

New method of tibio-calcaneal-navicular arthrodesis after talectomy.

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Research Article

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Abstract

Purpose

To develop and investigate the results of a new, simple and versatile method of tibia- calcaneal arthrodesis that reduces limb shortening.

Materials and methods

This prospective study was conducted in patients who voluntarily agreed to a new operation. Informed consent was obtained from all individual participants included in the study. For 17 years, we have observed 14 patients with various forms of osteomyelitis, fractures and septic necrosis of the talus, who underwent a new method of tibio-calcaneal-navicular arthrodesis (TCNA). The age of the patients ranged from 23 to 75 years, (42 years on average). 2 patients were female, 12 were male. The Ilizarov apparatus was used as a fixator. The average time of immobilization in the apparatus was 4.9 months (from 3.5 to 6 months). The operations were performed by one surgeon.

Results

In all patients the wounds healed by primary intention. The average limb shortening 1.9 ± 0.5 cm. AOFAS Ankle-Hindfoot score (n=14) in all patients came up to $77,9 \pm 6,8$ (min 68, max 86) SD 12,8. Patients wore ordinary footwear without arch supporter and heels till 2cm. Only two female patients over 70 years used a stick. 2 patients had minor pain during prolonged walking.

Conclusion

Excellent and good results were obtained in all patients. The new TCNA method allows restoring the support ability of a limb, reduces shortening and improves the quality of life for patients.

Introduction

Removal of the talus (astragalectomy) - is the surgery that is widely used in modern traumatology and orthopedics.

For the first time in 1641, Hildanaus described a patient with astragalectomy. In 1901, Whitman performed astragalectomy in 3 patients with paralytic equinovarus deformity of the foot. After that, this operation became known by his name [1,2]. In severe open injuries of the talus, its necrosis or total osteomyelitis, to eliminate the purulent necrotic focus and restore the support ability of the patient's limb, surgeons are faced with the need to perform an operation to remove the talus and create a tibia -

calcaneal arthrodesis (TCA). As a result, we observe a significant (up to 4-6 cm) shortening of the limb, impaired gait statics, and formation of significant deformations in soft tissues of the ankle joint.

Removal of talus is practiced in children with severe rigid foot deformities with arthrogryposis, myelomeningocele, myeloplasia [3,4,5,6,7]. Analysis of treatment results shows that the astragalectomy is recommended for patients under 5 years old [8]. At the same time, it was shown that it is preferable to carry out TCA in older patients, because this reduces the development of subsequent foot deformities [9]. Removal of talus with the subsequent TCA is often performed as a result of osteonecrosis of talus in adult patients. TCA is currently recommended for patients with symptomatic, secondary consequences of osteonecrosis of the talus body [10,11,12,13,14,15].

There are studies on TCA in diabetic Charcot's foot, when destruction of talus is present [16,17]. An absolute indication for TCA is a total osteomyelitis of talus of various genesis - post-traumatic, post-operative, etc. [18,19,20,21]. Some authors recommend performing astragalectomy with simultaneous TCA for severe fractures and fracture-dislocations of the talus [22,23,24,25]. In case of osteomyelitic lesion of the talus, a necessary condition for the elimination of the purulent process is not only astragalectomy and thorough debridement, but also the creation of a TCA. In the result of this operation, a significant (up to 4-5 cm) shortening of the lower limb occurs, gait is impaired, significant folds of skin are formed along the medial and lateral sides of the ankle joint. For stabilization in the place of arthrodesis and elimination of the shortening occurred in result, the external fixation devices and various methods of both free and non-free bone grafting according to Ilizarov are used [20,21]. As the authors show, the results obtained satisfy the patients, nevertheless, one of the negative aspects in such operations is the duration of treatment and the complications arising in the course of treatment that are inherent for the treatment of patients with bilocal osteosynthesis by the Ilizarov method (suppuration in the area of the wires with prolonged wearing of the apparatus, nonunion in the extension area and etc.) [33,34]. All this forces surgeons to look for such methods of surgical intervention that would reduce the above disadvantages.

