

# The Fate of Fracture Fragment in Diabetic Calcaneal Insufficiency Avulsion Fracture

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**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 surgi-

cal 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.

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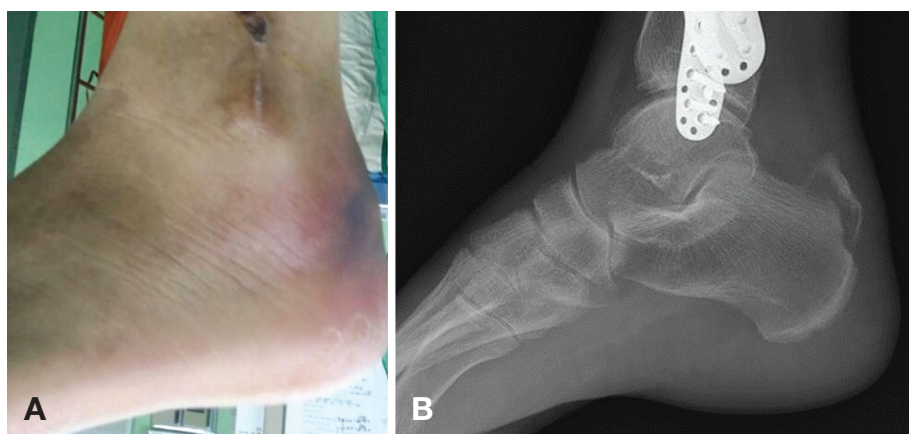
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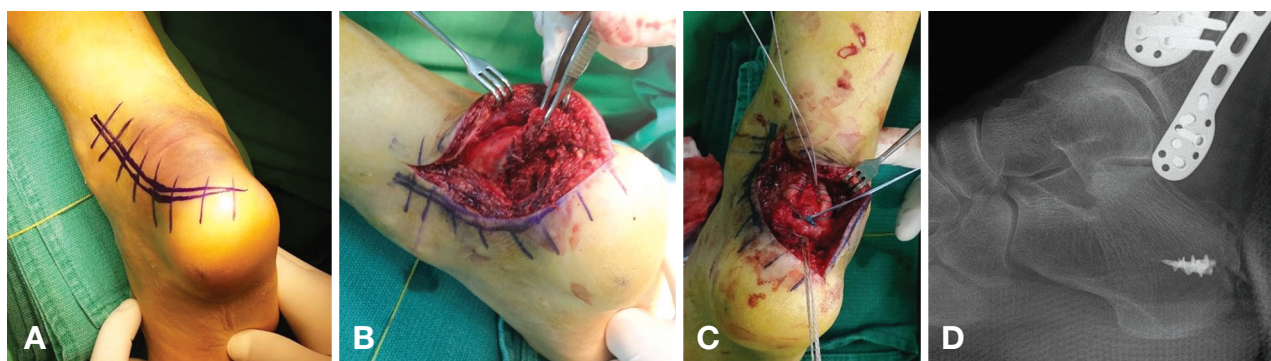
## Cases Report

### Case I

A 53-year-old woman with type 2 diabetes mellitus for



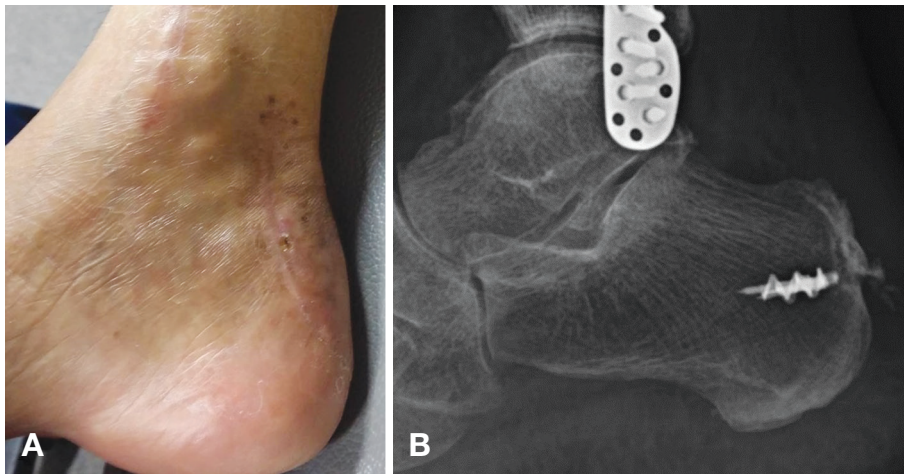
**Fig. 1.** A: Skin ecchymosis to compression by the fracture fragments, B: The simple radiograph showed about 1 cm upwardly displaced avulsed fragment of calcaneal tubercle.



