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CASE REPORT

Spontaneous calcaneal fracture in patients with diabetic foot ulcer: Four cases report and review of literature

Mehtap Evran, Murat Sert, Tamer Tetiker, Gamze Akkuş, Ömer Sunkar Biçer

Mehtap Evran, Murat Sert, Tamer Tetiker, Gamze Akkuş, Department of Internal Medicine, Division of Endocrinology, Cukurova University Medical Faculty, University of Cukurova in Adana, 01330 Adana, Turkey

Ömer Sunkar Biçer, Department of Orthopedics and Traumatology, Cukurova University Medical Faculty, University of Cukurova in Adana, 01330 Adana, Turkey

Author contributions: Evran M, Sert M and Tetiker T performed and designed the research, and followed and treated of the patients; Evran M and Akkuş G researched data; Bicer ÖS contributed that followed, debridement or operated of the patients; Evran M, Sert M and Tetiker T wrote the paper; all authors approval final paper.

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Correspondence to: Mehtap Evran, MD, Assistant Professor, Endowed of Endocrinology, Department of Internal Medicine, Division of Endocrinology, Cukurova University Medical Faculty, University of Cukurova in Adana, Sarıçam, 01330 Adana, Turkey. mehtap.evran@hotmail.com
Telephone: +90-532-7818634
Fax: +90-322-3386879

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Abstract

Spontaneous calcaneal fractures in diabetic patients without obvious trauma may occur, sometimes accompanying diabetic foot ulcers. In the current study we report four cases who were hospitalized for diabetic foot ulcer with concomitant calcaneal fractures. There were four diabetic patients (one type 1 and three type 2) who registered with diabetic foot ulcers with coexisting calcaneal fractures, all of which were classified as Type A according to Essex Lopresti Calcaneal Fracture Classification. Two of the patients with renal failure were in a routine dialysis program, as well as vascular compromise and osteomyelitis in all of the patients. The diabetic foot ulcer of the 61 years old osteoporotic female patient healed with local debridement, vacuum assisted closure and then epidermal growth factor while the calcaneal fracture was then followed by elastic bandage. In two patients could not prevent progression of diabetic foot ulcers and calcaneal fractures to consequent below-knee amputation. The only patient with type 1 diabetes mellitus improved with antibiotic therapy and split thickness skin grafting, while the calcaneal fracture did not heal. In the current study we aimed to emphasize the spontaneous calcaneal fractures as possible co-existing pathologies in patients with diabetic foot ulcers. After all the medical treatment, amputation below knee had to be performed in 2 patients. It should be noted that other accompanying conditions such as impaired peripheral circulation, osteomyelitis, chronic renal failure, and maybe osteoporosis is a challenge of the recovery of calcaneal

fractures and accelerate the progress to amputation in diabetic patients.

Key words: Diabetes mellitus; Foot ulcer; Calcaneal fracture

Core tip: Spontaneous calcaneal fractures may occur without any trauma in diabetic patients, sometimes accompanying diabetic foot ulcers. In the current study we report four cases who were hospitalized for diabetic foot ulcer with concomitant calcaneal fractures. Despite all treatment applied, amputation below knee had to be performed in 2 patients. It must be remembered that spontaneous calcaneal fracture may develop in patients with diabetic foot ulcer and this condition may lead to amputation earlier.

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INTRODUCTION

Diabetes mellitus is a chronic systemic disease which may cause vascular, infectious and neuropathic problems together with bone and joint problems. Spontaneous calcaneal fractures may occur without any trauma in diabetic patients[1]. The incidence of calcaneal fractures are reported to be 11.5/100000 annually by Mitchell *et al*[2]. Extra-articular calcaneal fractures which don't involve the posterior articular surface of the calcaneus or the subtalar joint consist as 25%-30% of all the calcaneal fractures[3]. Open calcaneal fractures in diabetic patients may be complicated with infection, osteomyelitis and with consequent amputation[4]. We aimed to report our four cases to emphasize co-existing calcaneal fractures in diabetic patients with diabetic foot ulcers (DFU).

