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ORIGINAL RESEARCH

Open Reduction and Internal Fixation in Pediatric Mandibular Fractures: A Report of 10 Cases and Review of Literature

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ABSTRACT

A pediatric facial trauma patient provides several different considerations that are not present in an adult. First, the pediatric patient has the advantage of an accelerated ability to heal in a very short time with few complications, aided by the well-vascularized tissues of the face. Second, through the assistance of growth and an inherent ability to adapt, recovery of damaged orofacial tissues and function is much better than in adults. The aim of this study was to prospectively analyze the effect of open reduction and internal fixation (ORIF) for treating various pediatric mandibular fractures and evaluating the advantages and disadvantages of ORIF along with the assessment of any complications in a series of 10 cases. We also reviewed various papers on pediatric mandibular fractures.

Keywords: Closed reduction, Malunion, ORIF, Pediatric mandibular fractures, Plate and screw system.

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INTRODUCTION

Maxillofacial fractures in the pediatric age group are relatively uncommon, yet they are no less important. The impact of craniofacial trauma in pediatric population is minimized due to the light weight and small size of the facial skeleton. The force of impact is absorbed by the forehead and the skull rather than the face, since the ratio of cranial volume to facial volume is greater in children than in adults (8:1 at birth, 4:1 at 5 years, *vs* 2:1 in adults).[1] Pediatric facial bones are more resistant to fractures due to higher elasticity, poor pneumatization by the sinuses, thick surrounding adipose tissue, and stabilization of the mandible and maxilla by the unerupted teeth.[2]

Pediatric mandible fractures are uncommon and have been treated by a wide variety of fixation methods. Incomplete or nondisplaced fractures as well as fractures of the subcondylar region are treated by traditional methods of a soft diet or closed reduction. Displaced fractures are better served by open reduction and internal fixation (ORIF).

Excluding the nasal bones, the mandible is the most frequently fractured facial bone in pediatric patients. One-third of pediatric trauma patients with facial fractures have mandibular fracture. The treatment of pediatric mandibular fractures is controversial and complicated by many factors such as tooth eruption, short roots, developing tooth buds, and growth especially at the mixed dentition stage. Rigid fixation is a technique used in the management of facial fractures that has been developed for more than 20 years.[3] However, use in children is somewhat controversial. Many studies on infant animals showed that plate fixation across the mid-facial and cranial sutures lines have resulted in growth retardation along these suture lines. Since these studies were performed on infant animals with rapid facial growth patterns, it was difficult to draw firm conclusions with regard to human children.[4] But these studies did highlight the fact that rigid fixation should be used cautiously in children. If proper reduction of facial fractures is not achievable by other means, rigid fixation should be performed because the alternative of improper correction is unacceptable.

The goals of treatment should be an accurate reduction, three-dimensional restorations of preinjury form and functions.[5] If it requires rigid fixation with plating, then this must be done using monocortical screws at the inferior border of the mandible to avoid damaging the underlying teeth. The commonly used osteosynthesis technique for the fixation of adult parasymphysial fractures is to use two miniplates: One at the inferior border of the mandible and the other above it as a tension band to withstand the torsion forces in this area of the mandible.[6]

Many factors make closed reduction difficult in pediatric mandibular fractures. The child is more difficult

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to examine both clinically and radiologically. It is more difficult to make use of the teeth in children for fixation, because deciduous teeth may be either insufficient in number or their roots may be resorbed and permanent teeth may be incompletely erupted. The shape of the deciduous crown is also not favorable for retention of wires and splints, being bell shaped with little undercut area. Elasticity of the bone in children, the relatively small size of the face, and the growth process in the young bone is also among the factors that influence the pattern of fracture and its management and also depends on the postoperative period of fixation. Ankylosis of the temporomandibular joint causing impairment of function is more common in children and damage to the condylar growth center can result in facial deformity.[5] This paper focuses on the assessment, evaluation, and treatment of mandibular fracture in young children by ORIF.