Objective: to develop a new method of tibio-calcaneal-navicular arthrodesis (TCNA) after astragalectomy, that would reduce the abovementioned negative consequences and study the results of treatment.

Materials And Methods

We have developed and applied a new TCNA method. For 17 years under our supervision there were 14 patients with various forms of osteomyelitis, open fracture and necrosis of the talus. The age of the patients ranged from 23 to 75 years, (42 years on average). 2 of the patients were female, 12 were male. Table 1.

Table I. Clinical details of 14 patients who had talectomy

	A	B	C	D	E	F	G	H	I
1	M	40	L	Open fracture	septic necrosis of the talus	3 months	Fall from a height	5	77
2	M	24	R	Open fracture-dislocation	Same	2 days	Road-traffic accident	4	84
3	M	33	R	closed fracture-dislocation	Same	3 day	Fall from a height	5	82
4	M	75	L	closed fracture-dislocation	Same	3 day	Fall from a height	4.5	71
5	M	40	R	Open fracture-dislocation	Same	14 day	blast injury	5.5	80
6	M	20	R	closed fracture-dislocation	total osteomyelitis after operation	24 day	Road-traffic accident	6	86
7	M	27	L	closed fracture-dislocation	Same	3 day	Fall from a height	5	84
8	M	32	R	open fracture-dislocation	total osteomyelitis after operation	6 months	Fall from a height	5	82
9	M	48	R	closed fracture-dislocation	total osteomyelitis after operation	36 months	Fall from a height	3.5	74
10	F	71	R	closed injury	closed injury	36 months	unknown	4.5	70
11	M	23	L	closed fracture-dislocation	total osteomyelitis after operation	6 months	Fall from a height	5/5	83
12	M	28	R	open fracture-dislocation	total osteomyelitis	4 months	Road-traffic accident	5.5	85

					after operation				
13	M	60	R	open fracture-dislocation	total osteomyelitis	4/5 months	Road-traffic accident	5.5	Full arthrodesis did not take place, minor pain (68)
					after operation				
14	F	71	R	closed injury	septic necrosis of the talus	36 months	Fall from a height	4.5	minor pain (65)

A- patients' gender, B- age, C-limb,D- type of injury, E-diagnosis, F- Time from disease onset to surgery, G- mechanism of injury (disease), H- immobilization time, I-the AOFAS Ankle Hindfoot scale (after treatment).

Astragalectomy in talus osteomyelitis was performed from the anterolateral approach with resection of the external malleolus and anteromedial access with resection of the internal malleolus. After astragalectomy and debridement, the destroyed cartilage of the tibia, the articular surface of the scaphoid and calcaneus were removed in patients with chronic osteomyelitis. In patients with fracture-dislocations of the talus, the articular cartilage was resected in the region of the anterior and posterior edges of the tibia. The edge of the navicular bone was resected (using a chisel or a rasp a thin layer of cortical bone was removed until the appearance of "bloody dew"). In the area of the *facies articularis talaris posterior* of the calcaneus, the cartilage was transversely removed to the bone using a chisel 5-10 mm wide. The posterior edge of the tibia, after processing it with a rasp was embedded in prepared chute and the anterior edge of the tibia, also after removing a thin layer of cartilage, was juxtaposed with the processed surface of the navicular bone. The foot was fixed in 2 half-rings from the Ilizarov apparatus using 3 needles. One ring with two 2 mm needles and one 6 mm rod were placed on the lower third of the tibia. The half rings and the ring were interconnected with threaded rods. The angle between the foot and the tibia was set at 100 ° (Fig. 1).

Example: A 40-year-old male patient received an open injury in the area of the left ankle joint. Within 2 months he was treated in a clinic at the place of residence. He admitted the department of purulent traumatology of the Azerbaijan Scientific Research Institute of Traumatology and Orthopedics with complaints of pain, purulent discharge from fistulas in the ankle joint. The patient was examined, underwent laboratory and radiological studies and diagnosed with purulent arthritis of the left ankle and talocalcaneal joints, septic necrosis of the talus. Radiographs and fistulography revealed the complete septic necrosis of the talus, complicated by purulent arthritis of the ankle and talocalcaneal joints. **Fig. 2.**

The patient was offered an astragalectomy operation, debridement, TCA and bilocal osteosynthesis with the Ilizarov apparatus in order to eliminate the shortening. However, the patient refused to lengthen the tibia and gave a voluntary consent for a new operation - TCNA.

