



## Original article

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**Traumatic partial hindfoot amputation with injury to the posterior tibial artery**

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**Abstract**

**Introduction** Talus and calcaneus fractures account for about 2 % of skeletal injury and 70 % of the foot fractures. Open fractures of the hindfoot are diagnosed in 30 %. More than half of the injuries are graded as type III according to classification of R.B. Gustilo, J.T. Anderson (1976). Injury to the posterior tibial artery is observed in 6.4 % of patients. Amputations resulting from an osseous-vascular injury and gangrene and crushed soft tissues are observed in 3-60 %. The **objective** was to demonstrate a rare clinical case of traumatic partial hindfoot amputation on the right side associated with open calcaneus and talus fracture and injury to the posterior tibial artery and resulted in a good outcome. **Material and methods** A clinical case of a 36-year-old patient who suffered a traumatic partial hindfoot amputation and injury to the posterior tibial artery. **Results** Restoration of the anatomy and the function of the right foot was achieved in the patient. **Discussion** There are no clinical guidelines and a unified classification for bone and vascular injuries and no universal method for the treatment of a combined injury including an open fracture of bones and injury to blood vessels. The choice of treatment modality, diagnosis of osteovascular injuries are produced on an individual basis depending on the external and internal factors affecting the injuries. An angiotraumatological approach used to treat the patient with the hind foot injury on the right included early primary surgical treatment of the osteovascular injury, accurate reduction and stable fixation using a sparing technique for the calcaneus, repair of the posterior tibial artery, complex drug therapy to improve blood rheology, reduce coagulability, address tissue ischemia and provide adequate regional anesthesia. **Conclusion** The combination of factors and use of an angiotraumatological approach employing organ sparing strategy and a multidisciplinary team of orthopaedic and trauma surgeons, angiosurgeons, anesthesiologists-resuscitators facilitated foot salvage, improved function and supportability.

**Keywords:** combined osteovascular injury, open fracture of the calcaneus, injury to the posterior tibial artery

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## INTRODUCTION

Talus and calcaneus fractures account for about 2 % of skeletal injury and 70 % of the foot fractures [1, 2]. Injury severity and complications are associated with an increased risk of permanent disability [3]. Open fractures of the hindfoot are diagnosed in 30 % [4]. These are high-energy injuries resulting from traffic accidents and falls from a height [2, 4, 5, 6]. Treating open calcaneal fractures remains challenging [7, 8]. More than half of open hindfoot injuries are type III as classified by R.B. Gustilo, J.T. Anderson (1976) [4]. They are accompanied by injury to the posterior tibial

artery in 6.4 % of patients [9]. Vascular injury is a severe trauma associated with the development of complications (47.8 %) including pyosis of the postoperative wound, thrombosis of the repaired vessel and death (7.3-24 %). Limb amputations resulting from an osseous-vascular injury and gangrene and crushed soft tissues are observed in 3-60 % [10]. The objective was to demonstrate a rare clinical case of traumatic partial hindfoot amputation on the right side associated with open calcaneus and talus fracture and injury to the posterior tibial artery and resulted in a good outcome.

## MATERIAL AND METHODS

A 36-year-old man received an industrial injury at a sawmill on October 29, 2020 stepping on a band saw to saw wood and injured his right foot. He was delivered to a district hospital by an ambulance team in the Arkhangelsk region and examined by a surgeon. His condition was rated as medium severity on admission. There was no operating facilities and anesthesia, no anesthetist-resuscitator at the hospital, and the wound on the right foot was treated with an antiseptic solution, pressure bandage used to control

hemorrhage, 1g cefazolin solution injected intravenously, and transport immobilization of the foot performed with a Cramer splint. Five hours after the injury the patient was transported to the emergency department of the Arkhangelsk Regional Clinical Hospital with a diagnosis of traumatic amputation of the right calcaneus and class I hemorrhagic shock. He was examined by a trauma surgeon on call, anesthesiologist-resuscitator and transported to the operating room for therapeutic and diagnostic manipulations.

