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The heterogeneous management of pediatric ankle traumas

A retrospective descriptive study

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Abstract

Frequent misdiagnosis of pediatric ankle traumas leads to inappropriate management, which may result in residual pain, instability, slower return to physical activity, and long-term degenerative changes. The purpose of this study was to evaluate the consistency of diagnosis, management, and the treatment of acute lateral pediatric ankle trauma in a tertiary care pediatric hospital. The hypothesis was that the initial diagnosis is often incorrect, and the treatment varies considerably amongst orthopedic surgeons.

We conducted a retrospective study of all cases of ankle sprains and Salter–Harris one (SH1) fractures referred to our orthopedic surgery service between May and August 2014. Exclusion criteria included ankle fractures other than SH1 types, and cases where treatment was initially undertaken elsewhere before referral to our service. Primary outcome was the difference between initial and final diagnosis.

Among 3047 cases reviewed, 31 matched our inclusion criteria. Initial diagnosis was 20 SH1 fractures, 8 acute ankle sprains, and 3 uncertain, with a change in diagnosis for 48.5% at follow-up.

Accurate diagnosis can be difficult in pediatric ankle trauma, with case management and specific treatments varying considerably. This study reinforces the need to evaluate the safety of a general treatment algorithm for all lateral ankle trauma with normal radiographs.

Level of evidence III.

Abbreviations: CT = computerized tomography, ED = emergency department, MRI = magnetic resonance imaging, MRI = Magnetic Resonance Imaging, PT = physical therapy, SH1 = Salter–Harris one.

Keywords: ankle, pediatric, sprain, trauma

1. Introduction

Ankle sprains are common athletic injuries, with an incidence rate estimated at 2.15 per 1000 person-years in the general population.[1] The peak lifetime incidence is between the ages of 15 and 19 years, especially in young males.[1] A recent high-quality meta-analysis conducted by Doherty et al[2] found that children were at greater risk of ankle sprains than adolescents, who were themselves at greater risk than adults.

Skeletal immaturity puts pediatric patients at greater risk of physeal fractures than ligament tears, as open physes are less resistant to physical stress than ligaments and may result in premature growth arrest or angular deformity, as well as pain and disability.[3,4]

However, an accurate initial diagnosis is often difficult, as the distinction between ankle sprains and nondisplaced Salter–Harris type 1 (SH1) fractures is determined entirely on physical examination.[5,6] Conventional radiographs are typically not diagnostic, since growth plates are radio transparent,[5,6] while computerized tomography (CT) scans and magnetic resonance imaging (MRI) are generally not indicated for nondisplaced fractures or sprains.[3,7,8] SH1 ankle fractures carry an excellent prognosis, and only require 3 to 4 weeks of immobilization to heal properly.[3,4]

Ankle sprains, although they are often thought of as a more benign condition with a similar presentation, have a very different clinical course.[9] Even though patients tend to return to their activities earlier after a sprain than after a fracture, a significant proportion of patients report residual symptoms upon long term follow up.[10,11] A retrospective case–control study reported that ankle sprains significantly affected quality of life in the majority of cases at 2 year follow-up.[11] In addition to residual pain, chronic ankle instability and premature degenerative changes may also develop following ankle sprains.[11–13] These complications highlight the importance of an accurate diagnosis, as well as a comprehensive treatment plan, and systematic follow up. The treatment of the vast majority of ankle sprains is usually, as for noncomplicated ankle fractures, a conservative one. In contrast to fractures, early mobilization is encouraged in the case of ankle sprains, and physical therapy (PT) is a controversial but frequently used modality.[7,9,14,15] Even for the most severe low ankle sprains, the recommended

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immobilization period rarely exceeds 10 days.[16] In our institution, immobilization in a walking boot depends on physician evaluation and initial diagnosis. For a classic lateral ankle sprain, 7 to 10 days of walking boot is recommended. In this context, it is not surprising that some hospitals have reported important disparities in the evaluation, treatment, and follow-up of pediatric ankle trauma patients.[17]

Therefore, the purpose of this study was to evaluate the management of patients with acute low ankle sprains in a university affiliated pediatric tertiary care hospital, in order to identify flaws in diagnostic and treatment. Our hypothesis is that the initial diagnosis is frequently incorrect, and treatment varies considerably amongst orthopedic surgeons.

