

Pseudoarthrosis of second metatarsal fracture

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Abstract

Metatarsal fractures make up the greatest portion of foot fractures in children. Most of them are treated with closed reduction and non-weightbearing cast immobilization. Usually, these fractures heal uneventfully and delay union and pseudoarthrosis are rare. We report a case of a 10-year-old child with non-union of the second metatarsal following a traumatic fracture, caused by an accident 10 months before, and treated successfully by osteosynthesis with plate and screws. Good clinical outcome was achieved at 2 years follow-up.

Introduction

Fractures of the metatarsal bones are the most frequent fracture of the foot: they represent 35-88.5% of all fractures involving the foot.¹ During childhood and adolescence, the 5th metatarsal is the commonest fracture of the foot and usually occurs in isolation. Although less frequent, fractures of the 2nd to 4th metatarsals are often accompanied by a neighboring metatarsal fracture.

Metatarsal fractures typically present with pain and swelling over the corresponding dorsum of the foot.²

Most childhood metatarsal shaft fractures can be successfully treated without surgery, with 4-6 weeks of non-weight bearing cast immobilization.³ They normally heal well, but pseudoarthrosis can occur, although generally it is a rare event in children.

Pseudoarthrosis defined as formation of a false joint where a fibrocartilaginous cavity is lined with synovium producing synovial fluid.⁴ The typical features of pseudoarthrosis were often reported as great motion at the fracture site on physical examination and the existence of a pseudocapsule and fluid collection between the fracture gap.⁵

There are different therapeutic strategies for metatarsal non-union. The non-invasive therapeutic strategies include ultrasound, electrical stimulation, electromagnetic stimulation, and shock wave and they are effective adjuvant.⁶⁻⁸ The invasive therapeutic strategies include various types of graft (autologous bone graft, vascularized bone flap graft and allograft), internal fixation with plate and screws, K-wires or intramedullary nail.^{7,9}

A case of a 10 years old child with pseudoarthrosis of the second metatarsal is discussed. We achieved a successful outcome after osteosynthesis with plate and screws.

Case Report

A 10-year-old male child reported traumatic displaced fracture of second and third metatarsals of right foot in May 2015 (Figure 1). He did not have accompanying diseases. He was managed non-operatively with 4 weeks of non-weight bearing plaster cast in another hospital. Once the plaster has been removed the patient started progressive weight bearing and functional re-education of foot and ankle.

Two months later he came to our attention for pain at the base of the second and third metatarsal and a great edema of the foot; X-rays control showed signs of fractures consolidation (Figure 2).

Despite treatment with physical therapy and orthoses the patient referred persisting pain and chronic edema of the foot. In October the radiographs showed healing of the fracture of third metatarsal, while the second one showed signs of delayed union (Figure 3). In December 2015 TC scan showed sclerotic changes of the fragments without sign of consolidation, which was considered an established pseudoarthrosis of the second metatarsal.

Because of the chronicity of the symptoms, osteosynthesis of the second metatarsal with plate and screws was performed in March 2016. A weight bearing short-leg plaster cast was applied for 5 weeks. A solid and well-aligned union was evident at 10-months follow-up after surgery (Figure 4), so in June 2017 the patient underwent plate and screws removal surgery.

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Discussion

Pseudoarthrosis occurs rarely in children. According to the US Food and Drug Administration, non-union is considered to be established after a minimum of nine months since injury and the fracture site shows no visibly progressive signs of healing for a minimum of three months.¹⁰

Generally, the progression to pseudoarthrosis is a process due to multiple factors. Two types of risk factors can compromise fracture healing: patient-dependent factors, such as age, gender, medical comorbidities, smoking and administration of pharmacological agents (steroids, non-steroidal anti-inflammatories) and patient-independent factors, such as the kind of the fracture, infections and adequacy of treatment.^{10,11} A recent study by Dimitriou *et al.*¹² even investigated the existence of a genetic predisposition to fracture non-union which, when combined with other risk factors, could synergistically increase the susceptibility of a patient to develop non-union.