## Case report

The patient presented with pain in the right foot on admission. He had no comorbidities and smoking habits. His condition was rated as severe and stable. He was conscious, oriented in place and time. The skin was pale. Blood pressure measured 100/60 mm Hg. His pulse was 94 beats per minute. A gauze pressure bandage abundantly soaked with scarlet blood was removed from the right foot. An extensive flapped lacerated wound with irregular edges was seen on the plantar surface of the right foot (Fig. 1). The foot was seen through from the bottom up as a “beak” being open to the plantar surface. Fragments of the calcaneus, plantar aponeurosis, the ends of the injured tendon of the posterior tibial muscle, and thrombosed ends of the posterior tibial artery were seen in the wound. A calcaneal fragment at the Achilles tendon was attached to the the proximal skin-tendon flap with the base of 7 cm wide. Moderate venous-arterial diffuse bleeding from damaged tissues was noted. The foot was warm to the touch. A lateral radiograph of the mid- and hindfoot on the right side performed in the operating room on admission showed an intra-articular displaced fracture of the right calcaneus, a marginal fracture of the talus with displaced fragments (Fig. 2).

CBC dtd October 29, 2020: erythrocytes  $4.1 \times 10^{12}/L$ , hemoglobin 128 g/l, leukocytes  $5.8 \times 10^9/L$ , hematocrit 23.3 %, platelets  $275.0 \times 10^9/L$ . Surgery performed under combined spinal-epidural anesthesia in the supine

position included replantation of the hindfoot on the right side as primary surgical treatment of an open calcaneus and talus fracture on the right side, reanastomosis of the posterior tibial artery, open reduction of the calcaneus fracture, metal osteosynthesis with cannulated screws and washers using image intensifier. About 6 liters of antiseptic solutions were used to wash the wound; blood clots, small pieces of cartilaginous tissue of the calcaneus and posterior process of the talus were removed. Non-viable tissue were excised. Calcaneal fragments were refreshed, reduced and temporarily fixed transcutaneously with Kirschner wires using image intensifier. An angiosurgeon on call was invited to the operating room. The ends of the injured posterior tibial artery were exposed. Thromboextraction was performed from the proximal and distal ends of the artery, satisfactory antegrade and retrograde blood flow was ensured. End-to-end reanastomosis of the posterior tibial artery was performed (Fig. 3). The distinct pulsation provided. Four cannulated spongy screws and washers were employed to fix the calcaneus fracture perpendicular to the fracture plane with the help of guide pins, 4 skin punctures at the calcaneal tubercle (Fig. 4) and an image intensifier. A polyprojective X-ray of the right foot showed satisfactory realignment of the foot fragments with the Behler angle being positive (Fig. 5). The wires were removed.



**Fig. 1** Preoperative appearance of the wound



**Fig. 2** Preoperative lateral radiograph of the right foot



**Fig. 3** Intraoperative appearance of the wound after reconstruction of the posterior tibial artery



**Fig. 4** Control intraoperative radiograph of the right foot (lateral view) after open reduction and fixation with Kirschner guide wires of the calcaneus



**Fig. 5** Postoperative radiograph of the right foot (lateral view)

The injured tendon ends of the posterior tibial muscle were sutured using the Rozov-Vodyanov technique, and hemostasis controlled. The wound was drained with gloving transversal drainage and sutured in layers with a Vicryl Plus antibacterial thread (Fig. 6). Aseptic bandages applied. Plaster cast was applied to the right foot and the tibia. The operating time was 120 minutes. Intraoperative blood loss was 400 ml.



**Fig. 6** Postoperative appearance of the wound

Postoperatively, the patient was diagnosed with traumatic partial amputation of the hind foot on the right side: open intra-articular displaced fracture of the calcaneus (type 3C as classified by Gustilo – Andersen, grade 4 as classified by N.A. Koryshkov), open displaced fracture of the posterior process of the talus, extensive

flapped lacerated wound and injury to the posterior tibial artery, tendon of the posterior tibial muscle, plantar muscles and aponeurosis, class 1 traumatic shock. Dressing: the wound and sutures appeared unremarkable on the first day after the operation, tissues slightly swollen with scanty sanious discharge. No neurovascular disorders were observed (Fig. 7).



**Fig. 7** Appearance of the wound on the first postoperative day

CBC dtd October 30, 2020 indicated posthemorrhagic anemia of moderate severity: erythrocytes  $2.8 \times 10^{12}/L$ , hemoglobin 87 g/l, leukocytes  $11.9 \times 10^9/L$ , hematocrit 25.4 %, platelets  $193.0 \times 10^9/L$ .

