the mental and medial regions with a significant shift. The distribution by age was as follows: up to 2 years – 6 (40%), 3–6 years – 1 (7%), 7–12 years – 5 (33%) and 13–17 years – 3 (20%) cases from patients who underwent osteosynthesis.

Intraosseous (cortical) screws in combination with ORIF were used in 4 (1.5%) for different age groups with mental fractures with a slight displacement and by themselves-in one patient aged 14 years with a median fracture without displacement.

The fixation of fragments by an orthodontic bracket system with an inactive arch in fractures without displacement in the body and CP was performed for 3 (1.5%) children aged 5 and 7 years, and in combination with ORIF was performed in 1 (0.5%) child at the age of 5 years.

Two children (0.6%) refused treatment due to their parent's religious circumstances.

In six patients (2%), fractures were not immobilised because they were reviewed at the time when the primary consolidation of bony fragments already took place. The history of the injury was 2–3 weeks ago, and they did not seek qualified help initially.

Discussion

The purpose of this study was to characterise the types of immobilisation systems in traumatic mandibular fractures depending on children's age, occlusion stage, fracture location, type and the presence of fragment displacement.[4-6]

The mandible is the only mobile bone in the face and is involved in basic functions such as chewing, phonation, swallowing and occlusion support. Despite the fact that the mandible is the heaviest and strongest facial bone, it ranks first amongst jaw fractures and second amongst fractures of the facial bones overall, after the nasal bones, which correlates with other studies.[3] Mandibular fractures in children can lead to functional disorders, and to the development of the secondary deformities of the mandible itself and of the occlusion, due to the presence of growth zones, follicles, 'thick' periosteum, wide Haversian canals and its characteristic blood supply.[7]

The main principle of the treatment of mandibular fractures is its effective immobilisation. In this sense, fixation systems become important, the choice of which depends on the location of the fracture, the presence of fragment displacement, the period of occlusion and the age of the child. It is important to create optimal conditions for wound healing and restore the correct position of the fragments and fix them in a stable fashion. This allows to achieve of the early improvement of the haemodynamics at the microcirculatory level in the area of injury, not only in the bone itself but also in the surrounding soft tissues.[1,8]

The most common method of fixation is bimaxillary splinting in isolation or in combination with an ORIF of the mandible, as seen in our results, in which it accounted for 87%. This type of fixation was used for fractures localised in the body, angle, ramus and in the absence of, or only slight displacement. Fractures without displacement compared with displacement were five times more common in the case of such immobilisation.[2,8,9]

However, the technique of applying dental braces involves traumatising, acutely and chronically, the periodontal tissues, as ligatures are applied around the teeth. To fix the latter, a well-defined dental cervix is required. Given these, the splint was used in 50% of cases during the period of the permanent occlusion, when there is a sufficient number of stable teeth, which are anatomically formed and preserved. The complexity of splinting in the period of variable occlusion is due to the mobility of the teeth due to physiological resorbing or the formation of their roots. This type of splinting requires general anaesthesia both when applying and when removing them in children of different ages, depending on their psychoemotional state. They need to eat mechanically sparing food and may have difficulties with language, breathing and maintaining oral hygiene. This indicates the need to find modern technologies for fixing bony fragments during the period of variable occlusion.[10,11]

Undisplaced fractures of the CP in 44% of patients were also managed with dental splints during the period of temporary and variable occlusion. In children up to 8 years and older, with dislocation of CP up to 30°, nasal-maxillary splinting was performed without open repositioning.[12,13]

For fractures of CP for children under 2 years of age, which accounted for 6% of cases, dental braces were also used for immobilisation. However, at this age, difficulties occur with the splint fixation, due to the relative absence of permanent teeth and a little number of completely erupted teeth with pronounced clinical crowns. Over time, the rigidity of their fixation is compromised. In addition, in the post-operative period, there were problems with eating and maintaining oral hygiene.[14-18]

