Calcaneal Insufficiency Avulsion Fracture in a Well-Controlled Type 2 Diabetic Patient: A Case Report

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The calcaneal insufficiency avulsion fracture usually occurs in an area of fused apophysis in adults without significant history of trauma or overuse activities. It is an uncommon injury which has been described in patients with complications of diabetes, Charcot neuroarthropathy, amyloidosis with neuropathy, severe osteoporosis, and other conditions. Discussion of the issue of fracture location is still not sufficient. We report on a case of a 50-year-old male who experienced a non-traumatic diabetic calcaneal insufficiency fracture. Intraoperatively, a biopsy specimen was obtained from the exposed fracture site for histological study. We assume that the calcaneal fused apophyseal line is the weak point of failure due to various incomplete mixtures of trabecular bone, woven bone, and cartilaginous tissues, and may fail when repeated tensile stress is imposed.

Key Words: Diabetes mellitus, Calcaneus, Insufficiency fracture

CASE REPORT

A 50-year-old type 2 diabetic patient visited an outpatient clinic with complaints of spontaneously swollen heel. After light jumping exercise, negligible discomfort developed three days prior to the visit. His height and weight were 165 cm and 55 kg. He had no history of total hip/knee joint arthroplasty, self-indulgence, and heavy labor. He could continue routine daily work without any difficulty. Diagnosis of diabetes mellitus was confirmed 22 months ago at another clinic. Diabetes was well-controlled by metformin monotherapy. Glycated hemoglobin (HbA1c) was measured 6.4% preoperatively. During the period of hospitalization, average blood glucose level was 126.3 mg/dL (range, 80-182 mg/dL). The clinical evidence of diabetic neuropathy or sensory deficit of foot and ankle were not confirmed.

By physical examination, swollen heel was identified, but there were no ecchymosis, localized tenderness, and palpable gap in the heel cord. The mid-calf circumference was 34 cm bilaterally. Functional loss of the triceps surae complex resulted in a calcaneal gait. On the simple radiograph, about 1.5 cm upwardly displaced large avulsed fragment of calcaneal tubercle was observed. Additionally, another sclerotic insufficiency avulsion fracture was combined which slipped upwardly parallel to the fused apophyseal line (Fig. 1). Preoperative American Orthopaedic Foot and Ankle Society (AOFAS) hindfoot score was 88 point.

The operation was performed under spinal anesthesia. In the prone position, avulsed fragment was reduced and fixed with cannulated screws, cerclage wiring and nonabsorbable sutures (Fig. 2). A biopsy specimen was obtained from the exposed fracture site for histological study. We assumed that the calcaneal fused apophyseal line is the weak point of failure due to various incomplete mixtures of trabecular bone, woven bone, and cartilaginous tissues, and may fail when repeated tensile stress is imposed.

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Fragmented bone trabeculae, hemorrhage, necrosis and few chronic inflammatory cells were noted (Fig. 3).

Postoperatively, immobilization in a short leg cast was continued for six weeks. Twelve weeks of non-weight-bearing crutch ambulation was followed by full weight-bearing. At postoperative four months follow-up, about 9 mm proximal migration of fixated fragment was identified, but patient had no significant problems. Eleven months after surgery, all hardware and migrated fragment were removed. At the final follow-up, the patient showed full recovery. Range of ankle motion was the same as compared to the opposite side with dorsiflexion 20° and plantar flexion 50°. Ankle plantar flexion power was checked to be grade five. Final AOFAS hindfoot score was 95 point.

**DISCUSSION**

Calcaneal insufficiency avulsion fracture is uncommon injury which has been described in patients with diabetes, Charcot neuroarthropathy, amyloidosis with neuropathy, and severe osteoporosis. High occurrence of the calcaneal avulsion fracture in patients who had undergone renal transplantation was reported. Miki et al. reported five cases of calcaneal stress fractures in pos-
There have been no plausible explanation why in some diabetic patients develop Charcot neuroarthropathy with tarsal disintegration combined with insufficiency avulsion fracture of posterior tubercle and fused apophysis of calcaneus. Diabetes mellitus affects the various organs and tissues such as nerve, vessel, tendon and bones; thus it can lead to neuropathy, atherosclerosis, tendinopathy, and so on. It can be followed by various pedal complications including ulceration, tissue necrosis, infection, neuropathic joint and spontaneous bony dissolution. Also skeletal fragility can be increased in diabetes with various factors. Generally, fracture risk is increased in both type 1 and type 2 diabetes mellitus. Also disease related complications increase the fracture risk by increasing risk of falls and causing regional osteopenia. Diabetic neuropathy can lower cortical bone mass in the distal limbs compared with those without neuropathy. There are some differences in the mechanisms by which skeletal fragility is increased in type 1 and type 2 diabetes mellitus, Factors including regional osteopenia, increased fall risk, decreased bone quality, specific disease treat-
ment modality (e.g., thiazolidinediones) are known as the causes of increased skeletal fragility in type 2 diabetes mellitus.6) Higher incidence of fractures in the elderly and diabetics are known to be due to abnormal cross-link formation of the collagen which reduce pliability and contracture of the motor unit secondary to the altered glycation.2,8) Generally, the altered carbohydrate metabolism in diabetics exerts effect on collagen cross-linking and collagen isomerization in cancellous and cortical bone, and such changes are determined by the degree of turn-over suppression in bone. Bone matrix is the structured composite consisting of a protein phase and a mineral phase. Mineral phase provides the stiffness and the collagen fibers provide the ductility and the ability to absorb energy (i.e., toughness).9) Glycation of bone tissue has been shown to make bone more brittle with decrease in the deformability of bone before fracture. Histologic finding showed that hyaline cartilaginous chondrocytes were arranged in small clusters surrounded by large amounts of moderately violescent stained bone matrix and abnormally oriented trabecular bone mixed with woven bones. It is indicative of various osteopathies and healing process and incomplete ossification and calcification in insufficiency fracture area.

Osteopenia and altered cross-linking of bone collagen in diabetics create thin cortical and cancellous bones which may not be able to resist severe tension at the tendon attachment, and therefore a segment of bone may be pulled off by tendon during sudden triceps muscle contraction. We assume that calcaneal fused apophyseal line is 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. We hope the hypothesis being supported by further studies in the coming years.

REFERENCES