Gloving drainage was removed from the wound after 2 postoperative days. Swelling and pain in the right foot decreased. Drug therapy the patient received postoperatively included antibiotics (ciprofloxacin 400 mg 2 times a day intravenously, metrogil 100 ml 3 times a day, 10 days), oral anticoagulants (eliquis 5 mg 2 times a day), ropivacaine solution administered into the epidural catheter for analgesia for 3 days, analgesics (ketonal 100 mg 2 times a day, 5 days), antiplatelet agents (trental 5 ml per 250 ml of 0.9 % sodium chloride solution, 5 days), iron preparations (ferritab, 1 tablet 3 times a day), omeprazole 20 mg 2 times a day, tetanus toxoid 1 ml subcutaneously; dressings with antiseptics; plaster immobilization of the right foot for 2 weeks, and elastic compression of the lower extremities. Doppler ultrasound of the vessels of the lower extremities performed after 3 postoperative days showed no obstructions to blood flow.

## RESULTS

The treatment demonstrated a positive effect. He could walk using crutches and bearing no weight on his right leg. The sutures were removed after 21 postoperative days (Fig. 8). The wound healed by primary intention.

Inpatient treatment lasted 23 days. He was discharged in a satisfactory condition for outpatient treatment and recommended to continue treatment with a surgeon in a polyclinic at the place of residence, walk bearing



## Case report

no weight on the right leg for 3 months. Postoperative recommendations included computed tomography or a radiograph of the right foot and the ankle at 3 and 5 months, anticoagulants (Eliquis 5 mg 2 times a day until full physical activity), elastic compression of the lower extremities, exercise therapy, massage, physiotherapy, analgesics, chondroprotectors, vitamins, Doppler ultrasound of the lower extremities at 3 and 5 months, warm baths using herbs and sea salt, use of orthopedic insoles for combined flat feet wearing shoes with heel fixation and heels no higher than 2.5-3 cm.

The patient was examined by an orthopedic surgeon at 5 months at the State Budgetary Institution of Healthcare JSC "AOKB". He could walk bearing full weight on both lower limbs without limping. Swelling and pain in the area of the right lower limb is not determined. The skin of the foot was pale pink and

warm to the touch. Motion of the right ankle joint and the foot joints were not limited, the limb sensitivity being not impaired and toes of the right foot showed full ROM. Postoperative scar of the right foot showed no signs of inflammation and was pale pink (Fig. 9). A moderate flattening of the arches of both feet, flattening of the forefeet were determined. Computed tomography scan of the right foot showed consolidated fracture of the calcaneus and stable metal constructs at 5 months (Fig. 10).

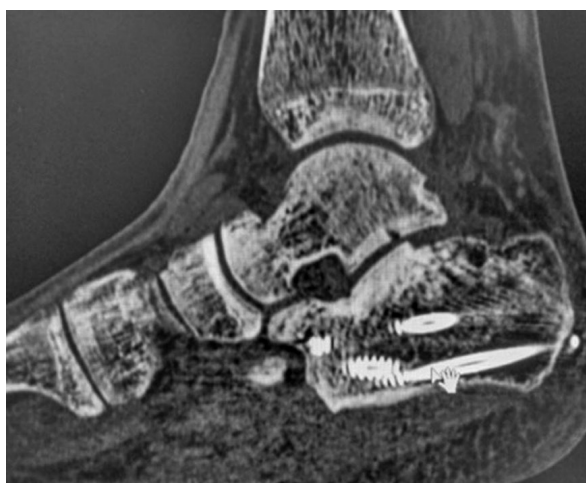
Doppler ultrasound of the vessels of the lower extremities produced at 5 months of injury showed no obstruction to the blood flow. The patient was satisfied with the outcome of the treatment. A good anatomical and functional result was obtained. The patient was disable for 5 months of injury. He could return to his job as a frame saw operator at a sawmill.



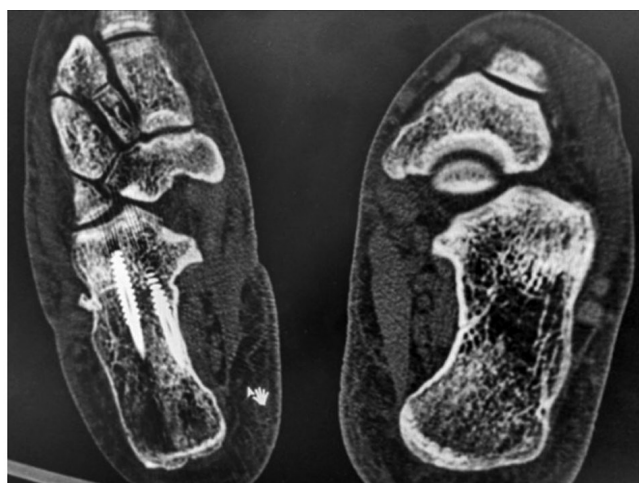
**Fig. 8** Appearance of the wound at 21 days



