

Functional Outcomes of Clavicular Fractures Fixation in Adolescent Children

Sarkhell Radha¹, Irrum Afzal², Avinash Joshi¹, Anestis Iossifidis¹

1. Croydon University Hospital NHS Trust;
2. South West London Elective Orthopaedic Centre.

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Correspondence to: Anestis Iossifidis, MD, FRCS Ed, FRCS Ed (orth.) Head of Orthopaedic Surgery, Croydon University Hospital, 530 London Road, Croydon, London, CR7 7YE, United Kingdom.
Email: anestis.iossifidis@gmail.com
Telephone: +0044 (0) 7802404708

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ABSTRACT

BACKGROUND: Fractures of the clavicle are common in both adults and children. Recent studies in the treatment of adult fractures have indicated that improved outcomes are achieved after open reduction and internal fixation. The aim of this study was to conduct a retrospective study of the functional outcomes after open reduction and internal fixation of displaced clavicle fractures in adolescent children.

MATERIAL AND METHODS: We analysed a retrospective case series of 28 adolescent children who had displaced fractures of the clavicle which were treated with open reduction and internal fixation. The rate of healing, radiographic outcomes, functional outcomes, and complications were looked at.

RESULTS: There were 28 children with an average age of 13.8 years (range 13-16 years) had their closed unilateral clavicle fractures treated with open reduction and internal fixation. All the patients

were boys. The right side was affected in 14 patients and the left in 14. There were 26 mid-shaft fractures and two lateral-end fracture. Patients were followed for an average of 12 months. There were no superficial or deep infections and all cases went on to clinical and radiological union. Twenty-four (86%) of children returned to unrestricted sporting activity. The mean QuickDASH score at 12 months was 3.24. Four patients had scar sensitivity, and four had plate prominence. Ten patients required metalwork removal.

CONCLUSION: Historically, almost all clavicle fractures in children were treated non-operatively regardless of the displacement and the location of fractures, with variable outcomes. We conclude that open reduction and internal fixation of displaced clavicle shaft fractures in older children can be performed safely and gives predictable results especially with healing periods and functional outcomes.

Key words: Trauma surgery; Paediatric orthopaedics; Clavicle fractures

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INTRODUCTION

Clavicle fractures are one of the most commonly sustained traumatic injuries in the adult (2-5%) and paediatric population (10-15%)^[1]. In children, mid-shaft fractures account for the majority of cases, with some estimates to be as high as 90% of all clavicle fractures^[2,3]. Conventional teaching dictates that clavicle fractures should be treated conservatively as long as the fracture is closed and there is no associated neurovascular deficit. Much of this advice is based on studies by Rowe and Neer in the 1960s when they found operative management of clavicular fractures had higher non-union rates than non-operative (3.7%-4.6% vs 0.8%-0.1% respectively) and operations were associated with a large number of complications^[4,5]. However, the recent data on operative treatment of clavicular fractures in adults show lower rates of malunion and non-union, shorter time to radiographic union, and improved patient satisfaction rates, with less postoperative complication and improved objective measures of shoulder strength

and function^[6-10].

In the paediatric population, very little data exists in the literature on operative management of clavicle fractures. It is assumed that children have higher remodeling potential thus better outcomes following non-operative management of clavicle fractures. However, post-mortem data shows that the clavicle extends from the medial physal plate and achieves most of its length by age 14, thus exhibiting limited remodeling potential thereafter^[11,12]. There is still much debate and controversy regarding the operative versus non-operative management of clavicle fractures in children, and in particular in the adolescent population.

In the absence of randomised controlled trails (RCTs), the highest level of evidence currently published relating to this topic is a retrospective cohort study of 42 adolescents 17 patients treated operatively and 25 patients treated non-operatively^[13]. The authors conclude that open reduction and internal fixation (ORIF) in the 12-18 age groups led to reduced time to radiographic union and return to activities. While they reported no non-unions, there were five cases of symptomatic malunion in the non-operative group, four of which were later treated with osteotomy and internal fixation.