The next common type of fixation of mandibular fragments in children's age was ORIF, which was used only in 5% of cases during temporary and variable occlusion, with a significant displacement, with the localisation of fractures in the mental and medial parts of the mandible. In our study, this percentage is lower than according to Motamedi – 40% (ORIF) and Vetter and etc., – 60% of cases.[8,10] This is due to the fact that the rigidity of fixation of ORIF and their stability in the children's age is reduced due to low bone mineralisation and the presence of teeth rudiments inside the bone. Therefore, in 85% of cases, we fixed the elements on the lower edge of the jaw. A number of authors report osteoporosis in the area of overlapping plates and screws, the release of the metal ions, dislocation of elements, additional artefacts during X-ray examinations and the impact on the growth of the jaws, which all are negative consequences of performing an ORIF in the children's age. When titanium mini-plates are used, a second operation is required to remove them. In this regard, the use of resorbable materials is promising; which include substances that create conditions for better consolidation of fragments, and there is no need for surgery to remove the fixing elements.[11,13]

ORIF in 14% of patients was used in combination with bimaxillary splinting as an additional fixation of the jaws in the bite. This tactic was more often effective in CP fractures with a small fragment displacement >30° and loss of CP height in children older than 8 years during the period of variable and permanent occlusion. When choosing and applying ORIF systems with fracture localisation within the CP, its structure should be taken into account: The head is similar in shape to a mushroom cap, the neck is thin, elongated with age and has a high bone marrow content, the cortical layer is relatively thin, movements are in three planes.

In double or multiple fractures in the region of the angle, ramus and the body of the mandible, with a significant fragment displacement, in combination with fractures of the CP, in the period of variable and permanent occlusion, a combination of fixing systems, namely ORIF and bimaxillary splinting, was also used. The latter helps to maintain the correct positioning of the jaws, by regulating muscle traction.

Intraosseous (cortical) screws in isolation (0.3%) and in combination with ORIF (1.3%) were used in fractures of the middle, mental, CP and without or with a slight displacement of fragments, in children aged 12–13 years. The condition for the installation of screws with optimal fixation is a certain thickness of the cortical layer, which can be calculated on the basis of CT examination and determine the adequate length, and the direction of insertion of the screws. The advantages of this fixation include the possibility of intervention under local anaesthesia, its short duration, minor trauma to the periodontal tissues and the best conditions for maintaining a sufficient level of oral hygiene. This type of fixation avoids the use of Tigerstedt splints with its negative consequences but has limited indications-the possibility of using only a permanent bite-the risk of injury to the rudiment and roots of the erupting permanent teeth.

The use of an orthodontic brace system with an inactive arch as a fixation system was used in 1% of fractures without displacement in the lower jaw and CP in children aged from 5 to 7 years. Performing this type of immobilisation requires stable temporary and permanent teeth with a pronounced clinical crown. The advantages of this type of immobilisation in addition to the above, was also that it is minimally invasive, due to the involvement of teeth alone.[10,12,19]

Conclusions

The choice of the type of immobilisation system for fixing fragments of the mandible in its fractures depends on the location, the presence of fragment displacement, the location of the teeth rudiments, the degree of formation and resorption of the roots of abutment teeth and the age of the child.

The most common method of fixation of fragments of the mandible was bimaxillary splinting in fractures without displacement in the area of the CP, the body and the mental part of the mandible in all age groups, but it is also the most traumatic.

ORIF in isolated form and in combination with splinting is most often used for fractures in the mental and medial regions with fragment displacement, during the period of temporary and variable occlusion. It is necessary to take into account the location of the roots and follicles of the teeth in the jaw and the growth zones before applying the fixing elements. Further research in ORIF fixation is aimed at systems with variable resorption times.

