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Technical Tips

Supraintercondylar fracture of the proximal phalanx of the hallux

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Abstract

Toe phalanx fractures are prevalent worldwide. The proximal phalanx of the hallux requires different treatment from the other four lateral phalanges. Poor positioning of rotation and angulation is not acceptable for this bone, since it can result in significant functional deficit. Indications for surgical treatment are: joint fractures with deviations greater than 2 mm, metadiaphyseal fractures with rotational and/or angular deviation, open fractures and unstable fractures. The classic medial approach in surgical treatment involves some high-risk neurovascular structures and does not allow the correct positioning of osteosynthesis systems in some cases. The aim of this study is to present an option for the surgical treatment of deviated and unstable supraintercondylar fractures of the proximal phalanx of the hallux by the dorsolateral approach, with a traction screw through the plate and a lateral neutralization plate.

Level of Evidence V; Therapeutic Study; Expert Opinion.

Keywords: Hallux/surgery; Osteotomy/methods; Fracture fixation, internal.

Introduction

Phalanx fractures of the toes are common, representing 3.6 to 8% of lower extremity injuries[1]. Of these, the phalanges of the hallux represent the largest proportion of all phalanx fractures of the toes (38-56%)[2].

In general, with appropriate initial treatment, diaphyseal fractures of the proximal phalanx of the hallux tend to consolidate in a good position. However, if proper treatment is not applied, clinical outcomes with significant functional sequelae, such as delayed union accompanied by pain, nonunion and angular deformity, are expected[3-5]. As the peak of plantar pressure at the moment of detachment of the foot during normal gait passes through the hallux, the anatomical reduction of this injury is important to avoid gait disturbances and forefoot disability in the future[6].

Diaphyseal fractures of the proximal phalanx of the hallux are not usually treated surgically, as reduction (generally closed) is acceptable[7].

The main indications for surgical treatment of the proximal phalanx of the hallux are:

- Joint fractures with deviation greater than 2mm;
- Metadiaphyseal fractures with rotational deviation;
- Metadiaphyseal fractures with angular deviation;
- Open fractures;
- Unstable fractures.

Open reduction and stable internal fixation (ORIF) is ordinarily the best option when treatment is surgical.

Internal fixation can be performed with one or more compression screws or a neutralization plate. The plate increases

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the degree of fixation and allows a higher degree of weight bearing, which facilitates functional rehabilitation. Whenever possible, the insertion of a traction screw through the plate further improves the rigidity of the assembly[7,8].

Alternatively, closed reduction using fixation with two or more Kirschner wires can be performed. This can be indicated in patients with significant soft tissue damage or major medical comorbidities[7,8].

The classic medial approach to the hallux is indicated for fractures of the two phalanges of the hallux with or without joint involvement. It can also be used for ORIF procedures involving the medial sesamoid bone or distal fractures of the first metatarsal bone, and in the treatment of hallux rigidus (cheilectomy, osteotomy, or fusion)[7].

Some anatomical structures such as vessels and nerves are at risk in this approach. The head of the first metatarsal bone receives its blood supply from an artery that enters the metatarsal head in the plantar aspect of the distal metaphysis[7].

The dorsomedial (collateral) digital nerve (in most cases a branch of the deep fibular nerve) runs in the dorsal half of the medial side, and the medial plantar sensory nerve of the hallux runs along its plantar aspect.

Other approach options are needed for the proper surgical planning of some fractures[7].

The aim of this study is to present an option for the surgical treatment of deviated and unstable supraintercondylar fractures of the proximal phalanx of the hallux, through the dorsolateral approach.

Surgical technique

The technique is indicated for supraintercondylar fractures of the proximal phalanx of the hallux (AO 88.1.2) involving instability, angular and rotational deviation.

In the case used to illustrate the technique, there was a metadiaphyseal fracture with lateral deviation and intact medial cortex (Figure 1). The ideal surgical planning strategy is to use an intercondylar traction screw and a neutralization plate on the side of the deformity/deviation - lateral surface of the phalanx, introduced through the dorsolateral approach.