2. Methods

This retrospective descriptive study was approved by the Medical University Direction (DAMU) of the Centre Hospitalier Universitaire Sainte-Justine/ to review all visits to the outpatient orthopedic surgery clinic at Sainte Justine Hospital between May 15 and August 20, 2014.

Patients were included if they had an ankle sprain or SH1 ankle fracture, normal initial ankle radiographs, were referred directly from the institution's emergency department, and with an initial consultation date at least 12 months prior to the study, so as to monitor treatment and follow up time. These criteria ensured we had access to all clinical files and test results, including all imagery and medical prescriptions.

Patients were excluded if neither an SH1 fracture nor a sprain were part of the initial differential diagnosis, if they had any concomitant injury that could have modified the investigation or treatment of the ankle injury or had initiated treatment prior to the initial orthopedic consultation.

2.1. Definitions

SH1 fractures were defined as ankle trauma cases with normal x-rays and maximal focal tenderness over the distal fibular physis. Ankle sprains were defined as ankle trauma cases with normal x-rays and maximal focal tenderness over the lateral perimalleolar ankle ligaments. The difference in diagnosis was based on the findings of the clinical exam, as well as review of the imaging at the moment of initial consultation, as well as follow up.

2.2. Endpoints

The primary endpoint was the change in the initial diagnosis, either between the emergency physician and the orthopedic surgeon, or between orthopedic surgeons.

The secondary endpoints were the duration of immobilization, the presence of residual symptoms, and physiotherapy referral for each diagnosis.

2.3. Data collection

A retrospective file review was carried out to evaluate patients on a clinical and radiographic basis. Patient demographics, including age and gender, as well as injury mechanism, date, and setting were recorded. Patient history, physical examination, imaging results, diagnosis, and treatment modalities (immobilization, medication, physical therapy) were recorded at each visit, including the emergency department visit, and subsequent orthopedic clinic appointments. Patient follow-up appointments were not necessarily conducted by the same orthopedic surgeon as the initial consultation. Five different orthopedic surgeons contribute to the fracture clinic. Although both initial and final diagnosis were noted, patients were grouped by final diagnosis for statistical comparisons. Rigid immobilization was carried out with an air cast boot or a plaster cast.

2.4. Statistical analysis

Chi-square analysis was used to evaluate the relationship between categorical variables. Independent sample *t* tests were performed to evaluate the relationship between continuous variables. Spearman's correlation coefficient was used to evaluate bivariate correlations of quantitative data. Statistical significance was set at a *P* value of .05 or less, and statistical analysis was performed using the SPSS software, version 20.0 (SPSS Inc., Chicago, IL).

3. Results

Between May 15 and August 20, 2014, 3047 patients were seen at the orthopedic outpatient clinic, amongst whom 31 patients met the inclusion criteria. The cohort consisted of 17 girls and 14 boys, with a mean age of 10.4 years (3–17 years). All injuries were sustained in leisure settings, mostly in sports. The most frequent settings were while jumping on a trampoline (6 cases) or while playing soccer (5 cases). Other team sports made up 7 cases, and the remaining 13 cases were accounted for by individual activities, such as cycling, running, or roller blading.

All patients consulted the emergency department (ED) within 3 days of the injury and were then referred to the pediatric orthopedics outpatient clinic. The delay between the first visit at the ED and the initial consultation with an orthopedic surgeon was highly variable, ranging from 1 to 29 days (Fig. 1). Patients were seen by an orthopedic surgeon at an average of 10.4 days after their ED visit, with 71% (22/31) of patients seen in the first 10 days.

The initial diagnoses at the emergency department included 8 ankle sprains, 20 Salter–Harris type 1 ankle fractures (SH1), as well as 3 cases where the physician was unable to distinguish between both pathologies (Fig. 2). However, 48.5% of diagnoses were modified over the course of the follow-up, either upon the initial orthopedic surgery consultation, or upon follow-up in orthopedic surgery. Ultimately, final diagnoses included 12 ankle sprains, 11 SH1 ankle fractures, 5 uncertain, 1 missed SH4 fracture, 1 contusion, and 1 malunion of an earlier peroneal fracture. The latter 3 cases were excluded from the subsequent statistical analysis of the differences in treatment amongst groups. The patient with an SH4 fracture was diagnosed following a CT scan, which was initially taken to rule out a talar fracture. However, the scan showed a nondisplaced SH4 fracture of the posterior distal tibia, treated with 4 weeks of nonweight bearing below-knee cast. It should be noted that some diagnoses changed more than once throughout the follow-up visits.

