SURGICAL MANAGEMENT OF PIP JOINT REPETITIVE STRESS EPIPHYSEAL FRACTURE NONUNION IN ELITE SPORT CLIMBERS

El-Sheikh, Y.[1], Lutter, C.[2], Schoeffl, I.[3], Schoeffl, V.[4], and Flohe, S.[5]

[1] Division of Plastic Surgery, University of Toronto, info@climbingmedicine.com
[2] Department of Sports Medicine-Sports Orthopedics, Bamberg, christoph.lutter@googlemail.com
[3] Department of Pediatrics, Bamberg, isabelle.schoeffl@me.com
[4] Department of Sports Medicine-Sports Orthopedics, Bamberg, volker.schoeffl@me.com
[5] Department of Trauma Orthopedics and Hand Surgery, Solingen, flohe.sascha@klinikumsolingen.com

ABSTRACT:

Repetitive stress fracture of the middle phalanx epiphysis is an injury specific to elite adolescent sport climbers. As sport climbing becomes increasingly popular in younger age groups, there have been an increased number of these injuries reported in recent years. To date, treatment of these fractures has been nonsurgical, with strict rest and physiotherapy prescribed until fracture union. However, when these patients present in a delayed fashion with an established nonunion, non-operative treatment may fail, leading to disabling chronic pain and/or digital deformity in some cases. In this presentation, we will discuss the general management of these injuries, including our novel technique for treating nonunion: percutaneous spot drilling epiphysiodesis.

KEY WORDS:

epiphyseodesis; proximal interphalangeal joint; sport climbing

AKNOWLEDGEMENTS:

Many thanks to Regine Roloff and Catherine Brunel for their help with French translation

ABRÉGÉ:

La fracture de stress répétée de la phalange médiane épiphysaire est une lésion typique, ces dernières années, chez les adolescents grimpeurs d'élite. Chez les jeunes, une augmentation de ces lésions est observée en relation avec un engouement croissant pour l'entraînement spécifique à l'escalade. Jusqu'à présent, le traitement de ces lésions ne passsait pas par la chirurgie. On préconisait une mise au repos absolue et des séances de physiothérapie, jusqu'à la réduction de la fracture. Cependant, la réduction de la fracture peut se faire avec un certain retard et un traitement non chirurgicale peut conduire à une douleur chronique et/ou à une éventuelle déformation du doigt, dans certains cas. Dans cette présentation, nous démontrons la façon chirurgicale d'aborder ces lésions en expliquant notre nouvelle technique pour traiter ces fractures: une épiphysiodèse percutanée par forage sélectif ("spot drilling")

MOTS-CLÉS:

Épiphysiodèse percutanée, articulation interphalangienne proximale, escalade sportive

INTRODUCTION:

Epiphyseal fracture of the middle phalanx base is an injury specific to elite adolescent sport climbers. Since the first reported case in 1997, there have been almost 100 of these fractures published in the literature.[1,2,3,4,5] The middle or ring finger is most commonly affected and the fracture pattern is usually Salter-Harris type III (81%).[3,4]

The largest case series of these injuries to date, reported on twenty-four patients identified over a ten-year period, and described a non-operative management protocol, including complete cessation of climbing, and gentle finger range of motion exercises until fracture healing.[3] Results of non-operative management were excellent in the eight patients (33%) who presented with acute, non-displaced fractures. Two of the sixteen patients presenting with chronic nonunion, however, went on to develop osteonecrosis of the epiphyseal fracture fragment, with resultant pain, permanent angular deformity and stiffness of the affected joint.[3]

Therefore, because suboptimal outcomes have been observed more commonly with non-operative management of displaced, non-united fractures, we decided to consider operative treatment this subset of patients. In this report, we present a case of operative treatment for displaced, non-united epiphyseal fractures in the fingers of elite sport climbers.

CASE REPORT:

A 13-year-old male sport climber was referred with a 9-month history of bilateral middle finger PIP joint pain. There was no recalled preceding trauma. The boy was a nationally ranked junior competition climber, involved in sport-specific training five days/week. Pain was aggravated by climbing, alleviated by rest, and had increased in severity over the preceding six months.

Examination of the hands revealed mild, localized, symmetric swelling of the middle finger PIP joints, but was otherwise normal.

Plain radiographs demonstrated bilateral middle finger, middle phalanx dorsal base Salter-Harris III epiphyseal fractures. The fracture appeared dorsally displaced in the left hand and non-displaced in the right hand.

CT scan of both hands was performed, demonstrating cortication of the fracture margins in the left middle finger, suggesting chronic nonunion. The fracture fragments measured 8x3mm and 6x2mm in the left and right middle fingers, respectively.