1. The surgical procedure is performed with the patient in the supine position under general anesthesia in combination with local nerve block;
2. Pneumatic tourniquet positioned at the root of the thigh 270mmHg;
3. Dorsolateral L-shaped approach incision made along the lateral edge of the hallux (Figure 2);
4. The neurovascular bundle is protected and moved to the side, and the extensor hallucis longis and brevis tendons are not touched (Figure 2);
5. Distal traction is exerted on the hallux and a 1.5mm Kirschner wire is used for temporary fixation (Figure 3A);

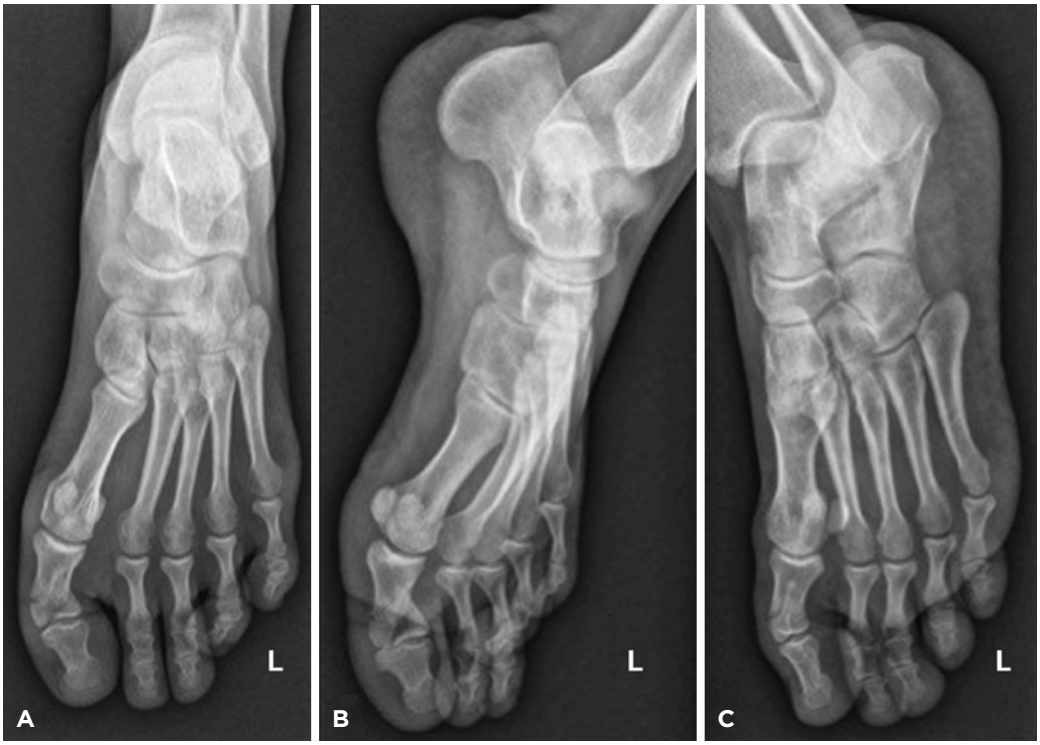

Figure 1. Laterally deviated metadiaphyseal fracture and intact medial cortex.

Figure 2. A and B. L-shaped dorsolateral approach incision made along the lateral edge of the hallux. C. Closure of surgical wound.

