The Fate of Fracture Fragment in Diabetic Calcaneal Insufficiency Avulsion Fracture

Jeong-Hyun Park1,*, Kwang-Rak Park1,*, Gun-Hyun Park2, Jaeho Cho1,2

1Department of Anatomy & Cell Biology, School of Medicine, Kangwon National University
2Department of Orthopedic Surgery, Chuncheon Sacred Heart Hospital, Hallym University of Medicine

Abstract: Diabetic calcaneal insufficiency avulsion (CIA) fracture are unusual injury. The treatment may be challenging due to the low healing potential from diabetes or Charcot neuroarthropathy, so far. The poor surgical outcomes and surgical failures from treatment of the traumatic calcaneal avulsion fractures were associated with poor bone stock, lack of proper fixation, and the wound problem. Thus, the proper treatment for diabetic CIA fracture was still controversy. This report described two cases of diabetic CIA fracture treated with fixation of fracture fragment and calcaneal tenodesis. In both cases, fracture fragments were re-avulsed despite of fixation. Through investigation for the fate of fracture fragment from these cases, we discussed the proper treatment strategy in diabetic CIA fracture.

Keywords: Diabetes, Calcaneal insufficiency avulsion, Fracture, Fragment fixation

Introduction

Avulsion fractures of the calcaneal tuberosity are rare injuries, representing only 1.3% to 2.7% of all calcaneal fractures [1]. Particularly, calcaneal insufficiency avulsion (CIA) fracture associated with diabetes or Charcot neuroarthropathy (CN) is unusual and caused by repeated activity without significant trauma history [2,3]. Traditionally, diabetic CIA fractures have commonly been surgically treated with open reduction and internal fixation, in the same method as the traumatic calcaneal avulsion fractures. However, poor surgical outcomes and surgical failures were reported in these cases, due to the low healing potential related diabetes [4,5]. For these reasons, some authors have recently proposed the surgical technique with calcaneal tenodesis after excision of fracture fragment through revision surgery after experiencing the fixation failure [6]. Therefore, there is still no general consensus of appropriate treatment for diabetic CIA fractures. Herein, we reported two cases of diabetic CIA fracture treated with both fixation of fracture fragment and calcaneal tenodesis. In addition, we discussed not only the necessity of fracture fixation but also proper treatment strategy in diabetic CIA fracture.

Cases Report

Case I

A 53-year-old woman with type 2 diabetes mellitus for
over 15 years visited an outpatient clinic with complaints of spontaneously swollen heel during walking from 3 days ago. She had history of open reduction and internal fixation for distal tibio-fibular fracture 2 years ago. The patient denied any traumatic event and had no history of ulceration to the left foot. Glycated hemoglobin (HbA1c) was measured 7.4%. By physical examination, skin problem such as ecchymosis to compression by the fracture fragments was observed (Fig. 1A). The simple radiograph demonstrated about 1 cm upwardly displaced avulsed fragment of calcaneal tubercle (Fig. 1B). To prevent skin necrosis or soft tissue problem caused by a displaced bony fragment, emergent operation was performed. Using a posteromedial lazy J incision (Fig. 2A), an avulsion fracture fragment accompanied calcaneal tendon avulsed rupture were exposed at insertion site of calcaneal tendon (Fig. 2B). Using suture bridge technique of inserting two sutures anchors, the proximal sutures were passed through the calcaneal tendon with the avulsed bone fragment and the distal sutures were passed through the calcaneal avulsed tendon (Fig. 2C). Postoperative radiograph showed two suture anchors in situ and the fracture fragment in reduced position with calcaneal tenodesis (Fig. 2D). At three months, the patients was able to bear full body-weight without wound related complication (Fig. 3A) and radiograph showed no displaced fracture fragment, although sclerotic change was existed (Fig. 3B). At six months, the patient restored to normal gait, but complained skin irritation with focal infection at surgical wound. The radiograph showed re-displaced fracture fragment (Fig. 4A) and migrated fragment was immediately removed to prevent the progression of soft tissue problem due to skin tenting. On the latest follow-up visit at 25 months after initial operation, she showed good clinical outcomes with normal activities of daily living (Fig. 4B).
Case II

A 85-year-old woman with type 2 diabetes mellitus for over 25 years visited an emergency room with spontaneously heel pain during climbing a hill. The patient stated that she had no history of definite trauma event. Glycated hemoglobin (HbA1c) was measured 8.1%. On physical examination, skin ecchymosis to compression by the fracture fragments was observed. The preoperative radiograph demonstrated displaced avulsed fragment of calcaneal tubercle (Fig. 5A). The skin tenting was observed, and then operation was performed with calcaneal tenodesis and fixation of fracture fragment using screw (Fig. 5B). At 8 weeks, gentle range of motion exercises was encouraged without weight-bearing ambulation and full weight-bearing gait was permitted from postoperative 12 weeks. At postoperative three months follow-up, proximal migration of fixated fragment was identified with screw loosening on the radiograph (Fig. 5C), but patient had no significant problem. On the latest follow-up visit at nine months after initial operation, the radiographs demonstrated mal-union of fracture fragment and failure of fixation (Fig. 5D). The patient was able to walk on daily living, although weakness and fatigue were complained during walking.