CASE REPORT

Case 1

Sixty-one years old female patient was 55 kg in weight. She entered menopause 11 years ago, and had diabetes mellitus (DM) and hypertension for 12 years. Addiotinally, she had diabetic neuropathy and retinopathy. She was also treated for osteoporosis, glucose regulation and hypertension including alendronate plus vitamin D, valsartan, lercanidipine, human regular insulin, insulin glargine and acetylsalicylic acid. She was hospitalized for pain on her right heel, with endurance around a fissure. She developed a 3 cm × 4 cm DFU with necrosis at the end of thirty days. A calcaneal fracture was diagnosed on her lateral foot

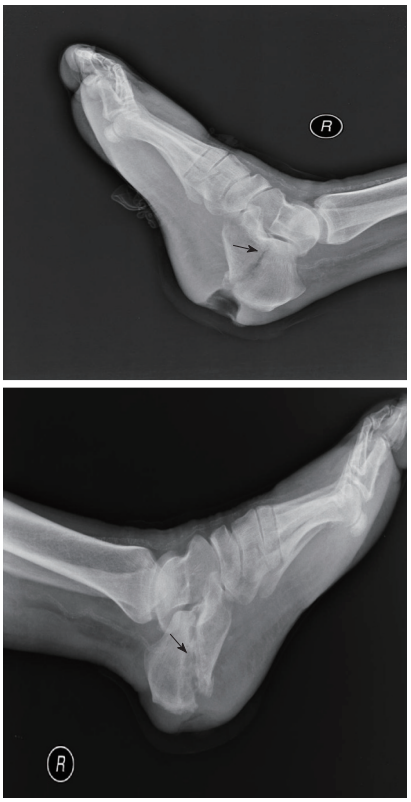

Figure 1 Type A fracture according to Essex-Lopresti Calcaneal Fracture Classification in Case 1 and progression of the type A fracture of Case 1 was observed compared to baseline.

X-ray (Figure 1). Her laboratory data are presented in Table 1. Intensive insulin therapy, antihypertensive therapy and empirical antibiotherapy for her infected DFU were applied. The antibiotherapy was changed after isolated microorganism in the antibiogram. Vacuum assisted wound closure (VAC) therapy was applied after the local debridement of the necrosis, as decided by the multidisciplinary diabetic foot care council of the institute. Bone marrow sampling was made to rule out multiple myeloma due to anemia and high erythrocyte sedimentation rate. Twice debridement performed and VAC therapy was continied due to the wound did not improved. There were numerous calcified or soft atheroma plaques seen in the dynamic computed angiogram of lower extremity with no significant stricture indicating revascularization. Epidermal growth factor was applied after the soft tissue infection was treated. The patient was discharged her foot wrapped by an elastic bandage although the fracture was minimally displaced (Figures 1). The wound on the heel was healed, but the calcaneal fracture resulted in non-union at the latest follow-up.

Case 2

Fifty-one years old female patient was 62 kg in weight hospitalized for DFU. She entered menopause 5 years ago, and had type 2 DM, hypertension, heart failure for 17 years, chronic renal failure (CRF) treated with dialysis for 2 years. She was using some drugs

Table 1 Laboratory results of the patients at the admission

	Hb	WBC	CRP	ESR	HbA1c	ALT	Creatinin	Sodium	Potassium	Total calcium	PTH
Case 1	10.8	11900	2.6	96	89	15	1.2	121	5.2	2.35	67
Case 2	8.7	13200	5.9	95	86	17	5.8	131	5.8	2.15	180
Case 3	8	17200	25	110	88	13	1.9	131	4.2	2.15	138
Case 4	9.1	13400	17.7	120	76	45	1.25	131	5.1	2.27	70

Hb: 11.6%-15.7%; WBC: 4.070-12300 μL; CRP: 0-0.8 mg/dL; ESR: 0-20 mm/h; HbA1c: 4%-6% (20-42 mmol/mol); ALT: 14-54 U/L; Creatinin: 0.4-1 mg/dL; Sodium: 136-144 mmol/L; Potassium: 3.6-5.1 mmol/L; Calcium: 2.22-2.57 mmol/L; PTH: 12-88 pg/mL; 25(OH)D3: 10-60 ng/mL. Hb: Hemoglobin; WBC: White blood cell; CRP: C-Reactive protein; ESR: Erythrocyte sedimentation rate; HbA1c: Glycosylated hemoglobin; PTH: Parathyroid hormone.

