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Factors influencing time to return to sport following clavicular fractures in adolescent athletes

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Background: There is a trend toward increased surgical treatment of displaced clavicle fractures in the adolescent population presumably because of extrapolation of adult-derived best practice guidelines. The purpose of this study was to compare return to sport between nonoperative and operative treatment of clavicle fractures in high school athletes.
Methods: A retrospective review of clavicle fractures sustained in scholastic athletes participating in school-sponsored athletics in the upstate South Carolina was performed from 2015 to 2019. Injury circumstances, demographics, radiographs, treatment, and return to sport data were documented for all patients. Radiographs were evaluated for fracture location, comminution, displacement, shortening, and angulation. Patients were followed until complete return to sport, and results were compared based on sport participation, injury mechanism, fracture morphology, treatment type, and time to return to sport.
Results: Forty-seven patients (44 were male; average age 15.6 years) were included who all returned to sport within the original or subsequent season. Thirty-six patients (73%) were managed conservatively (30 middle third fractures, 4 medial third fractures, 2 distal third fractures), whereas 11 were managed surgically (11 middle third fractures). Eighty-one percent of fractures occured in collision athletes (55% in football). There was no difference in time loss based on participating in collision vs. noncontact sports ($P = .4$). Conservatively managed fractures returned to sport faster (61 ± 38 days vs. 100 ± 49 days; $P = .008$) compared with surgically managed patients. Fracture displacement $\geq 100\%$ (100 ± 51 days vs. 54 ± 27 days; $P = .001$), greater comminution (128 ± 50 days vs. 59 ± 31 days; $P = .001$), and angulation (86 ± 52 days vs. 54 ± 22 days; $P = .001$) all were statistically significant for slower return to sport. Athletes presenting with clavicular shortening <2 cm returned to sport within a similar time frame as athletes with ≥ 2 cm ($P = 0.1$).
Conclusion: Our results show that adolescent athletes with clavicular fractures predictably return to athletics, including collision sports. Athletes conservatively managed returned 40% faster than those with surgery. However, this appears to be associated with the severity and complexity of fractures treated surgically. This study provides evidence to counsel adolescent athletes following clavicular fractures on return to sport expectations.
Level of evidence: Level III; Retrospective Comparative Study

Keywords: Pediatric; adolescent; clavicle fracture; return to sport; nonoperative; operative

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Over the past 20 years, there has been a paradigm shift favoring operative management of significantly displaced clavicular fractures in the pediatric and adolescent populations.[3,19,20] Historically, most clavicle fractures managed nonoperatively demonstrated high healing rates and excellent patient satisfaction.[11] More recent Level I and II studies with a focus on subjective patient-reported outcomes in adults have demonstrated a higher incidence of symptomatic malunion or nonunion and worse subjective outcomes with nonoperative management than previously thought.[2,8,9,13]

In 2011, the results of a Pediatric Orthopedic Society of North America (POSNA) e-mail survey found that physicians demonstrated a trend toward surgical intervention based off of the adult-derived literature.[3] The increase in fixation of these injuries occurred with very little high-level pediatric and adolescent data. Amid these changing trends, the Function After Adolescent Clavicle Trauma and Surgery (FACTS) multicenter study group and prospective study cohort was recently developed at Boston Children's Hospital in an attempt to address these deficiencies.[11]

A quicker return to high-impact activity has been a proposed benefit of surgical fixation of clavicle fractures based on small retrospective adult-based studies.[15,16] At present, there is no high-level pediatric or adolescent population study analyzing the impact of treatment on return to sport. The purpose of this study was to compare return to sport between nonoperative and operative treatment of adolescent clavicle fractures in high school athletes. We hypothesized that similar to the adult literature, surgical fixation would result in a quicker return to sport activity.

Materials and methods

A retrospective chart review from 2015 to 2019 identified high school athletes who sustained a clavicle fracture during school-sanctioned sporting activity and received complete clinical and radiologic examinations and subsequent treatment within our orthopedic and sports medicine practice. Patients were excluded if they did not complete the total episode of care, did not return to sport, exhausted sporting eligibility, graduated, or were lost to follow-up.

A chart review identified 47 patients who met our inclusion/exclusion criteria. Eleven athletes were treated operatively, and 36 athletes were treated nonoperatively. The injury anterior-posterior clavicle radiograph was used to evaluate fracture morphology. Fracture location (medial, middle, distal third, lateral), presence or absence of comminution, displacement greater or less than 100%, and shortening greater or less than 2 cm was analyzed. In general, surgery was suggested if the fracture had $\geq$2 cm shortening with or without comminution or angulation. However, the ultimate decision for surgery or nonoperative care was a shared decision-making process between the treating surgeon and the patient and his or her consenting guardians.

Patients meeting inclusion criteria were followed until complete return to sport. Results were compared based on sport participation, injury mechanism, fracture morphology, treatment type, and time to return to sport.