There are only a few studies in the literature evaluating operative management for children with clavicle fractures, and particularly given the encouraging data obtained from the adult population, we decided to do a retrospective study regarding the outcomes in children who have undergone ORIF for closed clavicle fractures.

METHODS

Electronic search strategy of the trauma registry from 2009 to 2019 was conducted. 28 patients treated with ORIF for closed, isolated and neurovascularly intact clavicular fractures were identified. Case notes were reviewed and radiographic evidence analysed, paying special attention to the rate of healing, radiographic union, functional outcomes and complications. Mean shortening and vertical displacement were measured on pre-operative antero-posterior (AP) films. The type of clavicle fracture and the operative fixation used were identified. All children were scored at 12-month follow-up using the Quick Disability of the Shoulder, Arm and Hand (QuickDASH) score, an 11-item questionnaire used to objectively measure shoulder function^[14].

All patients had been operated on within seven days of injury using an infraclavicular approach. Care was taken to preserve supraclavicular cutaneous nerves with meticulous soft tissue dissection. All post-operative complications and further operations were noted.

RESULTS

Twenty-eight children treated with ORIF for clavicle fractures were identified. Mean age was 13.8 years (range 13.1 - 16), and all 28 cases were males. Twenty-six children had mid-shaft fractures and two had a lateral-end fracture. The mean shortening at time of injury was 15.2mm on the AP film (range 12-21mm) with mean vertical displacement 18.2mm (range 16-23mm). The mid-shaft fractures were fixed using Acumed® clavicle plates Fig 1a&b and Fig 2a&b, and the lateral-end fracture was fixed with a hook plate Figure 3a & b.

Radiographic healing was achieved in all cases by three months. Post-operatively, there were no wound infections and only two patients reported sensitive scars. None of the patients had any loss of sensation in the distribution of supraclavicular nerves. In total, ten patients had implant removal post-operatively, four cases who had scar sensitivity, four patients because of plate prominence and two hook plate for lateral end fracture. There were no instances of residual inci-

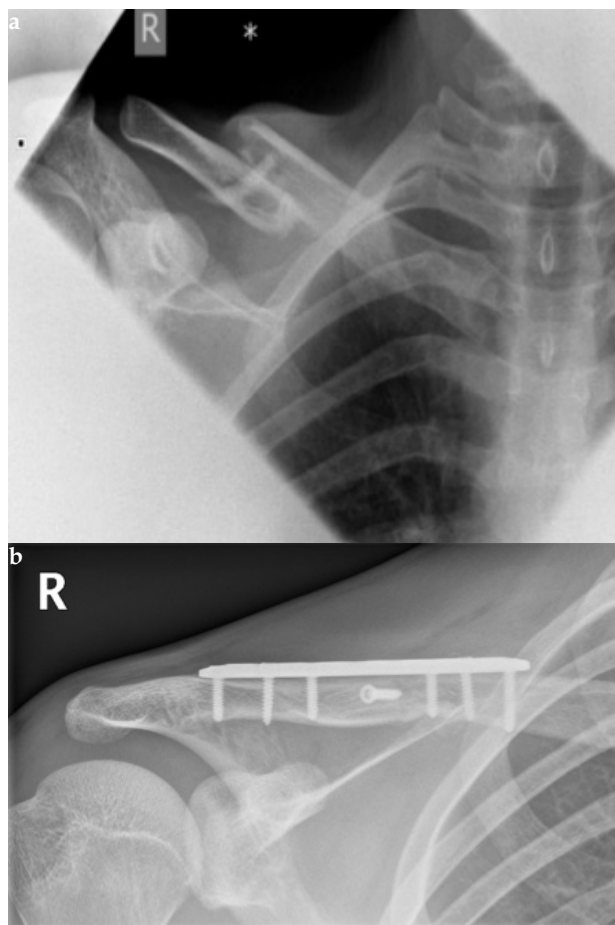


Figure 1 a & b:Pre-operative (a) and 3-month post-operative (b) radiographs of a 13-year old boy with comminuted midshaft clavicle fracture treated operatively; post-operative showing radiological union.