MATERIALS AND METHODS

The present study was undertaken in the Department of Oral and Maxillofacial Surgery, Kannur Dental College, Anjarakkandy, Kannur district, Kerala, India. The criteria for selection of cases were patients below 14 years of age with mandibular fractures, gross displacement of the fracture segments, and without any medical problems. The study, conducted between 2011 and 2013, included 10 patients (7 boys and 3 girls) reported, the youngest patient being 6 and the oldest 12 years. The causes included road traffic accident (RTA), fall from cycle, and sports injuries. All 10 patients were the subjects of this follow-up study with informed consent. Each patient was given the following evaluation: Extraoral and intraoral clinical examination, periapical radiographs of the affected site, lateral oblique view where required, preoperative and postoperative orthopantomograph (OPG), routine blood investigation, chest X-ray, ECG. All the diagnostic procedures were performed without medication or sedation. All 10 patients were advised treatment by ORIF. Average time for surgery was 45 to 70 minutes. All the patients selected for ORIF were operated under general anesthesia (GA) with nasotracheal intubation. An intraoral approach was used in all the patients treated. In this approach, a vestibular incision was placed to expose the fracture site. Care was taken to make the exposure and stripping of periosteum to the minimum, since it reportedly can interfere with future growth of mandible. Reduction was achieved by gentle manipulation and held in occlusion with temporary intermaxillary fixation (IMF) using minimal eyelets and tie wires.

An appropriate plate was selected, adapted onto the buccal cortex at the lowest position, and fixed using suitable screws. The plates used were four-hole continuous monocortical miniplates with screws of 1.5 mm diameter and length 5 mm. Both titanium and stainless steel plates were used; the selection of which was based on the financial status of the patient. Even though we followed Champy's principles, modification was done in sites where there were unerupted tooth buds.[7]