Discussion

The neuropathic avulsion fractures of the calcaneal tuberosity were recognized as an insufficiency fracture, and often appeared in a patient with long-term diabetes mellitus [5]. In these patients, calcaneal insufficiency avulsion (CIA) fracture occurred without a history of significant trauma or overuse activities [3]. In the literatures review, diabetic CIA fractures were mostly treated by conventional surgical method for traumatic calcaneal avulsion fracture. However, diabetic CIA fractures were known to
have higher incidence of complications, such as loss of reduction, nonunion, mal-union and soft tissue problems (delayed wound healing or skin necrosis, wound infection, and skin irritation) than traumatic calcaneal avulsion fractures [5]. Thus, the proper surgical treatment for diabetic CIA fracture was still controversy.

The radiological finding of the diabetic CIA fracture is that the fracture line is parallel to the fused apophyseal growth plate, usually only compromising the superior calcaneal portion and extends distally to the calcaneal tendon insertion (Fig. 6A). Until now, a few authors defined the pathogenesis of diabetic CIA fracture around the fused apophyseal line in adults. Kim et al. [7] assumed that calcaneal fused apophyseal line was the weak point to failure due to various incomplete mixture of trabecular bone, woven bone and cartilaginous tissues, and may fail when the repeated tensile stress is imposed. In addition, it may not be possible to fix fracture fragment at calcaneal fused apophyseal line, considering poor bone quality related to diabetic condition and the inherent characteristics of fracture. Therefore, the authors believed that conservative treatment such as short leg cast should be considered as initial treatment for diabetic CIA fracture rather than surgical fixation.

However, the displacement of fracture fragment caused by the pull-out tension of the triceps surae could frequently induce the skin necrosis by increasing pressure overlying skin in diabetic CIA fracture. Although anatomical reduction and internal fixation of fragment would be essential to avoid this pitfall and to restore function of the triceps surae, the maintaining reduction for fragment after fixation was quite challenging. Due to skin irritation by fragment, fixations for avulsion fragment using suture anchor and cancellous screw were respectively tried for the two cases of diabetic CIA fracture at our institution. However, the fracture fragments were pulled out eventually in both cases.

Choi et al. [6] reported that the competent clinical outcome of three patients of diabetic CIA fracture initially...
REFERENCES

1. Lee SM, Huh SW, Chung JW, Kim DW, Kim YJ, Rhee SK. Avulsion fracture of the calcaneal tuberosity: classification and its characteristics. Clin Orthop Surg. 2012; 4:134-8.

2. Biehl WC, 3rd, Morgan JM, Wagner FW, Jr., Gabriel R. Neuropathic calcaneal tuberosity avulsion fractures. Clin Orthop Relat Res. 1993; 296:8-13.

3. Kathol MH, el-Khoury GY, Moore TE, Marsh JL. Calcaneal insufficiency avulsion fractures in patients with diabetes mellitus. Radiology. 1991; 180:725-9.

4. Khazen GE, Wilson AN, Ashfaq S, Parks BG, Schon LC. Fixation of calcaneal avulsion fractures using screws with and without suture anchors: a biomechanical investigation. Foot Ankle Int. 2007; 28:1183-6.

5. Yu SM, Yu JS. Calcaneal Avulsion Fractures: An Often Forgotten Diagnosis. AJR Am J Roentgenol. 2015; 205:1061-7.

6. Choi Y, Kwon YW, Sim YS, Kim T, Song D, Lee S. Achilles tenodesis for calcaneal insufficiency avulsion fractures associated with diabetes mellitus. J Orthop Surg Res. 2017; 12:192.

7. Kim ST, Moon MS, Kwon KT, Park BK, Ha CW, Ahn J. Calcaneal Insufficiency Avulsion Fracture in a Well-Controlled Type 2 Diabetic Patient: A Case Report. J Korean Foot Ankle Soc. 2015; 19:73-6.
당뇨병성 발꿈치뼈 찢김골절에서 골절조각의 운명

박정현*, 박광락*, 박근현, 조재호

1강원대학교 의학전문대학원 해부학교실, 2한림대학교 의과대학 춘천성심병원 정형외과학교실

간추림 : 당뇨병성 발꿈치뼈 찢김골절은 매우 드문 손상이며, 당뇨병 혹은 당뇨병성 신경병증에 의한 치유 능력의 저하로 치료가 어려운 것으로 알려져 있다. 이러한 골절에 대해 외상성 발꿈치뼈 찢김골절에서 시행되는 수술적 치료와 동일한 방법으로 치료하였을 경우, 낮은 뼈밀도, 부족한 고정력, 상처와 관련된 합병증으로 인하여 그 결과가 좋지 못한 것으로 보고되고 있다. 따라서, 당뇨병성 발꿈치뼈 찢김골절에 대한 적절한 치료는 아직까지 논란의 여지가 있는 실정이다. 이 연구는 당뇨병성 발꿈치뼈 찢김골절에서 골절조각의 고정 및 발꿈치뼈고정술을 동시에 시행하였던 두 증례를 기술하였고, 추적조사를 통해 고정된 뼈조각은 다시 찢김골절이 재발하였으나 발꿈치뼈고정은 잘 고정되어 유지되는 것을 확인하였다. 본 연구를 통해 당뇨병성 발꿈치뼈 찢김골절의 치료에서 골절조각의 해부학적 발생 병인을 고찰하고, 적절한 치료 방법에 대한 논의를 하고자 한다. 또한, 수술적인 치료가 필요한 경우 골절조각의 제거에 대한 임상적인 유용성을 논의하고자 한다.

 찾아보기 낱말 : 당뇨병, 발꿈치뼈, 찢김골절, 골절조각, 발꿈치뼈고정

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