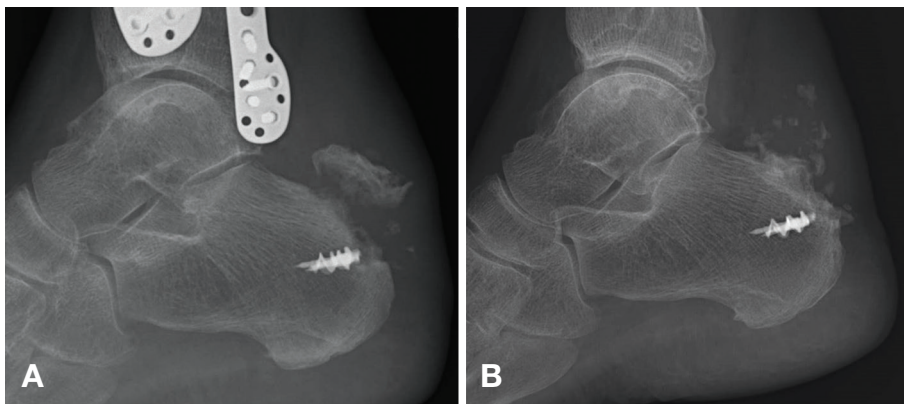
**Fig. 2.** A: Posteromedial lazy J incision, B: An avulsion fracture fragment and calcaneal tendon avulsed rupture were observed at insertion site of calcaneal tendon, C: The fragment and calcaneal tendon were both fixed using suture bridge technique, D: Postoperative radiograph showed two suture anchors in situ and the fracture fragment in reduced position with calcaneal tenodesis.

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).



**Fig. 3.** At postoperative three months. A: The recovery of skin problem by decreasing the compression pressure applied on the surgical site, B: Radiograph showed no displaced fracture fragment, although sclerotic change was existed.



**Fig. 4.** A: The radiograph at postoperative six months showed re-displaced fracture fragment, B: On the latest follow-up visit at 25 months after initial operation, the radiograph showed re-displaced fragment was removed.