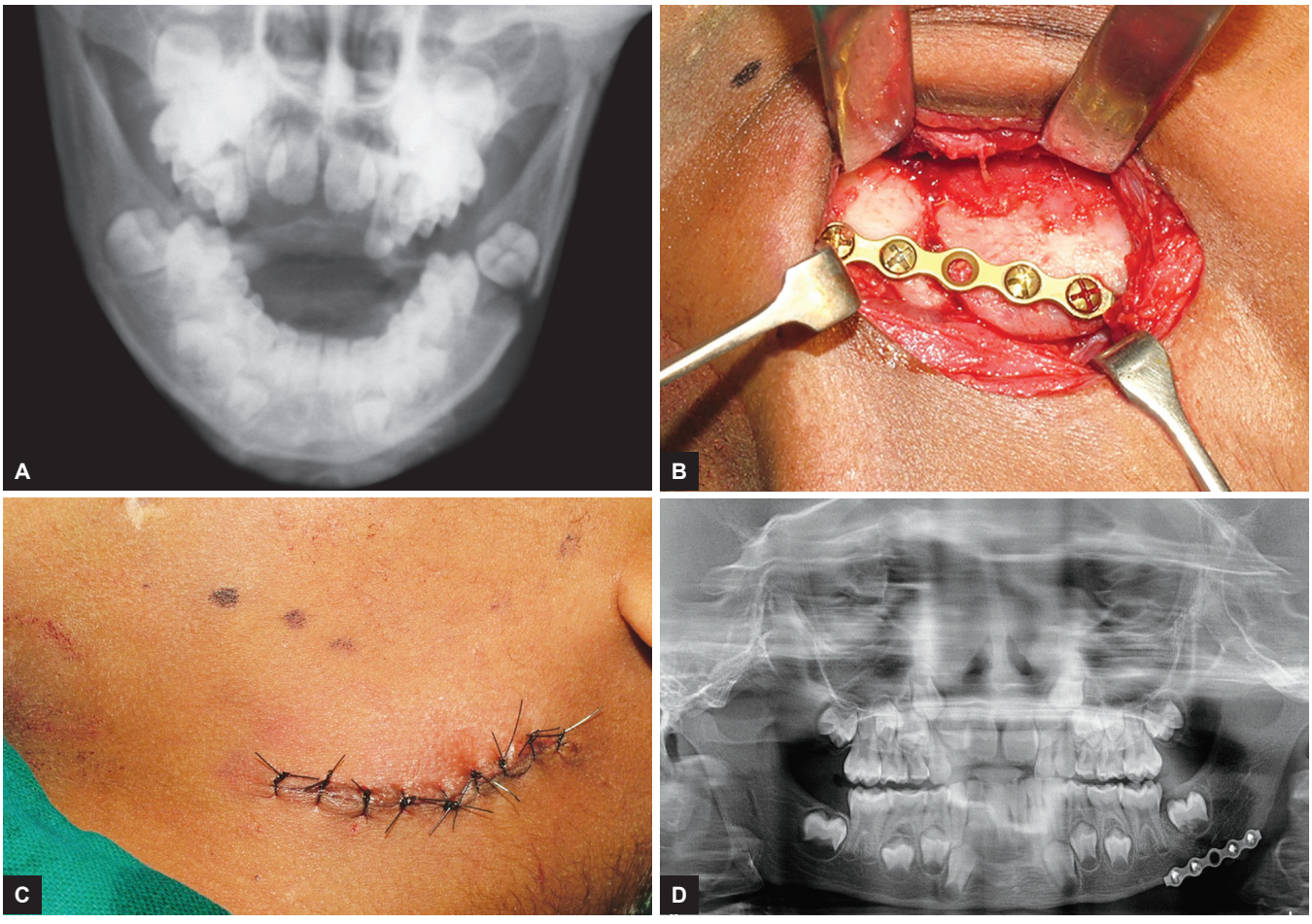
Occlusal reassessment was done immediately after plating. Incision lines were closed using 3–0 vicryl sutures. Patients were given antibiotics and analgesics for 5 to 7 days. Postoperatively, patients were advised to have soft diet for 1 month. Postoperative checkups were done at an interval of 1 week, 1, 2, and 6 months. Union of fracture site was tested by palpating for mobility. The patient was also asked to open the mouth against force applied at the point of the chin by the operator's hand. If this maneuver produced pain at the fracture site, union was considered to be inadequate.[8] During this period, only one patient reported with mild infection at the incision line, which was successfully managed by oral antibiotics and local measures. In all the other patients, postoperative evaluation period was uneventful. Once bone healing was complete, plate removal was done after 6 months of surgery (Figs 1A to D for first patient and Figs 2A to C for second patient).

RESULTS

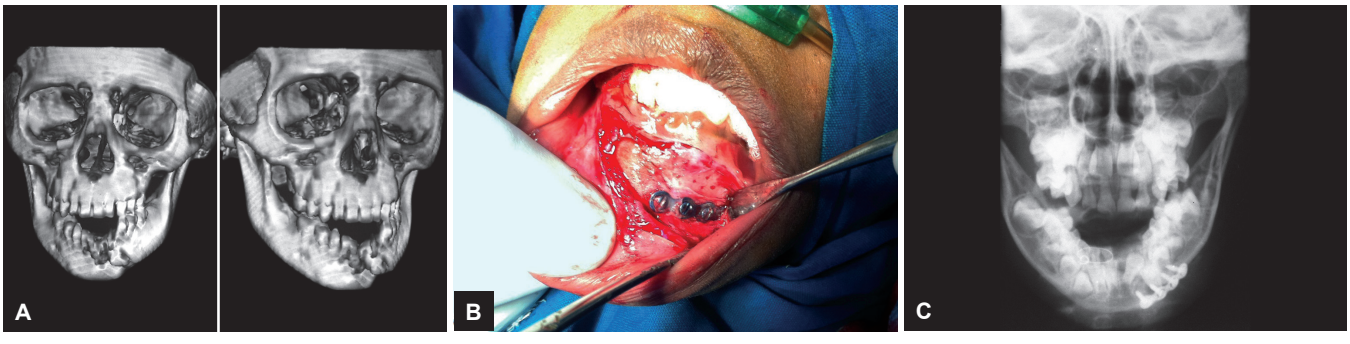
Postoperative pain was calculated based on the following grading: Not present, mild, moderate, and severe. One case of infection was reported at the site of fracture along the suture line. An orthodontist evaluated the occlusion on the first and second postoperative visits and at 6 months and found it to be ideal in all patients. There was no mobility of the segments postoperatively. Return to function and patient comfort were the major concerns. Most of the patients showed impressively rapid recovery and returned to their normal activity within a week. The results were tabulated and shown in the table.

