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Epidemiology of syndesmotic fixations in a pediatric center

A 12-year retrospective review

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Abstract

Syndesmosis injuries need to be accurately diagnosed and managed to avoid chronic pain, early arthritis, and instability. To this end, the present study aimed to analyze the epidemiology of syndesmotic injuries in a pediatric ankle fracture cohort and identify patient and surgery-related characteristics.

A retrospective review of all the ankle fractures during a 12-year period at a single pediatric referral center was conducted. Inclusion criteria were: a fractured ankle that underwent a surgical fixation, at least 1 radiograph available for review before fixation, available information regarding surgery, including operative report and fluoroscopic images, and younger than 18 years at the time of surgery. Demographic information, trauma, radiographs, surgical details, clinical examination, follow up, outcomes, and physeal status (skeletally immature, transitional, or mature) were recorded. Finally, patients were divided in 2 groups: with or without syndesmotic fixation. Statistical analysis included descriptive statistics, Mann–Whitney test for nonparametric data to compare continuous parameters, and χ^2 test for categorical parameters.

A total of 128 patients were included with a mean age of 14.1 years. There were 80 boys and 48 girls. There were 51 skeletally immature patients, 23 with transitional fractures, and 54 that were skeletally mature. The main finding of this study is that only 11 patients from the mature group underwent syndesmotic fixation. There were no cases of syndesmotic fixation in the skeletally immature and transitional groups.

This is the first retrospective study to focus specifically on syndesmotic injuries in a pediatric population who underwent ankle fracture fixation. Only 11 skeletally mature patients underwent syndesmotic fixation out of 128 patients in this cohort. This result raises the question of whether there are accurate diagnostic tools to evaluate syndesmosis in children.

Abbreviations: MRI = magnetic resonance imaging, ORIF = open reduction and internal fixation.

Keywords: ankle, high ankle sprain, pediatric, syndesmosis

1. Introduction

Pediatric ankle injuries differ from those in the adult population in many ways. One important difference is the greater tensile strength in immature ligaments that often leads to a higher proportion of fractures, rather than sprains, in young patients.[1–5] Furthermore, the increasing participation of skeletally immature athletes in high-level sports creates injury patterns not commonly found in adults.[6] Although injury types, diagnostic methods, and treatment have been accurately described for syndesmotic injuries in the adult population[7], the same cannot be said for the pediatric population. Indeed, little is known about pediatric syndesmotic injuries and poorer outcomes have often been described in the young athletic population following syndesmosis strain.[8] In both adults and adolescents, this injury can cause chronic ankle pain and post-traumatic arthritis when not properly treated.[9,10]

The distal tibiofibular relationship is very difficult to qualify in children because of the ongoing ossification process. Although imperfect, magnetic resonance imaging (MRI) remains the best diagnostic tool available.[10] However, according to Bozic et al, adult radiographic criteria used to assess syndesmosis integrity cannot be applied to the pediatric population.[11] This raises the question of whether the lack of evidence for syndemostic injuries in skeletally immature children is the result of inadequate diagnostic methods, or whether this type of injury truly is almost nonexistent at this age.

To achieve a better understanding of this question, a retrospective study was undertaken to describe the epidemiology of syndesmotic fixations in a pediatric population and identify patient and surgery related characteristics. The rationale for this study was to set the stage for future research on pediatric syndesmosis injury.

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2. Materials and methods

A retrospective review of all the ankle fractures occurring during a 12-year period at a single pediatric referral center was conducted. A database search of medical records of all pediatric patients who underwent surgical fixation of an ankle fracture from 2002 to 2013 at our level 1 referral pediatric center was undertaken. This retrospective study was approved by the local Director of Medical and Academic Affairs and Research Ethic Board of CHU Sainte-Justine. The 7 following keywords were used to ensure no patients were unintentionally excluded: ankle ORIF (open reduction and internal fixation), syndesmosis ORIF, malleolar ORIF, triplane, Tillaux, ankle fracture, and pilon fracture. The following inclusion criteria were selected to have the necessary patient information: a fractured ankle that underwent surgical fixation, at least 1 radiograph available for review before fixation, available information regarding surgery including operative report and fluoroscopic images, being younger than 18 years at time of surgery. Demographic data, trauma, radiographs, surgical details, clinical examination, follow-up, and outcomes were retrieved from patient charts.