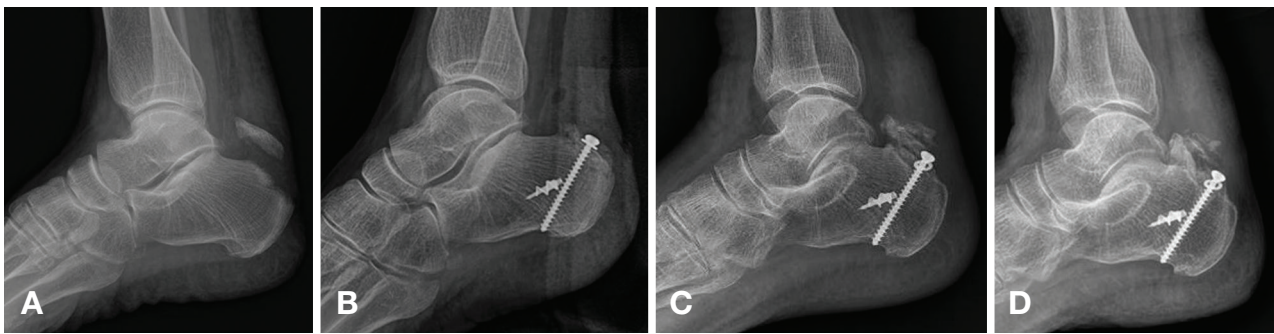
## Case II

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

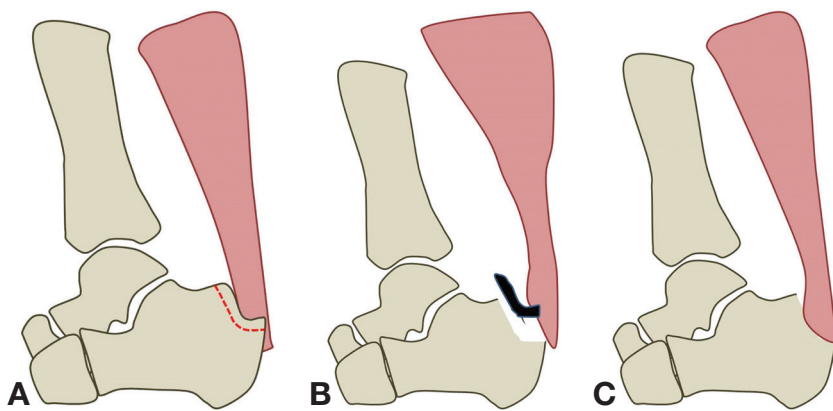
had no significant problem. On the latest follow-up visit at nine months after initial operation, the radiographs demonstrated mal-union of fracture fragment and failure of fixation (Fig. 5D). The patient was able to walk on daily living, although weakness and fatigue were complained during walking.

## 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



**Fig. 5.** A: The preoperative radiograph showed displaced avulsed fragment of calcaneal tubercle, B: Calcaneal tenodesis and fixation of fracture fragment using screw were performed, C: The radiograph at postoperative three months showed proximal migration of fixated fragment with screw loosening, D: On the latest follow-up visit at nine months after initial operation, the radiographs showed mal-union of fracture fragment and fixation failure.



**Fig. 6.** A: In diabetic calcaneal insufficiency fracture, fracture line (red dotted line) is parallel to the fused apophyseal growth plate, usually only compromising the superior calcaneal portion and extends distally to the calcaneal tendon insertion, B: Upward migration of an avulsion fracture fragment (black colored area) with calcaneal tendon avulsed rupture at insertion site of calcaneal tendon, C: Reattachment of calcaneal tendon (calcaneal tenodesis) after excision of the fracture fragment.

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

treated with calcaneal tenodesis after resection of the fragment on a short term follow-up. In our cases, initial calcaneal tenodesis using suture anchors was able to achieve direct fixation of the avulsed tendon to calcaneus. This procedure was considered to be possible for patients to perform daily activities by restoring function of the triceps surae, despite the occurrence of migration of the fracture fragment. Furthermore, in one case, re-displaced fragment was later removed due to skin irritation, but function of calcaneal tendon was maintained. Therefore, the authors suggested that fixation of the fracture fragment may not be necessary in patients with the diabetic CIA fracture who are in need of surgical treatment due skin problems and it is more appropriate to perform calcaneal tenodesis after removal of fragment (Fig. 6B and 6C).

In conclusion, the anatomical pathogenesis of the diabetic CIA fracture makes the fixation for these fractures more difficult. The present study demonstrated that fracture fragments in diabetic CIA fracture were likely to be re-displaced by fixation failure, which provides inherent advantage to the calcaneal tenodesis of diabetic CIA fracture. We believe that calcaneal tenodesis and excision of fracture fragment would be appropriate treatment strategy to prevent further sequelae, if surgical treatment was inevitable due to skin problem by fragment in diabetic CIA fracture.

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## 당뇨병성 발꿈치뼈 찢김골절에서 골절조각의 운명

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**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 발꿈치힘줄고정술을 동시에 시행하였던 두 증례를 기술하였고, 추적조사를 통해 고정된 뼈조각은 다시 찢김골절이 재발하였으나 발꿈치힘줄은 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, 발꿈치힘줄

\*공동 제1저자로서 동등한 역할을 수행하였음.

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