DISCUSSION

Waldron et al recognized the differences between traumatized children and adults, thus recommending a conservative approach for the management of facial and mandibular fractures with closed reduction and immobilization.[8] From that epoch work, this paradigm has dominated the way most oral and maxillofacial surgeons treat injured children, and today, it is the standard treatment in the growing population.[9] Even though stable or greenstick fractures in pediatric patients generally do not require internal fixation and they are actually best treated conservatively, significantly displaced pediatric mandibular fractures may require an aggressive approach with internal rigid fixation, as has been already described by numerous authors.[10-12]



Figs 1A to D: (A) Preoperative radiograph showing angle fracture, (B) plate fixation, (C) wound closure, and (D) postoperative radiograph



Figs 2A to C: (A) Preoperative scan showing parasymphysis fracture, (B) plate fixation, and (C) postoperative radiograph

Surgeons, who advocate for closed reduction of mandibular fractures in children, have strong reasons to believe open reduction will put growing patients at risk. During the 1950s and 1960s, MacLennan, Rowe, and Graham and Peltier, as well as other leaders, reinforced the philosophy of Waldron et al and concluded that conservative management prevented the complications associated with tooth buds and growth centers. Today, the fundamental premise is that internal rigid fixation (i.e., plate-and-screw fixation) not only may damage developing teeth but also may interfere with the normal growth and developmentof pediatric mandibles, although few experimental studies have been performed and their conclusions are ambiguous.[13-15]

Discrepancies in alignment and occlusion are often corrected by the natural remodeling of the bone. In general, pediatric maxillofacial fractures are managed according to the same basic principles applied in adult fractures. However, because of the specific aspects related to the pediatric dentition and to certain anatomical differences mentioned earlier, conservative approach in the treatment of maxillofacial trauma in the pediatric age group may not produce the best possible outcomes.

In general, the diagnostic procedures in infants are difficult. Also, mandibular fractures in infants may result from relatively mild trauma or from short falls, but sometimes it is difficult to believe that such mild trauma may result in a mandibular fracture and a thorough workup is not done. Moreover, infants are not cooperative, their clinical examination is difficult, and the taking of radiographs of good or even reasonable quality is troublesome and sometimes even impossible. The clinical signs and symptoms are not striking. Mild chin abrasion might be present, intraoral floor of mouth hematoma is not always identified, and lack of discontinuity of the alveolar ridge might mislead the examiner from establishing a correct clinical diagnosis.[16]

Rigid metal fixation of mandibular fractures in children, however, can be complicated by a mixed dentition that can occupy the entire vertical dimension of the bone and places teeth and the inferior alveolar nerve at risk during screw insertion. In addition, ongoing development of the mandible poses risk of intrabony translocation of metal plates and screws, risking potential growth and teeth disturbances and difficulty with secondary removal if needed.

The final diagnosis of a suspected mandibular fracture requires good radiographs. The preferable exposures are intraoral lower occlusal and periapical radiographs, which should reveal the body and symphysis regions. Extraoral radiographs are of little value to show fractures in these sites. Unfortunately, not all emergency rooms have the necessary facilities to perform intraoral radiographs. For the ascending ramus and the temporomandibular joint regions, the diagnostic radiographs should be the same as those used for adults.[17] From our experience, it is advisable that the oral and maxillofacial surgeon be actively involved, together with the X-ray technician, while taking the diagnostic radiographs. The minimally displaced, or the greenstick fractures may be better demonstrated if two exposures are taken at slightly different angles.