Final diagnosis and ankle fracture classification based on physeal status (immature, transitional, or mature skeleton) were determined on preoperative radiographs by a fellowship trained pediatric orthopaedic surgeon to reduce the chance of misclassification. Patients were then separated into 2 groups, depending on whether or not they had undergone syndesmotic fixation.

Demographic data recorded were sex, age at the time of fixation, month of the surgery, time between trauma and surgery, operative time, relevant patient history, surgeon, injury mechanism, length of follow-up, and time between surgery and removal of plate and screws when applicable. Additionally, preoperative evaluation, intraoperative tests to evaluate syndesmotic stability, all relevant imaging and final post-operative follow-up data were reviewed. Complications were noted, including residual pain and swelling, wound healing, deformity, neurovascular impairment, and decreased range of motion. Postoperative range of motion was recorded and was compared to normal values, according to sex and age, based on the guidelines published by Grimston et al.[12]

Statistical analysis included descriptive statistics, Mann–Whitney test for nonparametric data to compare continuous parameters, and χ^2 test for categorical parameters. Statistical analysis was performed with SPSS 20.0 (IBM Armonk, NY).

3. Results

A total of 132 fractures were identified from the retrospective database. Four did not match the cohort's inclusion criteria (no preoperative radiographs available), leaving 128 fractures for analysis. The average age at the time of surgery for the entire cohort was 14.5 years for boys and 13.4 years for girls. There were 51 skeletally immature patients, 23 with transitional fractures, and 54 that were skeletally mature.

3.1. Epidemiology of syndesmotic fixation

Eleven patients from the mature group had undergone a syndesmotic fixation. There were no cases of syndesmotic fixation in the skeletally immature and transitional groups. Results comparing patients with and without syndesmotic fixation are shown in Table 1 and Table 2. There were no missing data for the variables included in Table 1 and Table 2.

Table 1

Descriptive parameters comparing the ankle fractures according to the presence of syndesmotic fixation.

Descriptive parameters	Ankle fractures without syndesmotic fixation	Ankle fractures with syndesmotic fixation	*P*
N	117	11	
Sex			
M	73	7	
F	44	4	
Age, y	14.0	15.1	.132
Operative time, h	1:34	2:08	.007
Follow-up length, mo	12.1	16.6	.271
Plate and screws removal	49	6	
Time length between fixation and plate and screws removal, mo	10.1	8.8	.484

3.2. Patient and surgery characteristics associated to syndesmotic fixation

There was no statistical difference between the mechanism of injury for syndesmotic injuries compared to other mature ankle fractures. Among the 43 fractures in the mature group without syndesmotic fixation, 8 occurred in a motor vehicle accident, 12 occurred during daily living activities, and 23 occurred while playing sports. In the syndesmosis group, 3 injuries occurred in a motor vehicle accident, 3 occurred during daily living activities, and 5 occurred while playing sports. No statistical significance was found using χ^2 test ($P=.688$).

Total surgical time was the only statistically significantly different data between the 2 groups, those involving syndesmotic fixation taking significantly longer than those without syndesmotic fixation (2 hour 8 minutes *vs* 1 hour 34 minutes, $P=.007$). There was no significant difference in follow-up length and in the delay between fixation and removal of plate and screws between patients with syndesmotic fixation and all the others, regardless of their physeal status. However, as all syndesmotic fixations were in the mature group, fractures with closed physis were

Table 2

Descriptive parameters comparing skeletally mature patients according to their syndesmotic status.

