Advances in Medical Sciences 63 (2018) 107–111

Contents lists available at ScienceDirect

Advances in Medical Sciences

journal homepage: www.elsevier.com/locate/advms

Original research article

Physeal fractures of the lower leg in children and adolescents: Therapeutic results, pitfalls and suggested management protocol-based on the experience of the authors and contemporary literature

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ARTICLE INFO

Article history:
Received 3 June 2017
Accepted 17 October 2017
Available online xxx

Keywords:
Salter-Harris fractures
Periosteum interposition
Complications
Physeal fractures
AOFAS scale

ABSTRACT

Introduction: Physeal fractures in children frequently give rise to concerns about the condition of the growth plate. Our observations have proven that the dysfunction of the growth plate is less frequent complication in those cases than misdiagnosed interposition of the periosteum. The aim of this paper is to familiarize the readers with the issue of treatment of physeal fractures of the distal tibia and fibula in the growing skeleton.

Materials and methods: We analyzed the group of 75 patients – children and adolescents – with surgically treated physeal fractures of the lower leg. The analysis included age, sex, circumstances of trauma infliction, type of sustained damage, employed therapeutic technique, timing of surgical procedure, duration of hospitalization, complications, duration of follow-up, radiological and functional results according to the AOFAS scale.

Results: The group consisted of 23 girls and 52 boys. The mean age was 13.6 years. The most frequent cause of trauma was same-level fall, usually during sports activities (35 cases). The most common type of damage was Salter-Harris type II fracture (35 cases). Among the employed surgical techniques, open reduction and stabilization with K-wires was the most often used (52 cases). A group of four patients attracted our attention, in whom after a closed reduction, signs of periosteum interposition were noted. These patients required a second procedure. In one patient, the growth plate arrest occurred; it was directly caused by local osteomyelitis.

Conclusions: With adequately conducted treatment of distal tibia and distal fibula physeal fractures, the results are good. Misdiagnosed periosteum interposition poses a more serious clinical problem as opposed to the commonly anxiety-provoking post-traumatic growth plate dysfunction.

1. Introduction

Physeal fractures of the lower leg do not represent the most frequent injury among children and adolescents; they are also rarely considered a clinical challenge. However, as all physeal fractures, they tend to give rise to concern about the condition of the growth-plate. The character of these injuries often causes anxiety among doctors inexperienced in the field of pediatric orthopedics, which results in abundance of referrals to specialized centers – such referrals are frequently excused only by "the lack of pediatric orthopedist on call".

Our observations have shown that the growth plate dysfunction is not the most frequent complication of the therapeutic process. Misdiagnosed periosteal interposition is observed more often.

The goal of this article is the assessment of the therapeutic results of the physeal fractures of the lower leg in children and adolescents; the second objective is to propose a comprehensive management protocol.

2. Material and methods

The material for our analysis consisted of patients with fractures of the distal physis of the tibia and/or fibula managed surgically in the period from June 2009 to December 2015. The

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https://doi.org/10.1016/j.advms.2017.10.001
1896-1126/

starting point in data gathering was the list of procedures performed in the operating room obtained from the OR office.

The initial analysis resulted in a group of 109 cases. In the course of further selection, the following exclusion criteria were applied: incomplete medical or radiology files and a follow-up period shorter than 2 months. The application of the aforementioned criteria resulted in limiting the study group to 75 patients.

Age at the moment of injury, sex and circumstances of the injury were listed among the analyzed criteria. Dividing patients into groups was difficult due to multiple variants of the sustained injuries, frequently combining Salter Harris fractures of the distal tibia, fractures of the fibula, damage to the tibiofibular syndesmosis and ligaments. While assessing the method of injury management in patients subjected to multiple operations, only the method employed during the final procedure was taken into account. Duration of this operation was obtained from the anesthetic files. A simple scoring system was devised for the assessment of the radiologic outcome; the system allowed for allocating 1 to 5 points:

5–an image resembling normal anatomy,

4–a slight deviation from normal anatomy – a condition appropriate for spontaneous correction

3–deviation not appropriate for spontaneous correction, but without the necessity of corrective surgery,

2–deviation requiring corrective surgery

1–persistent deviation

Any deviation from the normal post-operative course was considered a complication, with no regard for its impact on the outcome of the therapeutic process.

The follow-up period was measured in months, starting from the day of the surgery until the closure of the treatment recorded in the patient's clinical files. All the patients who decided to continue their post-surgical treatment in other medical centers were excluded from the study group.