Statistical analysis

Descriptive data were reported as mean (standard deviation), median (interquartile range), or count (percentage). Separate univariate analyses of variance were used to compare time loss from scholastic sport participation based on sport type (contact vs. noncontact), treatment type (conservative vs. surgical), and fracture morphology. For all statistical analyses, an alpha level of $P \leq .05$ was used. All data were analyzed with SPSS, version 24 (IBM, Armonk, NY, USA).

Results

The average age of the cohort was 15.6 years ($\pm$1.6 years). There were 44 male and 3 female patients. Eighty-one percent were contact athletes, of whom 55% played football, and 19% were noncontact athletes (Table I).

Thirty-six patients (73%) were managed conservatively. Thirty fractures were located in the middle third, 4 in the medial third, and 2 in the lateral or distal third. Eleven patients (27%) were managed surgically. In the 11 surgical patients, the fractures were located in the middle third of the clavicle. The surgical criteria for operative fixation was based on fracture displacement, comminution, and shared decision making. Table II outlines the breakdown of radiographic fracture morphology based on treatment group.

There was no difference in time loss based on participating in contact vs. noncontact sports ($P = .4$). Patients whose fractures were conservatively managed returned to sport faster (61 ± 38 vs. 100 ± 49 days; $P = .008$) compared with patients whose fractures were surgically managed. Fracture displacement $\geq$100% (100 ± 51 days vs. 54 ± 27 days; $P = .001$), greater comminution (128 ± 50 days vs. 59 ± 31 days; $P = .001$), and angulation (86 ± 52 days vs. 54 ± 22 days; $P = .001$) all were associated with slower return to sport. Athletes presenting with clavicular shortening <2 cm returned to sport (see Table II) within a similar time frame as athletes with $\geq$2 cm ($P = .1$) (Fig. 1).

Discussion

Recent literature suggesting an improvement in function and patient-reported outcomes in the adult patient population treated surgically has led to a re-evaluation of these results in the pediatric and adolescent population. The principal finding of our study was that when all fracture variations were considered, nonoperatively managed adolescent clavicle fractures were able to return to sport faster than surgically stabilized fractures.

Pediatric and adolescent patients often have a greater ability than adults to heal and remodel clavicle fractures, which has traditionally guided successful nonoperative management of these injuries. However, other evidence suggests that after 10 years of age, the ability of the clavicle

Table I Patient data (N = 47)

Characteristic	
Sex, male/female, n	44/3
Age, mean	15.6
Contact athlete, %	81
Height, cm, mean	175.8
Weight, kg, mean	70.4

Table II Group characteristics

Group characteristic	Nonoperative, n (n = 36)	Operative, n (n = 11)
Fracture displacement >100% (yes/no)	16	11
Fracture communion (yes/no)	7	4
Fracture angulation (yes/no)	14	11
Fracture shortening ≥2 cm (yes/no)	10	9

to remodel begins to decrease as it nears skeletal maturity, and the exact age at which this threshold is met is unknown.[3,6,7,10,12,14,18]

Several recent studies, although limited to smaller sample size and retrospective review, have favored conservative treatment of pediatric clavicle fractures. In separate study groups, Bae et al,[1] Schultz et al,[17] and Parry et al[12] all reported on nonsurgical outcomes. These studies found similar results with modest strength and motion deficits that likely lack meaningful clinical significance. On the other hand, Vander Have et al[20] retrospectively performed one of the first comparative studies of operative vs. nonoperative management in 43 displaced midshaft clavicle fractures. They found no nonunions in either group but a slightly faster time to union and similar return to activity with the surgical group. Interestingly, 5 of the 14 conservatively treated patients developed symptomatic malunions and 4 patients underwent a corrective osteotomy, a percentage much higher than previously reported literature.

In 2019, the FACTS study group reported preliminary results of their 2-year data at the American Orthopaedic Society for Sports Medicine annual meeting. In this Level I prospective multicenter study group involving more than 900 patients with displaced midshaft clavicle fractures, the authors concluded that nonoperative treatment of adolescent clavicle fractures demonstrated lower complication rates and similar satisfaction and functional outcomes.[4] This is in contrast to recent high-level adult-based studies.[2,8,9,13] Thus, at short term, the current treatment recommendation is favoring nonoperative management of displaced midshaft fractures.

As previously mentioned, there is a paucity of high-level studies reporting on return to sport in the adolescent clavicle fracture population, and clinicians often infer treatment based off adult-derived literature. Robertson et al,[16] in an adult population systematic review, found that the return times for conservatively managed displaced midclavicular fractures was longer than the surgically managed patients. Similarly, Ranalletta et al[15] in a series of 54 athletes patients found 90% of their patients returned in 12 weeks or less, with 17% returning less than 6 weeks after surgery. Lastly, Jack et al[5] reported on a National Football League population and found that surgically managed players played in a similar number of games per season and had similar career lengths.