Descriptive parameters	Mature group without syndesmotic fixation	Mature group with syndesmotic fixation	*P*
N	43	11	
Sex			
M	25	7	
F	18	4	
Age, y	15.1	15.1	.614
Operative time, h	1:31	2:08	.007
Follow-up length, mo	7.1	16.6	.029
Plate and screws removal	13	6	
Time length between fixation and plate and screws removal, mo	8.9	8.8	.467

Figure 1. (A and B) Preoperative anteroposterior and lateral view of a weber C ankle fracture (C and D) postoperative anteroposterior and lateral view of the same ankle, a syndesmotic fixation was performed with 3.5-mm screw, each with 3 cortices.

divided in 2 subgroups, based on syndesmotic fixation (Table 2). Again, surgeries with syndesmotic fixations were significantly longer than those without (2 hour 8 minutes *vs* 1 hour 31 minutes, $P=.007$). Furthermore, patients having undergone a syndesmotic fixation had a longer average follow-up (16.6 months *vs* 7.1 months, $P=.029$). Among the syndesmotic fixation group, 6 had 2-screw fixation (3 with 3.5-mm screws and 3 with 4.5-mm screws), 4 had 1-screw fixation (3.5 mm), and 1 underwent syndesmotic fixation with a single tight rope. Figure 1 shows an example of fibular plating with syndesmotic fixation. Time between fixation and plate and screws removal was comparable in both groups.

Discrete numerical data for range of motion were only available in 42% of patients. When compared to normal range of motion values described by Grimston et al,[12] both postoperative dorsiflexion and plantarflexion were not significantly different for patients with syndesmotic fixations compared to those without. There were 32 cases of minor complications (17 persistent edemas and 15 hypertrophic/adherent scarring) of 128 patients. More severe complications included peroneal nerve hypoesthesia in 3 patients and postoperative coronal plane deformity in 11 patients. Details of all complications are presented in Table 3. Unfortunately, owing to the small size of the syndesmotic group (11 patients), it was not possible to compare complication rates between the 2 groups.

Owing to the retrospective nature of this study, there were some missing data in the patient charts and, therefore, they were not included in the statistical analysis. However, there were no missing data in the descriptive parameters displayed in Tables 1 and 2.

4. Discussion

Our objectives were to analyze the epidemiology of syndesmotic injuries in a pediatric ankle fracture cohort and identify patient and surgery-related characteristics. The main finding of our study was the absence of syndesmotic fixation in the skeletally immature population.

Diagnosis of syndesmotic injuries can be difficult in the adult population[13–15] and even more so in the pediatric population because of the undergoing ossification process.[10] This could explain, in part, why the 11 patients requiring syndesmotic fixation were all skeletally mature. Compared to other studies, the proportion of syndesmotic injuries in the skeletally mature patients in this cohort (20%) is similar to existing data on ankle fractures in adults.[7,16,17] The absence of syndesmotic injury fixation in the 2 immature groups raises the following questions: either syndesmotic injuries are essentially nonexistent in skeletally immature patients or they cannot be diagnosed accurately with current techniques.

Diagnosis of syndesmotic injury in adults is made either on preoperative imagining or intraoperatively with stress testing. Several radiological criteria and stress tests have been defined for the adult population, although their reliability has been disputed.[11,13,18–24] However, according to Bozic et al, these

Table 3

Complications according to syndesmotic fixation status.

Complications	No syndesmotic fixation	Syndesmotic fixation	Total
Total	117	11	128
Postoperative edema status			
Normal evolution	101	5	106
Presence of oedema at the last follow-up	13	4	17
Missing information	3	2	5
Postoperative wound status			
Normal evolution	102	9	111
Hypertrophic or adherent	14	1	15
Missing information	1	1	2
Postoperative deformation status			
Normal evolution	107	9	116
Valgus deformation	5	0	5
Varus deformation	3	0	3
Pseudarthrosis	1	0	1
Arthrosis/chondrolysis	1	0	1
Talus deformation	0	1	1
Missing information	0	1	1
Postoperative neurovascular status			
Normal evolution	114	10	124
Deep fibular nerve hypoesthesia	1	0	1
Superficial fibular nerve hypoesthesia	2	0	2
Missing information	0	1	1