Promising immobilisation systems are orthodontic fixing devices and intraosseous (cortical) screws for fractures with or without fragment displacement, the end-to-end fixation of which can be achieved by closed repositioning and in the presence of stable temporary or permanent teeth.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Monnazzi MS, Gabrielli MA, Gabrielli MF, Trivellato AE. Treatment of mandibular condyle fractures. A 20-year review. Dent Traumatol 2017;33:175-80.
2. Kannari L, Marttila E, Toivari M, Thorén H, Snäll J. Paediatric mandibular fracture-a diagnostic challenge? Int J Oral Maxillofac Surg 2020;49:1439-44.
3. Shah N, Patel S, Sood R, Mansuri Y, Gamit M, Rupawala T. Analysis of mandibular fractures: A 7-year retrospective study. Ann Maxillofac Surg 2019;9:349-54.
4. Mahgoub MA, El-Sabbagh AH, Abd El-Latif EA, Elhadidy MR. Condylar fractures: Review of 40 cases. Ann Maxillofac Surg 2018;8:19-27.
5. Patel HB, Desai NN, Matariya RG, Makwana KG, Movaniya PN. Unilateral condylar fracture with review of treatment modalities in 30 cases – An evaluative study. Ann Maxillofac Surg 2021;11:37-41.
6. Kaushik S, Ali I, Dubey M, Bajpai N. 2 mm conventional miniplates with three-dimensional strut plate in mandibular fractures. Ann Maxillofac Surg 2020;10:10-5.
7. Srinivasan B, Balakrishna R, Sudarshan H, Veena GC, Prabhakar S. Retrospective analysis of 162 mandibular fractures: An institutional experience. Ann Maxillofac Surg 2019;9:124-8.
8. McGoldrick DM, Parmar P, Williams R, Monaghan A, McMillan K. Management of pediatric condyle fractures. J Craniofac Surg 2019;30:2045-7.
9. Atisha DM, Burr TV, Allori AC, Puscas L, Erdmann D, Marcus JR. Facial fractures in the aging population. Plast Reconstr Surg 2016;137:587-93.
10. Malinge M, Grimaud F, Perrin JP, Loin J, Anquetil M, Mercier J, *et al.* Outcomes of functional treatment of condylar mandibular fractures with an articular impact: A retrospective study of 108 children. J Stomatol Oral Maxillofac Surg 2022;123:177-83.
11. Abosadegh MM, Saddki N, Al-Tayar B, Rahman SA. Epidemiology of maxillofacial fractures at a teaching hospital in Malaysia: A retrospective study. Biomed Res Int 2019;2019. [doi: 10.1155/2019/9024763].
12. Li MX, Xing X, Li ZB, Li Z. Classification and treatment strategies for condylar fractures in children. Br J Oral Maxillofac Surg 2021;59:776-82.
13. Rodrigues MT, Schueng FE, Mendes BC, Vale DS, Souza FG, Nóia CF. A simple method of transoperative maxillomandibular fixation in pediatric facial fractures. J Craniofac Surg 2021;32:e375-6.
14. Almahdi HM, Higzi MA. Maxillofacial fractures among Sudanese children at Khartoum dental teaching hospital. BMC Res Notes 2016;9:120.
15. Wang Y, Kang P, Gong YP, Zhai XY, Li Q, Li R. Clinical analysis of 314 children with maxillofacial fracture. Zhonghua Kou Qiang Yi Xue Za Zhi 2018;53:555-7.
16. Kannari L, Marttila E, Thorén H, Snäll J. Dental injuries in paediatric mandibular fracture patients. Oral Maxillofac Surg 2022;26:99-104.
17. Marra PM, Itro A, Santoro R, Itro A. Management of an anterior mandibular fracture in a 13-year-old patient. J Biol Regul Homeost Agents 2020;34:1585-8.
18. Ortiz-Gutiérrez AL, Beltrán-Salinas B, Cienfuegos R. Mandibular condyle fractures: A diagnosis with controversial treatment. Cir Cir 2019;87:587-94.
19. Chen W, Fang R. Internal fixation of mandibular comminuted fracture with mini-titanium plate: A retrospective study of 21 cases. Shanghai Kou Qiang Yi Xue 2020;29:333-6.