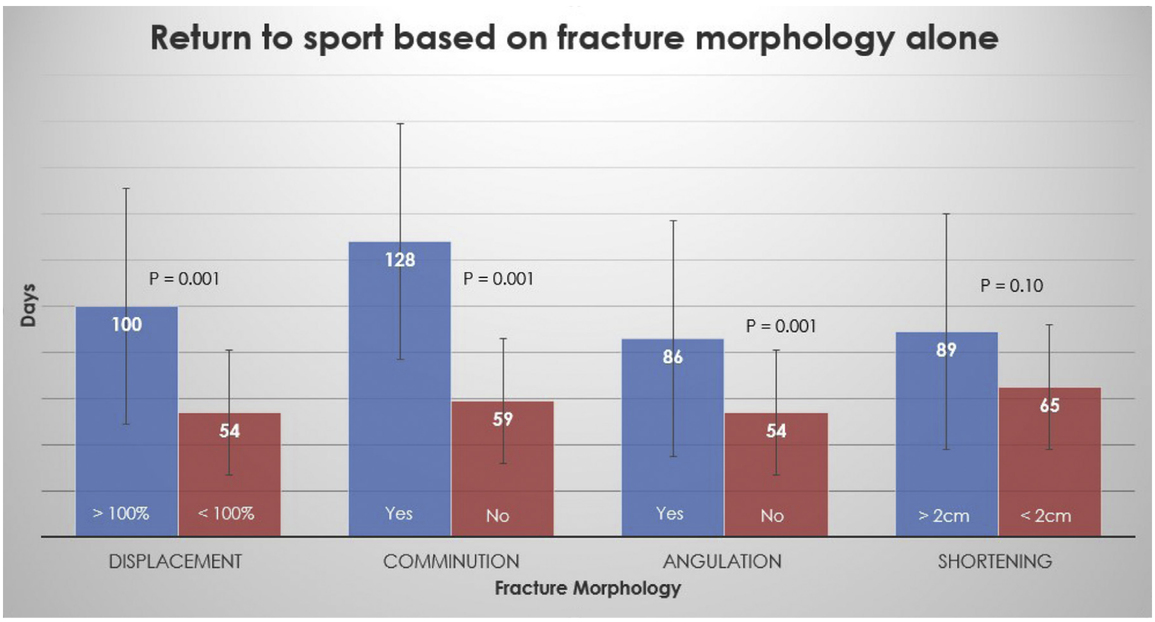

Figure 1 Return to sport (in days) based on fracture morphology.

Our study attempts to add to the literature regarding return to sport in adolescent clavicle fractures. Regardless of treatment, there is a high rate of return to sport, and this was unaffected by participation in collision sports. Our nonoperative patients returned to competition at an average of 61 days compared with 100 days with our surgical group. On the surface, this is contrary to what most literature reports; however, it is important to note our study was neither designed nor powered to compare treatment of typical "operative grade" injuries. We instead report on the results of conservative treatment for all degrees of fracture severity. It is no surprise that fracture severity has a direct correlation to return to play, even in the adolescent population with seemingly quicker remodeling potential. Our surgical cohort averaging a return to sport around 3 months is similar to what is published in the aforementioned adult studies. The range of return to sport time frames reflects that some patients returned closer to 6 weeks whereas some returned between 4 and 5 months. In both treatment groups, the large range of outcomes may be the result of the heterogeneity in fracture type and severity. Additionally, the time frame to fracture union and medical clearance may ultimately delay return to sport until the beginning of the next season. Regardless, we believe this study provides valuable counseling information for the treating clinician in guiding both the patient and parents in shared decision making.

Our study should be viewed within the limitations of the design. First, the retrospective design may have selectively biased those receiving conservative or surgical treatment based on other factors not controlled for prospectively. However, given that all athletes were referred by a certified athletic trainer (ATC) to a team physician, it is unlikely that these factors changed the treatment choice. There was no randomization, and treatment decisions were made by surgeons on the basis of patient input on an individual basis. As such, there is the possibility of selection bias within our data. Fracture severity varied significantly among the 2 treatment groups but demonstrates that the clinical decisions made reflect the use of best practice guidelines to advise treatment decisions. Although adequate for the primary aims of the study, the small sample size was not enough for secondary questions of interest related to return to sport based on variations of fracture morphology. Additional studies are recommended to provide long-term follow-up on patient-reported outcomes and complications relating to return to sport following clavicular fracture.

Conclusion

Our results show that adolescent athletes managed following best practice guidelines for clavicular fractures provide predictable return to athletics including collision sports. Athletes conservatively managed returned 40% faster than those with surgery. However, this appears to be associated with the severity and complexity of fractures treated surgically. This study provides evidence to counsel adolescent athletes following clavicular fractures on return to sport expectations.

Disclaimer

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