radiologic criteria are not reliable in the pediatric population because of the progressive appearance of the incisura fibularis.[11] Furthermore, in the current cohort, only 21 syndesmoses underwent intraoperative stress testing. Although some patients could have been tested without it being recorded in the operative report, syndesmotic testing is definitely not routine during most pediatric ankle fracture fixations where the study was conducted. Ideally, patients should undergo systematic intraoperative syndesmosis evaluation to help establish radiological criteria (tibiofibular clear space, tibiofibular overlap, and medial clear space) for both stable and unstable joints. However, even in adults, intraoperative radiological criteria to assess syndesmosis stability have been reported to be unreliable.[25] Theoretically, a combination of radiological assessment and direct visualization would allow adequate evaluation of syndesmosis integrity, but this can be challenging depending on the type of fracture and the fixation technique.[25]

Recently, Kramer et al[26] conducted a study evaluating isolated syndesmosis injuries and their risk factors in the pediatric population. Their results showed that 43 of 220 patients had syndesmotic injuries with open physes, but only 9 required syndesmotic fixation.[26] They concluded that an open physis might be a protective factor against syndesmotic ligamentous injury without associated ankle fracture. They also concluded that syndesmotic fixations were most often associated with closed physis and combined ankle fractures.[26] In the present study, syndesmotic fixation was only found in the skeletally mature children and severe syndesmotic injuries were only reported in the mature group, with minor injuries (thus not requiring fixation) in the skeletally immature children. Because Kramer et al used standard adult radiological criteria to diagnose syndesmotic injuries, they could have overestimated the prevalence of these injuries in immature patients.[11,26] Furthermore, if x-rays were inconclusive, they used physical examination (positive squeeze test, tenderness over the syndesmosis, pain with external rotation of the foot) to help confirm diagnosis.[26] Although this may be common practice, it has not been shown to accurately diagnose a syndesmosis injury and can be another reason why Kramer et al may have overestimated the rate of syndesmotic injuries in skeletally immature patients.[19,27–29]

Accurate diagnosis and treatment are important as syndesmosis injuries are associated with poorer outcomes. Indeed, Gerber et al found that syndesmotic strains are a strong predictor of chronic ankle disability. Boytim et al[30] compared lateral ankle sprains and syndesmotic sprains in a professional football team and also reported a prolonged recovery time and the need for more treatment when the syndesmosis was affected. In the present study, when comparing the skeletally mature patients, the follow-up time was also significantly longer for those with syndesmotic fixation. The fact that syndesmotic injuries are more complex and high-energy might explain why they require a longer recovery time.

Syndesmotic injury is not well understood in children (underdiagnosed, no tests specific to immature skeleton) and specific diagnostic methods and criteria are needed to accurately assess syndesmotic instability in the pediatric population and prevent long-term complications. A diagnostic test should be developed and validated to classify syndesmotic injuries. Then, it will be possible to undertake a prospective study to assess the mid- and long-term quality of life after this type of injury in a pediatric population. These promising research avenues are currently being pursued.

There are several limitations to this study, mostly deriving from its retrospective nature. There were missing data and data collection was not standardized which could create some interpretation bias. Furthermore, the data were collected 5 years ago but the conclusions that can be drawn from them remain. Finally, the follow-up was shorter than is normally deemed optimal, and the syndesmotic group was too small to perform a well-powered analysis. However, the present study also has several strengths including the long time-period covered and the relatively large number of patients included. It is also one of the few studies specifically focused on the issue of syndesmotic fixation in a pediatric population treated for ankle fractures.

5. Conclusions

Surgical fixation of syndesmotic injuries associated with ankle fractures is rare in the pediatric population. All patients who had a syndesmotic fixation in this study were skeletally mature, which raises the question of whether the diagnostic tools to detect syndesmotic injuries in skeletally immature patients are accurate. This study is a first step which could help launch new prospective research to address these shortcomings, potentially improve diagnostic accuracy and, eventually, patient outcomes.

Author contributions

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