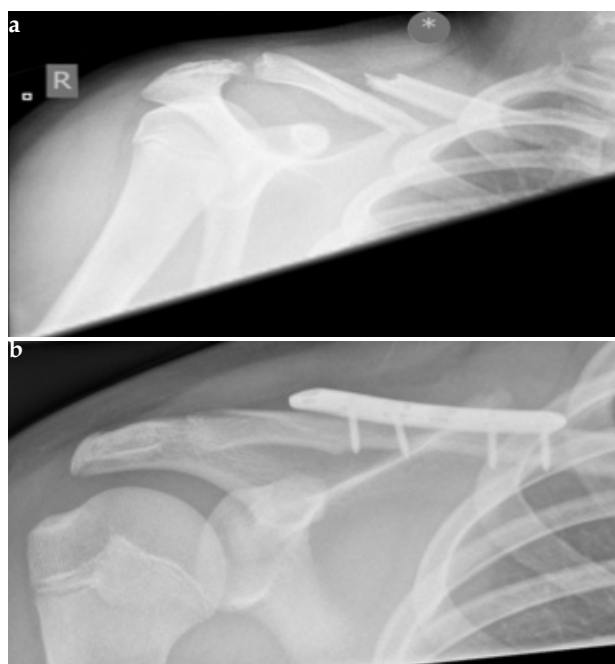


Figure 2 a & b:Pre-operative (a) and 4-month post-operative (b) radiographs of a 13-year old boy with displaced and significantly shortened midshaft clavicle fracture treated operatively; post-operative showing radiological union.

sional numbness. The hook plate did enable union but was associated with mild pain, sensitivity, inability to perform contact sports and was subsequently removed at six months post-operatively. Out of 28 patients, 24 were able to return to unrestrained sport at 12 months. The two patients with lateral-end fractures had to have the hook plate removed at six months, four patients had plate removal nine months due to plate prominence.

The mean QuickDASH score at 12 months follow-up was 3.24 (range: 0 - 15.9). The worst QuickDASH score was seen in the patient with the lateral-end fracture, who suffered with mild to moderate pain post-operatively and had limited ability to return to unrestrained sporting activity.

DISCUSSION

The clavicle is the most common site for fractures to be sustained in the paediatric population, and historically these fractures have always been managed non-operatively, despite the amount of radiographic displacement at the time of injury. Recently, evidence in the adult population showing improved subjective and objective long-term outcomes in the function of the shoulder with operative fixation has led many to question whether an operative approach will also be beneficial in children^[10]. This may be the case particularly in the adolescent population.

Indeed in our paediatric sample, fixation allowed radiographic union in all cases at three months follow-up, and at 12 months, 86% patients were able to return to unrestricted sporting activity. Patients also had good objective function, with mean QuickDASH score of 3.24. When the lateral-end fracture with hook plate fixation is excluded, this score improves even further to 2.26. However 36% patients required further surgery for metalwork removal.

Kubiak and Slongo were one of the first to report on the outcomes from operative management of various types of paediatric clavicular fractures (eight mid-shaft, two medial, five lateral)^[15]. They examined 15 children over a 21-year period who had fixation of the clavicle at their institution. All children had recovered full range of movement by 88 days of mean follow-up. They recommended operative management for the following indications: compound fractures, neurovascular injury, severe shortening of the shoulder girdle and impingement of soft tissue with or without potential for skin perforation.

Mehlman *et al.* examined a larger sample size of 24 who had primary ORIF and elective hardware removal at a later date^[12]. They found that 87% of children were able to return to unrestricted sports activities, but the remainder did not have parental permission. Subjective satisfaction with the outcome of fixation was achieved in all cases. There were no infective complications or cases of non-union. However, two patients reported scar sensitivity and one patient suffered from transient ulnar nerve neuropraxia. They concluded that operative treatment of clavicular fractures in children is safe and effective and argue that since most of the length of the clavicle is achieved early in life, clavicular fractures in children should be treated similarly to those in adults.