The average and range in immobilization duration are illustrated for each group in Figure 3. The average immobilization for SH1 ankle fractures was significantly longer than for ankle sprains (26.1 vs 17.3 days, $P < .001$). There was no significant difference in immobilization periods between the "SH1 or sprain" and "sprain" groups. A wide range of immobilization duration was evident in all groups.

The present study found that 17.9% of cases were referred to physical therapy (Table 1). Patients with a final diagnosis of ankle sprain were the group most frequently referred to physical

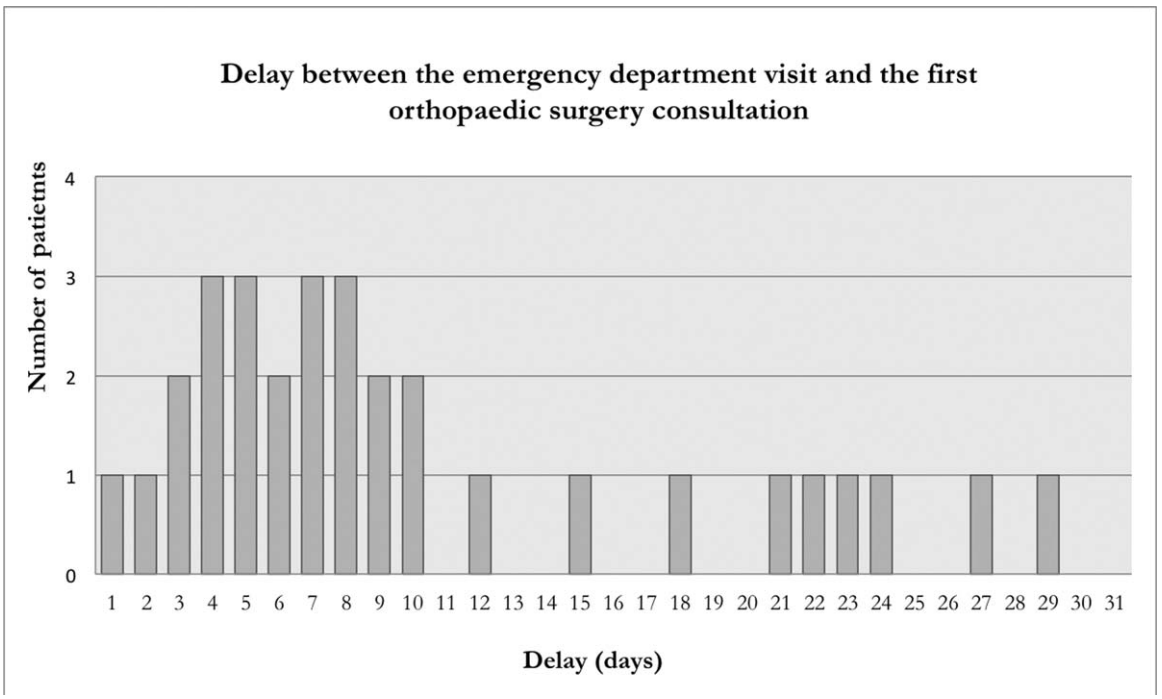

Figure 1. Histogram showing the delay between the initial visit at the emergency department (ED) and the first orthopedic surgery consultation. ED = emergency department.

therapy (4/12, 33%), although this was not statistically significant ($P = .081$).

Table 1 shows the proportion of patients with residual symptoms at discharge.

Upon discharge, 57.1% (16/28) remained symptomatic, with residual symptoms that included light residual swelling, subjective instability, pain during physical activities, and loss of range of motion. Patients with ankle sprains were more frequently symptomatic at discharge, although this difference was not statistically significant ($P = .175$).

4. Discussion

The purpose of this study was to evaluate the management of patients with acute low ankle sprains in a tertiary care center, in order to identify flaws in the diagnosis and treatment of this type of injury. Our hypothesis was that the initial diagnosis is frequently incorrect, and that treatment varies considerably amongst orthopedic surgeons.