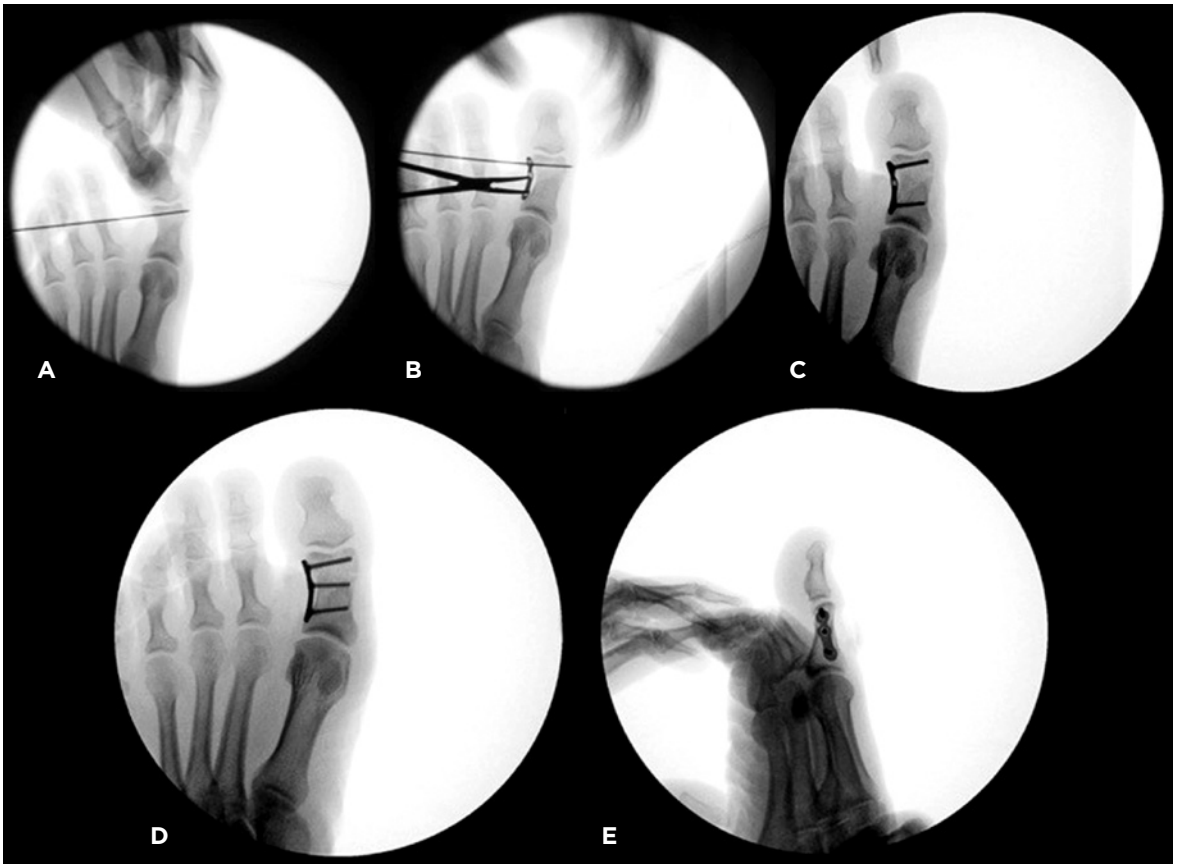

Figure 3. A. Temporary fixation with 1.5mm Kirschner wire. B. 2.0mm plate positioned on the lateral surface of the proximal phalanx of the hallux. C. Introduction of traction screw through the plate in the distal hole. D and E. Reduced articular surface.

6. The 2.0mm plate is positioned on the lateral surface of the proximal phalanx of the hallux, in order to function as a neutralization device (Figure 3B);
7. With the anatomical reduction of the joint surface maintained, a 2.0mm cortical screw is inserted through the most distal hole in the plate, in order to produce traction force (Figure 3C);
8. Once joint and metadiaphyseal reduction have been checked once again, a cortical screw is inserted in the most proximal hole in the plate, then a third locking screw is inserted in the central hole of the plate (Figures 3C, 3D and 3E);
9. The wound is irrigated with 0.9% saline solution and the approach is sutured with subcutaneous colorless 3.0mm vicryl and mononylon 4.0 in the skin (Figure 2C);
10. An occlusive dressing is made with cellulose acetate mesh impregnated with a petrolatum-based emulsion (Adaptic®) and sterile gauze covering the first commissure and hallux and protecting the surgical incision. The pneumatic tourniquet is then released with good peripheral perfusion.

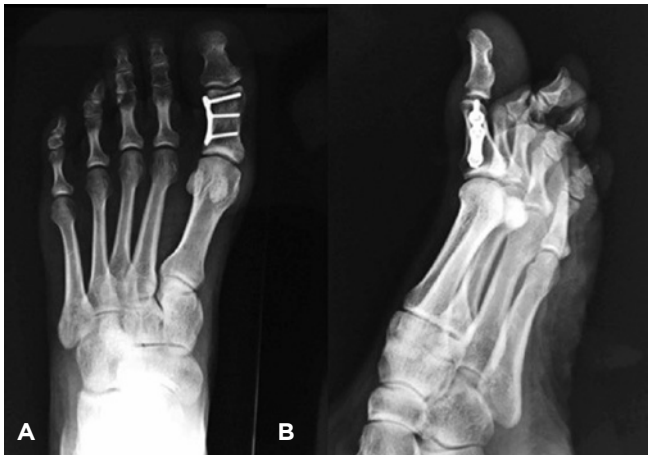

Figure 4. Five years after surgery. Fracture consolidated and without signs of mechanical failure of the implant.

The patient was followed up over a period of 5 years postoperatively with clinical and radiographic controls. Fracture consolidation was achieved with no signs of mechanical failure of the implant (Figure 4).

Discussion

Fractures of the phalanges of the hallux and toes are frequent injuries. They correspond to about 5.5% of foot and ankle fractures.[1] Although most injuries occur as a result of low-energy trauma, these fractures are often overlooked in polytrauma patients[8].

Some authors separate fractures of the phalanx of the hallux from fractures of the smaller toes[9]. There is consensus regarding the need for surgical treatment of unstable and deviated fractures of the hallux due to the importance of stability and mobility of the first ray for physiological gait[10,11].

The use of more rigid implants allows the maintenance of alignment during the consolidation process, reducing the risk of loss of reduction and treatment failure[12,13].