Figure 2 Type A fracture according to Essex-Lopresti Calcaneal Fracture Classification in Case 2.

including insulin glargine, insulin aspart, acetylsalicylic acid, sevelamer hydrochloride and darbepoetine alpha for her diseases. She had DFU for three months, and referred to our hospital. She had bilateral distal symmetrical polyneuropathy, hyperpigmented areas on her anterior tibial skin, and a necrotic wound under her right heel. There was a type A calcaneal fracture on the lateral X-ray of her right foot (Figure 2). Angiography of the lower extremity demonstrated diffuse stenosis in the bilateral anterior tibial arteries and tibiofemoral truncus at infrapopliteal level. The patient, who also received hyperbaric oxygen therapy as supportive therapy, underwent balloon dilatation of the stenotic arteries at the department of interventional radiology because of the progression of ischemia in the right heel. However, this procedure failed and the right below-knee amputation was performed.

Case 3

Fifty-year old male patient was 65 kg in weight who presented with DFU and high blood glucose level was hospitalized. His medical history revealed irregular insulin use for type 1 DM for 35 years, CRF, and heart failure. He was treated with insulin aspart, insulin glargine, furosemide, pregabaline, isosorbide monohydrate. He was smoking 20 pack/year during 30 years. His physical examination was unremarkable except for necrotic ulcerations in both heels and in the right knee. The color doppler ultrasonography (CDUS) of the lower extremity demonstrated obstruction in the right arteria dorsalis pedis, and type A fracture was determined on the plain foot radiograph (Figure 3). Empirical antibiotic therapy was started, and deep tissue culture sample was obtained by means of debridement of the both heels. Antibiotic therapy was modified based on the results of the culture. Foot MRI demonstrated osteomyelitis involving bilateral calcaneus and the left talus. Culture of the wound sample was repeated because of repeated wound discharge that occurred while planning graft for the patient who showed clinical and laboratory improvement, and the antibiotic was changed. The patient, who was clinically stable, was discharged recommending coming for control visits at the policlinic. During control visits, graft was performed for the foot ulcers, but calcaneal fracture remained stable.

Case 4

Forty-nine years old male patient 80 kg in weight was hospitalized for ulceration in the anterior surface of both tibia bones and in the left heel. His medical history revealed type 2 DM for 18 years, coronary angiography and stent implantation for recurrent myocardial infarction. He was using some drugs including insulin glargine, insulin aspart, prasugrel and atorvastatin calcium for his diseases. Deep tissue culture sample was obtained by means of the debridement of bullous tissues, which was performed by plastic and reconstructive surgery (PREC), due to the difficulty in wearing shoes for the last 10 d because of the problem in the left heel and subsequent ulceration in the same area. Determining plaques, multifocal stenosis and occlusions were found on CDUS of the arteries of lower extremity and angiography was planned. On his physical examination, there were 1 cm × 4 cm lesions on the anterior surface of the left and right tibia, and there was a 10 cm × 5 cm lesion with necrotic basis in the left calcaneal region. Intensive insulin therapy was started together with ongoing antibiotic therapy. Type A fracture was determined on the plain radiography of the left foot (Figure 4). Vascular flow was enabled by implanting stent in the arteries with stenosis and occlusions determined on the angiography of the lower extremity. Thereafter, antibiotic therapy was modified according to the result of wound culture and the necrosis extending from the lateral aspect of the left foot to the calcaneus which was debrided by PREC. He was followed at the department of infectious diseases because of the growth of *Acinetobacter boumannii* and

Figure 3 Type A fracture according to Essex-Lopresti Calcaneal Fracture Classification of Case 3.

Figure 4 Type A fracture according to Essex-Lopresti Calcaneal Fracture Classification of Case 4.