The functional result according to the AOFAS scale was based on the entries in the clinical files [1,2,3]. Although the scale was not in use during follow-up, the correctly conducted medical records contained description of each patient's condition: the function of the injured limb, post-traumatic deformities and deficits, complaints, physical activity. The descriptions combined with the aforementioned scale allowed for expressing the functional outcome as a numerical score.

3. Results

After applying the aforementioned criteria, the study group was limited to 23 girls and 52 boys, giving a total of 75 patients aged 7 to 17 years. The mean age in the study group was 13.6 years. The most frequent cause of injury was same-level fall, usually during sports activities, with football and gym-classes appearing to be the most common, as 35 patients sustained injuries in such circumstances. Multi-level falls (six patients) and incidents "involving a vehicle" (17 patients) were next on the list. A considerable number of cases lacked the description of the circumstances of the accident in the medical records (17 cases).

Classification of the injuries was based on X-ray imaging, When in doubt as to the type of the injury or the character of the dislocation, CT scans were obtained. Due to multiple variants of the injury, the classification was based on the type of Salter-Harris fracture of the distal tibial epiphysis [4]. The following division of the study group was obtained:

type I –9 patients (in 8 cases – a co-existing fracture of the lateral malleolus),

type II – 35 patients (in 28 cases – a co-existing fracture of the fibula),

type III – 9 patients, including two cases of Tilleaux fracture (in 4 cases – a co-existing fracture of the fibula),

type IV – 14 patients, including 8 cases of a "tri-plane fracture" (in 4 cases – a co-existing fracture of the fibula).

In addition, four patients were diagnosed with type I Salter-Harris fracture of the distal fibula and another four patients with the fracture of the tip of the lateral malleolus (just below the growth-plate).

In four patients with dislocation of the bone fragments of only 2–3 mm, a closed reduction and cast immobilization was performed. A closed reduction followed by bone fragments fixation was performed in 19 patients. K-wire was the most frequently used means of fracture fixation, in only one case was the screw used.

An open reduction and fracture fixation was performed in 52 patients – in nine cases the screw was employed; in the remaining cases, K-wire fixation was employed. In this group, in 30 cases, periosteal interposition between the bone fragments of a Salter-Harris fracture was diagnosed intra-operatively; four patients should be considered a distinctive sub-group: those patients were qualified for open revision of the fracture after a previously performed closed reduction – the X-ray showed widening of the growth plate, which suggested periosteal interposition (in spite of satisfactory reduction of the bone fragments) and this suspicion was confirmed during open revision.

The data concerning the duration of each operation were obtained through the analysis of the anesthetic files. The majority of the procedures lasted less than an hour (64 operations). In eight cases, the time needed for injury management was between 60 and 90 min. Only three patients did require an operation with the OR-time exceeding 90 min.

The patients with physeal fractures of the lower leg usually did not require prolonged hospitalization. The minimal recorded hospitalization time was two days, while the maximal duration was 14 days and the mean time was 4.65 days. The pre-operative hospitalization time was measured from the moment of admission until the final management of the injury; the recorded values ranged from 0 to 9 days, with the mean value of 0.53 day. The post-operative hospital care duration ranged from 1 to 13 days, with the mean value of 3.29 days.

The bone union was obtained in all the patients. The time required for bone union was measured in weeks from the moment of the final management of the injury to the moment when X-ray showed the stage of bone union suitable for hardware removal. In all the cases of non-surgical treatment, we measured the time needed for obtaining bone union suitable for full weight-bearing. The necessary data were obtained through the analysis of radiologic images and clinical file entries. The time of fracture healing in our study group lasted from 4 to 16 weeks, with the mean time of 5.73 weeks.

Any deviation from the normal course of treatment was considered a complication, with no regard for its impact on the therapeutic outcome. Problems with wound healing were the most frequent complication (five cases). The second most common was a misdiagnosed periosteal interposition that required revision (four cases). Pressure ulcer over the lateral malleolus – an effect of a poorly applied plaster splint – occurred in one patient. In three cases, infection was diagnosed: inflammation in the vicinity of K-wires (two cases) and osteomyelitis resulting in growth-plate arrest (one case).

The follow-up time was measured from the day of the operation until the day of the treatment completion as recorded in the patient's clinical files. All the patients who continued their post-surgical treatment in other medical institutions were excluded from our study group The shortest follow-up period was nine months, the longest one – two years. The mean follow-up period