The patient, his family, and coaches, were instructed that all climbing and sport specific training be immediately stopped. We elected to treat the displaced nonunion in the left middle finger with percutaneous spot drill epiphysiodesis, which was performed ten months after the onset of symptoms.

The procedure was performed using sterile technique, under general anaesthesia. Using a mini C-arm, the fracture was visualized and the location of the dorsal epiphyseal fracture fragment was identified and marked at the skin. Through a dorsal approach, in order to stimulate union of the dorsal epiphyseal fracture fragment with the intact epiphysis and total epiphysiodesis, a 0.7mm Kirschner wire was drilled through the dorsal fragment at four different angles: into the intact epiphysis transversely**,** into the intact physis, the middle phalanx proximal metaphysis, and the middle phalanx distal metaphysis.

Postoperatively, the finger was immobilized for two weeks day and night, followed by gentle active range of motion exercises and no climbing or sport-specific training until 3 months after surgery. The non-displaced fracture in the right middle finger was treated non-operatively with this protected rehabilitation protocol alone.

At three months post-operatively, plain radiographs demonstrated union of both the right and left middle finger fractures. The patient had full active range of motion in all digits of both hands and complete resolution of symptoms. He was thereafter allowed to return gradually to climbing and sport-specific training.

DISCUSSION:

Modern sport climbing places a tremendous amount of strain on the interphalangeal joints of the hands, with forces as high as 599N calculated at the proximal interphalangeal joints of climbers when clinging to small holds.[7] Not surprisingly, as the physical limits of the sport are more commonly being pushed by skeletally immature athletes, we are seeing an increase in the incidence of finger epiphyseal fractures caused by repetitive stress. Over the past 20 years, the incidence and proportion of finger epiphyseal fractures found in large case-series has increased from 2/604 to 16/911 injuries (0.3% to 1.8%).[8] This increase becomes even more alarming looking at the subset of young climbers (age </= 14 years), with 14/20 injured young climbers presenting with an epiphyseal fracture, making this, by far, the most common injury among young climbers.[8]

It is now established that non-operative management of these fractures leads to excellent outcomes, in cases where a timely diagnosis is made and the fracture is non-displaced. However, these athletes may present long after the onset of their pain, with a displaced, established non-union, for which non-operative management may be more likely fail.[3]

In this report, we present a case of surgical management for repetitive stress finger epiphyseal fracture nonunion in climbers, using a percutaneous spot drilling epiphysiodesis technique. The athlete went on to fracture union after surgery, without complications, and returned to elite-level sport climbing within three months of treatment. We chose this technique because it is minimally invasive and easy to perform, with the rationale that obtaining an epiphysiodesis across the fracture site may relieve pain and prevent the angular deformities we have observed in some patients with chronic non-unions.[3]

We cannot conclude that this fracture would not have healed with non-operative management alone. However, given that preoperative imaging confirmed established, displaced non-union 9-months after symptom onset, we feel that spontaneous healing was unlikely to occur. We therefore recommend that this technique be considered as an effective treatment option in the management of established non-union of PIP joint repetitive stress epiphyseal fractures in adolescent elite sport climbers when conservative treatment has failed.

REFERENCES:

1. Hochholzer T SV, Krause R. . Finger-Epiphysenverletzungen jugendlicher Sportkletterer. *Sport Ortho Trauma.* 1997;13:100-103.

2. Chell J, Stevens K, Preston B, Davis TR. Bilateral fractures of the middle phalanx of the middle finger in an adolescent climber. *Am J Sports Med.* 1999;27(6):817-819.

3. Hochholzer T, Schoffl VR. Epiphyseal fractures of the finger middle joints in young sport climbers. *Wilderness Environ Med.* 2005;16(3):139-142.

4. Schöffl I SV. Epiphyseal stress fractures in the fingers of adolescents: Biomachanis, Pathomechanism, and Risk factors. *European Journal of Sports Medicine (in press).* 2017.

5. Desaldeleer AS, Le Nen D. Bilateral fracture of the base of the middle phalanx in a climber: Literature review and a case report. *Orthop Traumatol Surg Res.* 2016;102(3):409-411.

6. Lutter C, El-Sheikh Y, Schoffl I, Schoffl V. Sport climbing: medical considerations for this new Olympic discipline. *Br J Sports Med.* 2017;51(1):2-3.

7. Burtscher M JE. Häufigste trainingsbedingte Beschwerden und Verletzungen bei Sportkletterern. *Prakt Sport Trauma Sportmed.* 1987;2:15–21.

8. Schoffl V, Popp D, Kupper T, Schoffl I. Injury trends in rock climbers: evaluation of a case series of 911 injuries between 2009 and 2012. *Wilderness Environ Med.* 2015;26(1):62-67.