Klebsiella pneumonia in the wound culture. In foot-ankle MRI demonstrated osteomyelitis and soft tissue inflammation and suppuration. Since the patient did not accepting the amputation, wound debridement was done again and IV antibiotherapy was continued. He was followed up like this for approximately 2 mo. In the control MRI, findings of osteomyelitis persisted and wound healing was not seen; therefore amputation of leg below knee was performed, after the patient's consent.

DISCUSSION

DFU is a morbid complication leading to extremity amputation and requiring long-term hospitalization. Although neuropathy is the major parameter in the etiology of DFU, peripheral vascular disease (PVD), foot deformities and infections can also be considered as important factors[5]. Herein, we aimed to review spontaneous calcaneal fractures together with the symptoms of the patients presented with DFU, in which we determined calcaneus fracture.

In general, calcaneal fractures are the most common form of tarsal fractures and account for approximately 60% of these fractures and 1%-2% of overall fractures[6]. Monitoring of calcaneus fractures in diabetic patients is more difficult and important as compared to non-diabetic patients with calcaneus fracture. Factors such as decreased bone mineral density (BMD), CRF, secondary hyperparathyroidism, avascular necrosis, cigarette smoking, drugs that are likely to pose a risk for fracture (glitazones, corticosteroids, *etc.*) and malnutrition may lead to spontaneous calcaneus fracture in these patients[7]. Different from type 2 DM, although decreased BMD in type 1 DM is associated with loss of islet cell peptides (insulin or amylin), which play important role in bone formation, it has been determined that the risk of fracture is similar in both types of diabetes[8]. Of our patients, 3 had type 2 and one had type 1 DM. Patient with type 1 diabetes (case 3) had poor glycemic control, poor peripheral vascular circulation, and heart failure and have been undergoing routine dialysis because of CRF. Osteomyelitis was determined in the patient presented with ulcerations in both heels and calcaneus fracture. It is thought to contribute a reduction in BMD that insulin deficiency in patient. Other three patients had type 2 DM with osteomyelitis, and calcaneus fracture developed on the basis of DFU in addition to the complications such as CRF and PVD. In these three patients developed hyperparathyroidism secondary to CRF, and to be easily developed osteomyelitis due to PVD may also cause spontaneous calcaneal fractures. Only case 4 had a history of smoking. Also the drugs of all patients used previously did not lead to a risk of osteoporosis. Additionally, the patients did not have any avascular necrosis in the MRI.

Charcot neuropathy is the other problem likely to cause spontaneous fractures in diabetic patient group. The use of immunosuppressive agents such as corticosteroids for kidney and/or pancreas transplantation appears to be a probable cause of high incidence of Charcot foot in diabetic patient group[8,9]. It has been reported that presence of advance glycation end products, reactive oxygen species, oxidized lipids and RANKL expression play a role in the development of neuropathy and osteopenia in type 2 diabetes[10]. Likewise, it was observed that local inflammation as well leads to neuropathy and osteopenia by a mechanism similar to that of RANKL expression. A study reported osteoprotegerin-associated polymorphism, which was then considered to cause osteopenia[11]. The signs of Charcot foot were not present in any of our patients. Although a patient had osteoporosis, presence of osteoporosis or osteopenia could not be excluded because BMD measurement has not been performed in other patients.

Calcaneal fractures are the most prevalent type of stress fractures. The basic information required in evaluating the type and location of fracture in detail in a patient with calcaneal fracture is the anatomy of calcaneus, which is partially complicated. This is also important for determining treatment method and predicting prognosis. Calcaneus is in the form of massive cancellous bone tissue surrounded by relatively thin cortex to the weight it bears, which is partially thicker