The first hypothesis was verified, as the diagnosis changed in 48.5% of cases in the studied cohort of pediatric ankle traumas presenting with SH1 fractures and sprains. This is consistent with

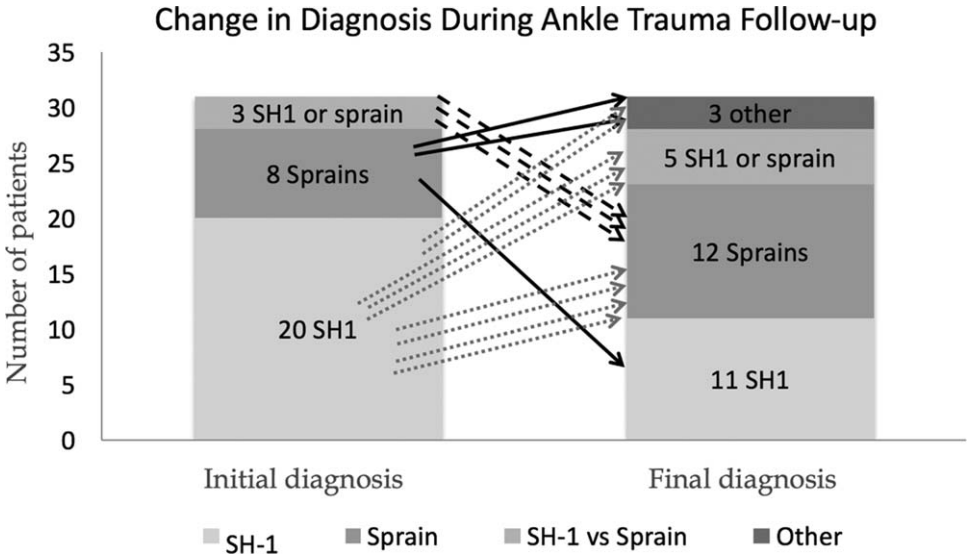

Figure 2. Distribution of diagnoses at admission and at discharge. The arrows illustrate the diagnostic changes explaining the differences between the two columns. SH1 = Salter–Harris type 1 fracture.

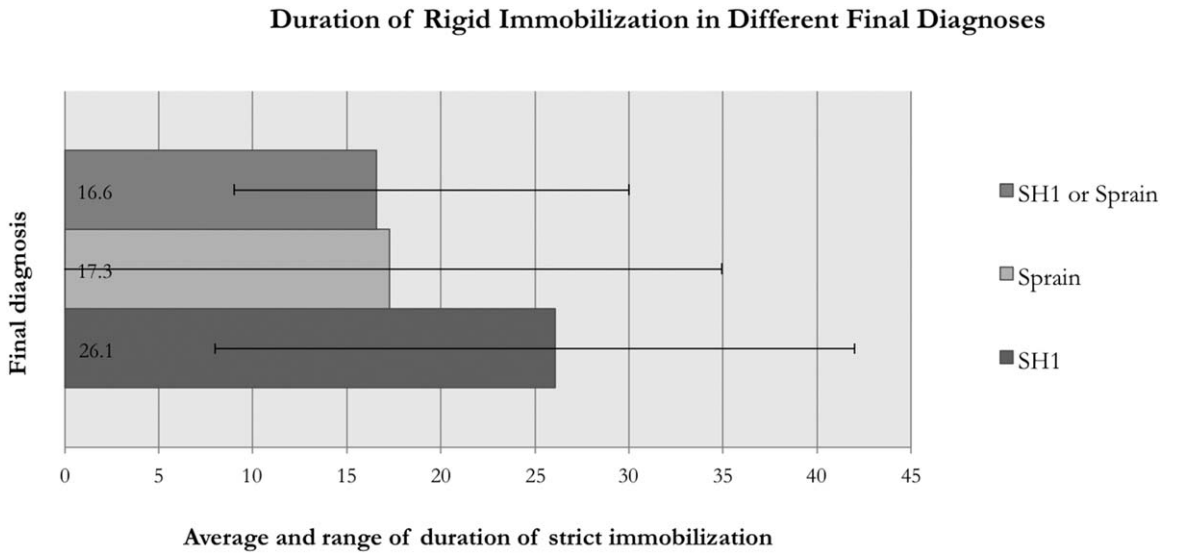

Figure 3. Duration of rigid immobilization in days of ankle injuries, classified by final diagnosis. The average duration in each group is indicated in the bars. The error bars indicate the longest and shortest immobilization periods in each group. SH1 = Salter–Harris type 1 fracture.

many publications that claim that diagnoses of those injuries are particularly difficult, as radiographs are often nonconclusive, and physical examination is of limited help in identifying the precise anatomical structure that is injured in an acute injury.[7,8,18] This suggests that those injuries cannot be distinguished from one another, and perhaps should all be treated the same way in the acute phase. Every time a clinician hesitated between an ankle SH1 fracture or a sprain, the final diagnosis was a sprain. In addition, 20 injuries were originally diagnosed as SH1 fractures, but only 11 SH1 were ultimately deemed as such. This illustrates that clinicians may have a tendency to follow the "children do not get sprains" rule, even though it could lead to an over-diagnosis of fractures, as well as an under-diagnosis, and an under-treatment, of pediatric ankle sprains. It must be emphasized that this study is not a critique of first line physicians, but rather a highlight of the challenging nature of this diagnosis.