Although much has been written about maxillofacial fractures in the pediatric age population, controversy continues regarding the management of these injuries. These controversies have arisen in part due to the unique characteristics of these fractures, in part due to the differences in maxillofacial structures in children and in part from the recognition that the pediatric facial skeleton is not a static system but a dynamic growing entity. Also there are very few studies documenting long-term follow-up.

Mandibular fractures in pediatric population are relatively uncommon. These patients present with their own unique treatment requirements. Closed reduction with maxillomandibular fixation (MMF) in young children though in theory seems a better option can pose several concerns including patient cooperation, compliance, and adequate nutrition. Treatment of fractures using ORIF, by contrast, circumvents the aforementioned concerns like the need for MMF and allows immediate jaw mobilization, early recovery, and return to early function.[18]

In the past, open reduction was generally avoided because damage to the tooth buds was a major concern. However, with the current availability of miniplates and microplates, it is possible to perform ORIF without damaging the tooth buds.[19]

Although some remodeling potential remains in the pediatric craniofacial skeleton, it is unpredictable and provides a poor rationale for inadequate anatomic reduction and fixation. Instead, the bony fragments should be reduced in the preinjury pattern with the teeth in occlusion, until union has occurred. The increased osteogenic potential of the pediatric facial skeleton should make early definitive treatment the rule.[20] When open reduction is indicated we often prefer the use of more stable methods of fixation that is micro or mini plates and screws. Advantages of plate and screw fixation that are especially beneficial in the pediatric age group are no need for maxillomandibular fixation, decreased necessity for tracheostomy for airway management in polytrauma cases, early mobilization of patients with associated condylar fractures, minimal chance of damaging tooth buds compared to transosseous wiring, early return to normal oral feeding especially in an age group where metabolic and nutritional demands are high, and early mobilization of patients leading to less risk of ankylosis in cases of condylar fracture.

In all our patients where ORIF had been done, postoperative recovery was uneventful except in one patient who had mild infection of the incision line, which was effectively managed with oral antibiotics and local measures. Although our follow-up period was short with regard to determination of the late effects of trauma or the treatment on facial growth, our preliminary impression was favorable. Upon healing, it has been our practice to remove the implant hardware. The indication to remove bone plates applied to a fractured pediatric mandible after bone healing and whether the retention may cause growth disturbances is still uncertain.

The development of resorbable plate-and-screw system may reduce our concern about using implants in the growing facial skeleton. But there are studies showing the bone resorption after bioresorbable fixation of a fractured pediatric mandible, so long-term prospective follow-up and monitoring the effects on facial growth in patients who have undergone ORIF are still required.[21]

Management of mandibular fractures in children differs somewhat from that in adults because of anatomic

variation, rapidity of healing, degree of patient cooperation, and the potential for interference with mandibular growth. As Kaban et al stated, the simplest treatment is usually the most satisfactoryone, and complications are more likely to occur from overzealous therapy of mandibular fractures in children than from conservative therapy.[22] Therefore, these patients require a different surgical approach. According to our study results, we currently believe that certain principles in the management of these injuries can be outlined, recognizing that they may require modification as additional experience accumulates. Thus, we can summarize and conclude the management of a pediatric fracture as follows.

CONCLUSION

Be as conservative as possible. If indicated, do open reduction and stable fixation as inadequate reduction and fixation will lead to malunion and contour deformities. Minimal exposure and stripping of periosteum as excessive periosteal stripping can cause scarring and growth retardation. Employing methods of fixation that adequately stabilize the facial skeleton without rigidly immobilizing long segments, monocortical miniplates or microplates are preferred to bicortical screws and transosseous wires. Compression plates should not be used as a rule. Be aware of the pediatric dentition and avoid iatrogenic injury to teeth and tooth buds.

According to our study results, we currently believe that fracture of the mandible in children can be effectively managed by ORIF with monocortical miniplates and screws, producing optimum outcomes with few or no complications.

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