in the posterior half[12]. The position of foot during injury, intensity of the force-components of force include compression, angling and shearing- and the quality of bone mass determine the anatomical shape of fracture. The majority of calcaneal fractures occurs by abnormal stress loaded onto the normal bone as in the inductee[13], but it may also result from high-energy trauma with sudden load as in the traffic accidents or fall from high places (don juan fractures)[12]. Whereas calcaneal insufficiency avulsion (CIA) fracture is as fatigue-type calcaneal fracture and usually it develops in the posterior tuberosity of calcaneus. This type of fracture was associated with longer duration of DM[14]. None of our patients with calcaneal fracture had the history of trauma and may be in our patients could be improved as CIA-type fracture. It should be noted that the duration of DM of our patients is long and these patients are exposed to recurrent traumas because of loss of sensation and deformities due to neuropathy[1,4,15]. Furthermore, fractures become more complicated and may lead to amputation because of infection, osteomyelitis and impaired peripheral circulation, which are the consequences of delayed diagnosis of calcaneal fracture due to loss of sense[16].

Approximately in 2/3 of the patients with DFU develops osteomyelitis. Osteomyelitis should definitely be excluded especially from a chronic, non-healing and deepened wound. The osteomyelitis may be diagnosed by reaching the bone with a prob at the ulcer base in open wounds[17,18]. In last decade, MRI method is prefered for its non-invasive and easy application in osteomyelitis diagnosis and it has specificity above 90% in diagnosis[19]. Treatment of the patient with a diabetic foot infection and underlying osteomyelitis is difficult. The patients require hospitalization, intravenous antibiotic therapy, and urgent operative intervention may ultimately prevent the spread of infection or major limb amputation[20]. Furthere more, osteomyelitis of calcaneus is a condition difficult to treat. Calcaneus is a cancellous bone which forms never involucrum but rarely isolated sequestrum. In the calcaneal osteomyelitis, the pus causes destruction by directly perforating the periosteum without impairing its own cortex[21,22].

The first step in radiological evaluation of the patients with calcaneus fracture should be antero-posterior, lateral and oblique radiographies of the foot and axial radiography of the calcaneus[14]. Detailed analysis by computed tomography (CT) is mandatory in the event of suspicious intra-articular calcaneal fracture on radiographs. CT is beneficial in explaining the problems that the patient might face during preoperative period, in deciding to perform surgical fixation or primary fusion, or in deciding reduction during surgery. Detailed analysis of the data on CT sections about intra-articular fractures can be done according to the Sanders classification[23,24]. In the present study, we evaluated the fractures according to the Essex-Lopresti method, which classifies the fractures taking the plane radiography into consideration, and type A fracture was determined in all patients[25].

In the calcaneal fractures, involvement of the joint surfaces, particularly the posterior surface, is the major factor that directs the treatment and affects the prognosis. Considering that the incidence of wound complications was high, many surgeons have begun to use minimal invasive methods in the treatment[26]. Therapeutic methods in calcaneal fractures include conservative, open reduction and internal fixation, minimal open reduction and internal fixation, and primary subtalar arthrodesis[12,23,24].

In our clinic, initially antibiotherapy, wound care, local wound debridement when needed and VAC therapy were applied to the patients with DFU and spontaneous calcaneal fracture.

However, below-knee amputation had to be performed in two patients because of impaired peripheral circulation, osteomyelitis and the presence of comorbid conditions. In the other two patients, calcaneus fracture was stable although foot ulcer has been improved.

The DM-related comorbidities and vascular issues are much more strongly associated with the risk of amputation in DM patients, including those who experience a spontaneous calcaneal fracture.

COMMENTS

Case characteristics

The authors report four cases who were hospitalized for diabetic foot ulcer with concomitant calcaneal frantures.

Clinical diagnosis

There were four diabetic patients (one type 1 and three type 2) who registered with diabetic foot ulcers with coexisting calcaneal fractures, all of which were classified as Type A according to Essex Lopresti Calcaneal Fracture Classification.

Differential diagnosis

Osteoporosis associated franctures, traumatic fractures.

Imaging diagnosis

In X-ray imaging were showed Type A fractures according to Essex Lopresti Calcaneal Fracture Classification.

Treatment

Amputation below knee had to be performed in 2 patients. The other two patients are followed by the nonsurgical methods.

Related reports

It is the most prevalent type of stress fractures,

Peer-review

The paper is well-written.

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