The second hypothesis was also validated, as there was substantial intra- and intergroup variability in the duration of ankle immobilization. Based on the error bars in Figure 3, some sprains were treated as fractures, with longer immobilization periods, and vice versa. Prolonged immobilization periods may also be explained partly by a consultation delay and diagnostic uncertainty.

Perhaps if those patients had been seen a few days later, after the pain and swelling have receded, an accurate diagnosis could have been made in 1 visit instead of 2, and immobilization would have been reduced. Some sprains were treated with soft immobilization, consisting of elastic wrap, which accounts for the very short strict immobilization periods, or even lack thereof, in some cases. Our results suggest that clinicians treated some SH1 fractures as sprains, without changing the initial diagnosis, as some fractures were immobilized for less than ten days, which is much shorter than the standard of care.[3,4] This reinforces the idea that these injuries could benefit from being treated as a single clinical entity, until a definitive diagnosis can be made.

Table 1

Proportion of patients from each group who were prescribed PT at discharge, and who reported symptoms at discharge.

	Sprains	SH1 fracture	SH1 vs Sprain	Total
Physical therapy referral				
Yes	4 (33.3%)	1 (9.1%)	0 (0%)	5 (17.9%)
No	8 (66.7%)	10 (90.9%)	5 (100%)	13 (46.4%)
Residual symptoms at discharge				
Yes	9 (75%)	5 (45.5%)	2 (40.0%)	16 (57.1%)
No	3 (25%)	6 (54.5%)	3 (60.0%)	12 (42.9%)

Results are presented as percentages (number).
PT = physical therapy, SH1 = Salter–Harris type 1 fracture.

Despite the persistence of symptoms at discharge in 57.1% of patients, only 17.9% of patients were referred to physical therapy. Patients having suffered ankle sprains had a tendency to be more symptomatic at discharge, compared to ankle SH1 fractures, although this was not statistically significant. This is consistent with the absence of any reports of distal fibula SH1 fracture complications in the pediatric orthopedic literature. However, it may reflect the clinicians' inclination to discharge a patient who has suffered an ankle sprain, despite residual symptoms and the varying prognosis of these injuries, based on the spectrum of injury severity. Patients with a final diagnosis of ankle sprain were the group most frequently referred to physical therapy, which is consistent with the usual treatment strategies specific to each diagnosis.[15,19]

Although they are consistent with the current literature, our conclusions should be interpreted with caution, since our study design and small sample size limit the possible statistical analyses and interpretations. As this was a retrospective study, and MRI is not routinely used to differentiate between SH1 fractures and ankle sprains, there was no gold standard of diagnosis. Furthermore, patient files occasionally provided limited clinical information, although essential information was always present. In addition, including patients solely referred from our hospital ER may have introduced a selection bias, as minor ankle traumas are less likely to consult in a tertiary care center.

In conclusion, an accurate diagnosis can be difficult in pediatric ankle trauma, with case management and specific treatments varying considerably. Our results suggest that the diagnosis of minor ankle trauma changes in more than 50% of the cases

during follow-up. This predicament is specific to a skeletally immature population and leads a new hypothesis: could all minor pediatric ankle trauma cases with normal radiographs at first visit be treated uniformly, with a follow up in physical therapy rather than orthopaedic surgery, maintaining the same outcomes. Currently, there is an ongoing effort to standardize treatment for each diagnosis; a lateral ankle sprain is treated with a walking boot for 7 to 10 days, with weight bearing as tolerated, and a SH1 fracture is treated either with a below the knee cast or a walking boot for 4 weeks.

Author contributions

Conceptualization: Marie-Lyne Nault.
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Formal analysis: Marie-Lyne Nault.
Resources: Stéphane Leduc.
Supervision: Stéphane Leduc, Marie-Lyne Nault.
Writing – original draft: Philippe Voizard.
Writing – review & editing: James Moore, Stéphane Leduc, Marie-Lyne Nault.

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