**Fig. 9** Photos of the right foot showing (a) the medial aspect and (b) the plantar surface at 5 months of surgery



a



b

**Fig. 10** Computed tomography of the mid- and forefoot on the right side showing (a) lateral view and (b) axial projection

## DISCUSSION

Despite technological progress in traumatology, treatment of patients with severe combined osseous and vascular injury is a complex surgical task employing an interdisciplinary approach [4, 8, 11, 12, 13]. Complications associated with open fractures of the calcaneus are reported to occur in 78 % [14]. A foot injury is considered an angiotraumatological issue [15]. Early surgical intervention is needed to restore blood circulation in a combined osteovascular injury [9, 16]. The optimal period from injury to the operational intervention is 6 hours. A delayed procedure can be associated with gangrene and amputation of the limb even with restored blood flow [17, 18]. The patient reported was delivered to the emergency room of a specialized hospital within 5 hours of injury that was rated as grade 4 severity according to the grouping of open injuries of the foot and ankle joint classified by N.A. Koryshkov [11]. An injury to the foot skeleton (option 2) was graded 2 points; the supporting area of the heel and the midfoot as 4 points; laceration as 2 points; wound depth – injury to the neurovascular bundle as 4 points; exfoliated area as 0 points with the total of 12 points. There was a poor prognosis for limb preservation and foot function. There are no clinical guidelines and a unified grading system to classify osteovascular injuries, no universal method for the treatment of the combined injury including an open skeletal fracture and injury to the blood vessels. The choice of treatment modality, diagnosis of osteovascular involvement is performed on an individual basis depending on the external and internal factors affecting the injuries [19].

An angiotraumatological approach used to treat impaired hindfoot on the right side in our case included

early primary surgical treatment of the osteovascular injury, accurate reduction and rigid fixation with a most sparing method of osteosynthesis of the calcaneus, repair of the posterior tibial artery, complex drug therapy aimed at improving the rheology, reducing coagulability, addressing ischemia with full regional anesthesia. A positive outcome in patients with open fractures of the foot bones and injury to the major vessels can be provided by a combination of certain conditions contributing to a positive result of rehabilitation with a high-quality surgical intervention. These include younger age, absence of comorbidities, such as diabetes mellitus, obliterating atherosclerosis of the vessels of the lower extremities, no smoking habits, the minimum time from injury to first aid and treatment at a specialized hospital. The main blood stream must be restored shortly and stable metal osteosynthesis of the fracture to be performed. Decompressive fasciotomy is produced with increasing compartment syndrome. The choice of osteosynthesis depends on the type of fracture, injury to soft tissues and the general condition of the patient. Extrafocal metal osteosynthesis is commonly performed with external fixation devices, as the definitive treatment that can be converted to internal fixation. Internal fixation is rarely used as the first choice as seen in the case reported. Modern endovascular techniques help to avoid or improve the conditions for the vascular stage of surgical intervention. Success in the treatment of the cohort of patients is achieved through coordinated efforts of orthopaedic and vascular surgeons [15, 20]. Functional results were evaluated at 5 months using the American Orthopedic Foot and Ankle Society (AOFAS) scale and Foot Function Index (FFI). The result of treatment assessed with the scales was rated as good.

## CONCLUSION

The combination of factors and the angiotraumatological approach employing organ-sparing strategy with the involvement of a multidisciplinary team

of orthopaedic and trauma surgeons, angiosurgeons, anesthesiologists-resuscitators made it possible to save the patient's foot, restore the function and support.

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**Ethical expertise** Not applicable.

**Informed consent** The authors obtained written consent from the patient for the publication of medical data and photographs.

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## Contribution of the authors

Iskusov P.V. – writing and editing the text, examining the patient, reviewing publications on the topic of the article, conducting surgery, analyzing and interpreting the data.  
 Bragina S.V. – writing and editing the text, review of publications on the topic of the article, analysis and interpretation of the data.  
 Sovershaev A.E. – examination of the patient, surgical intervention, analysis of the data.  
 Sobolev E.I. – examination of the patient, anesthesia, analysis of the data.  
 Zvorykin A.S. – examination of the patient, surgical intervention, analysis of the data.  
 Sharypova E.P. – examination of the patient, surgical intervention, analysis of the data.