Two articles showed the use of a miniplate on the medial surface of the phalanx of the hallux as an alternative method for osteosynthesis in the treatment of fractures of the proximal phalanx of the hallux[14,15]. Ideally, however, the plate should be applied on the stress side of the fracture, in order to generate compression forces during plantar weight bearing, thus constituting the ideal surgical approach[15-17]. As scant subcutaneous tissue is present on the proximal phalanx, the plate must have a low profile to reduce soft tissue irritation. Moreover, the use of locking plates and screws allows for greater rigidity during cyclic loading[18].

Thus, we advocate that fractures with medial deviation should be fixed with implants positioned medially. On the other hand, fractures with lateral deviation should be fixed with implants positioned laterally. The surgical approach can be done through the medial, dorsal, dorsomedial[19] or dorsolateral route[7]. The best approach indication will depend on the fracture pattern, the size of the fragments and the surgeon's experience.

Our technique allows the use of the 2.0mm plate with neutralization function on the lateral surface of the proximal phalanx of the hallux.

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References

1. Shibuya N, Davis ML, Jupiter DC. Epidemiology of foot and ankle fractures in the United States: an analysis of the National Trauma Data Bank (2007 to 2011). J Foot Ankle Surg. 2014;53(5):606-8.
2. Court-Brown CM, Caesar B. Epidemiology of adult fractures: a review. Injury. 2006;37(8):691-7.
3. Daly N. Fractures and dislocations of the digits. Clin Podiatr Med Surg. 1996;13(2):309-26.
4. Elleby DH, Marcinko DE. Digital fractures and dislocations. Diagnosis and treatment. Clin Podiatry. 1985;2(2):233-45.
5. Ly PN, Fallat L. Hallux fractures: diagnosis and treatment. J Foot Surg. 1992;31(4):332-41.
6. Elftman H. The force exerted by the ground in walking. Arbeitsphysiologie. 1939;10:485-91.
7. Buckley AR, Sands MC, Kabbash C. Hallux, proximal phalanx, diaphysis, simple [Internet]. Switzerland: AO Foundation; 2017. Available from: https://surgeryreference.aofoundation.org/orthopedic-trauma/adult-trauma/foot-phalanges/hallux-proximal-phalanx-diaphysis-simple.
8. Fitschen-Oestern S, Lippross S, Lefering R, Besch L, Klüter T, Schenzer-Hoffmann E, et al. Missed foot fractures in multiple trauma patients. BMC Musculoskelet Disord. 2019;20(1):121.
9. Roberts CS, Karam MD, Kellam JF. Fracture and Dislocation Classification Compendium-2018. J Orthop Trauma. 2018;32(Suppl1):S1-S170.
10. Ademoğlu Y, Ada S, Kaplan I. Should the amputations of the great toe be replanted? Foot Ankle Int. 2000;21(8):673-679.
11. Armagan OE, Shereff MJ. Injuries to the toes and metatarsals. Orthop Clin North Am. 2001;32(1):1-10.
12. Lindahl O. The rigidity of fracture immobilization with plates. Acta Orthop Scand. 1967;38(1):101-14.
13. Mittlmeier T, Haar P. Sesamoid and toe fractures. Injury. 2004 Sep;35 Suppl 2:SB87-97.
14. Salleh R, Beischer A, Edwards WH. Disorders of the hallucal interphalangeal joint. Foot Ankle Clin. 2005;10(1):129-40.
15. Chacon Y, Fallat LM, Dau N, Bir C. Biomechanical comparison of internal fixation techniques for the Akin osteotomy of the proximal phalanx. J Foot Ankle Surg. 2012;51(5):561-5.
16. Pirolo JM, Behn AW, Abrams GD, Bishop JA. Anterolateral versus medial plating of distal extra-articular tibia fractures: a biomechanical model. Orthopedics. 2015;38(9):e760-5.
17. Wajnsztejn A, Pires RES, Dos Santos ALG, Labronici PJ, Fernandes HJA, Ferretti M. Minimally invasive posteromedial percutaneous plate osteosynthesis for diaphyseal tibial fractures: technique description. Injury. 2017;48 Suppl 4:S6-S9.
18. Richter M, Gosling T, Zech S, Allami M, Geerling J, Droste P, Krettek C. A comparison of plates with and without locking screws in a calcaneal fracture model. Foot Ankle Int. 2005;26(4):309-19.
19. Nishikawa DRC, Duarte FA, de Cesar Netto C, Monteiro AC, Albino RB, Fonseca FCP. Internal fixation of displaced intra-articular fractures of the hallux through a dorsomedial approach: a technical tip. Foot Ankle Spec. 2017;11(1):77–81.