In Namdari's retrospective study on 14 children treated with ORIF for clavicular fractures, the authors also found union and good functional outcomes to be universally achieved post-fixation^[16]. All subjects performed well on the QuickDASH and simple shoulder test (SST) scores at follow-up. However surgical fixation did result in two cases of residual incisional numbness and four patients required hardware removal. Given the risks of surgical site numbness and revision surgery they recommended operative management only for patients who are at risk of complications from non-operative treatment.

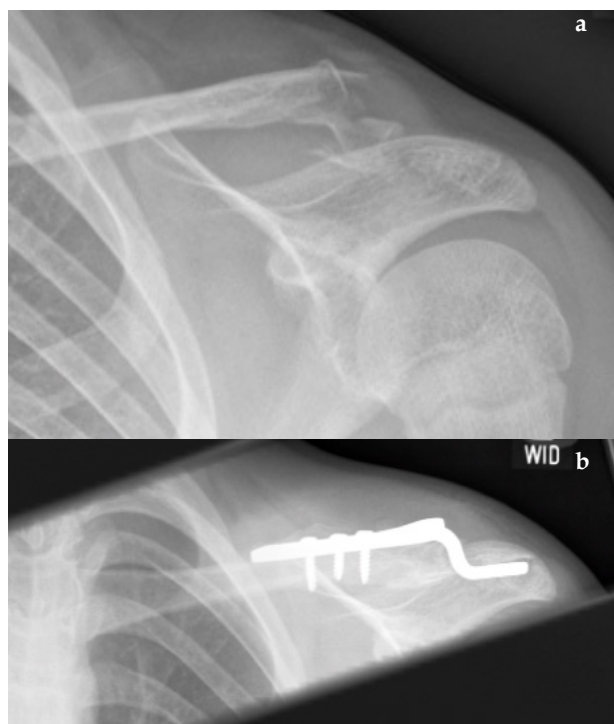


Figure 3 a & b: Pre-operative (a) and 3-month post-operative (b) radiographs of a 14-year old boy with comminuted and displaced lateral clavicle fracture treated operatively; post-operative showing radiological union. Plate subsequently removed at 6 months.

Considering the fact that five of our patients also required subsequent plate removal and two suffered from sensitive scar sites, we also feel that caution must be exercised before deciding to embark upon an operative route of management.

Prinz *et al.* looked at displaced midclavicular fractures in children, and followed up 59 children with 60 fractures^[17]. Ten had operations, all of whom were over ten years old. They found all but one of the under-10s managed non-operatively did well apart from a patient who developed a painful psuedarthrosis. However, whilst functional outcome in the older children was as good as the younger children independent of treatment method, the global and cosmetic satisfaction scores were lower. The authors also reported that older children with non-operative treatment suffered from more pain and were dissatisfied with the long immobilisation.

Labronici *et al* reported ten patients between the ages of five to eleven years (mean of 7.3 years) were observed. Nine patients were treated conservatively and one surgically. They reported The treatment indication for distal fractures of the clavicle in children should be based on the patient's age and the displacement of the fragments^[18]. This present study tracked the medium-term progress of clavicular fixation in a paediatric sample, however it is not without limitations. The sample size was relatively small and the study is retrospective in nature. Additionally, the presence of a baseline matched control group managed non-operatively would be required to better compare the long-term outcomes achieved from both modalities. Furthermore, whilst the QuickDASH score is well validated in the adult population, its internal validity in the paediatric population can only be gleaned from data obtained from those older than 18 years.

Further studies in the form of randomised control trials are required to evaluate the outcomes of operative vs non-operative management in paediatric clavicle fractures, and to help define the specific indications and conditions under which operative management may be recommended.

CONCLUSION

Good functional and radiographic outcomes can be obtained with internal fixation of clavicle fractures in children. Subjective satisfaction rates post-operatively tend to be high. However though incisional site numbness was not found in our case series, scar sensitivity and hardware prominence was a problem in our patients and required subsequent metalwork removal. Thus, despite a high rate of return to unrestricted sporting activity, we recommend that operative fixation be reserved for displaced mid-shaft fractures in line with the current recommendations for adult clavicular fractures.

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