Delayed bone healing and non-union occur in approximately 10% of long bone fractures¹⁰ but non-union is considered to be an unusual complication in children's fractures.¹³ Due to thick periosteum rich in osteoblasts, good vascularization and considerable remodelling capacity, children and young adults form new bone rapidly and the majority of their fractures unite and heal correctly.^{11,14}

The risk of non-union in children under the age of 15 is approximately 0.2%. This risk was greater in the lower limb than in the upper limb fractures throughout childhood until this age and, in general, increased steadily with age.¹³

Metatarsals are frequently involved in foot injuries, even during childhood, reaching 60% of foot fractures;^{2,15} pseudoarthrosis has been reported with a non-union rate of 7% to 28% using conservative treatment¹⁶ and of 6% to 40% using surgical treatment.¹⁷

In this case, the patient was a child in good health, without evident risk factors that could compromise fracture healing and lead to the development of pseudoarthrosis: the process is derived probably from the union of local factors and genetic predisposition that should be better investigated.

This case report describes the development of pseudoarthrosis in a metatarsal proximal shaft fracture, which is a transition zone between two different blood supplies. When the continuity of this area is interrupted and the blood supply is disrupted, fracture can present delayed healing or non-union. This anatomical reason can also explain the need for a longer period of immobilization and protected weight-bearing (until 6-8 weeks) compared with other fractures, with follow-up radiographs to check for union.

Furthermore, choice of the most suitable treatment is essential to ensure a correct healing and prevent pseudoarthrosis. For this reason, it is necessary to consider fragments displacement during fracture evaluation. In isolated metatarsal fractures, displacement is usually small and due to the action of the interosseous muscle and ligament insertions; in this case, the choice for conservative treatment is suitable and safe. Also fractures of two metatarsals with little displacement in the same direction, as in this child, can heal well with conservative treatment, considering that shortening and minimum deviation in the sagittal plane do not lead to negative late results.¹⁸ However, fractures with axis deviation of more than 20° or associated instability are better treated with surgery (K-wires or plate and screws



Figure 1. X-rays after trauma: displaced fracture of second and third metatarsals of right foot.



Figure 2. X-rays control at 2 months after trauma: signs of fractures consolidation.

fixation), especially in children over 12 years.⁶ Actually, restoring anatomic alignment in unstable metatarsal fractures is the goal in operative management, because is important and necessary for pain-free deambulation.⁹



Figure 3. Radiographs and TC scan at 6 months after trauma: (A) healing of the third metatarsal fracture; (B) signs of delayed union of the second one.



Figure 4. X-rays control at 10 months after surgery: solid and well-aligned union after osteosynthesis with plate and screws.

When pseudoarthrosis occurs, the aim of treatment is to guarantee the stability of the fracture. In this patient, pseudoarthrosis was treated with plate and screws. In a synthetic metacarpal shaft hand study, Curtis *et al.*¹⁹ established that plates are the most stable means of fixation of midshaft metacarpal fractures, compared with intramedullary nail and K-wires. Despite in literature some authors affirm that graft is the standard for the treatment of non-union, in some cases graft usage can be avoided considering the good perfusion of the fracture site, the minimal bone defect and the young age of the patient. Furthermore, using a graft, there is the possibility of donor site morbidity and complications.²⁰

At last, another aspect to consider is that fracture non-union could have devastating physical and psychological outcomes for the patient. Not infrequently, a complex and expensive treatment is required, associated with multiple surgical procedures, prolonged hospital stay, pain and functional and psychosocial disability.^{8,10}

Conclusions

Generally, fractures in children heal uneventfully, but this case report demonstrates that pseudoarthrosis can occur, even in child without evident risk factors. The exact biological process leading to a pseudoarthrosis remains obscure. A correct treatment is necessary to reverse this process and it is well accepted that any planned interventions should be well-timed and well-aimed to restore both biological and mechanical deficiencies, because it could be a cause of important functional and psychological disability.

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