Operation: Ankle joint arthrotomy was performed with antero-lateral and antero-medial approach, the lateral and medial malleolus were resected due to their lesion by the osteomyelitis process. It has been found that the talus lies almost freely in its bed. Talcotomy performed. Debridement: the destroyed cartilage of the tibia, the articular surface of the navicular bone and calcaneus were removed as they were completely destroyed. Cartilage was removed along the edge of the navicular bone and its edge was smoothed. The anterior and posterior edges of the tibia were rasped to bloody dew. In the area of the *facies articularis talaris posterior* of the calcaneus, a groove about 5 mm wide was made with a chisel in the transverse direction. After treating the wound with an antiseptic solution, the posterior edge of the tibia is placed in the prepared groove in the area of the calcaneus, and the anterior edge, devoid of articular cartilage, is placed on the edge of the scaphoid bone. The foot was fixed with the Ilizarov apparatus in accordance with the above method. The wounds were drained and sutured. **Fig. 3.**

The wound healed primarily. The device was removed 4 months after complete fusion and partial load (with crutches) started. Shortening by 2 cm. The patient walks with full load on his leg without any discomfort after four weeks.

Example 2. Patient M., 27 years old. He was admitted into the Clinic in 2006 with complaints of pain in the left foot. Received an injury at a construction site 2 days before admission. Examined clinically and radiologically. Diagnosed with the closed fracture-dislocation of the talus. The patient gave voluntary consent to a new operation. The operation was performed in accordance with the method described above. In contrast to the previous example, the cartilage with a width of 5 mm was removed from the calcaneus in the transverse direction. At the anterior and posterior ends of the tibia, the cartilage was also removed to bloody dew. The wound healed primarily. The device was removed 4 months later. **Fig. 4.**

Example 3. Patient N got an open fracture dislocation of the talus in the result of a car accident. The patient agreed to our operation. An astragalectomy with a TCNA was performed. The wound healed primarily. The device was removed after 5 months. **Fig.5**

Results

The observation was carried out within the period of up to 15 years, in 1 patient -17 years. All patients underwent a one-stage operation. In all patients the wounds healed by primary intention. Radiographically diagnosed good arthrodesis was obtained in 13 patients. In 8 cases with osteomyelitis of the talus, the purulent-inflammatory process was completely eliminated. The average time of immobilization in the apparatus was 4.9 months (from 3.5 to 6 months). The average limb shortening was 1.9 ± 0.5 cm. Radiographically diagnosed partial absence of fusion was formed in 1 patient. Biomechanics of walking was maximum maintained. Patients wore ordinary footwear and heels till 2cm without arch supporter. Only two female patients over 70 years used a stick. 2 patients had minor pain during prolonged walking. Mean AOFAS Ankle-Hindfoot score (n=14) in all patients came up to $77,9 \pm 6,8$ (min 65, max 86) SD 12,8.

A woman at the age of 71 had a minor pain in her foot and was using a walking stick. A 60-year-old man who reported mild foot pain while walking did not have an X-ray fusion between the tibia and scaphoid, but there was fusion of the posterior edge of the tibia and calcaneus. Nevertheless, all patients were satisfied with the result. They could move independently and take care of themselves.

Patients fully load the leg, use ordinary shoes with an instep support and a heel to compensate the shortening. Thus, the proposed method of arthrodesis made it possible to significantly reduce shortening and deformity in the ankle joint.

Discussion

Some authors suggest a more differentiated approach to the question of astragalectomy in osteomyelitis of the talus. ST Canale and FB Kelly (1978) describe negative results obtained after astragalectomy, which was performed as a result of aseptic necrosis of the talus following a fracture of the neck of the talus [26]. Obviously, this is why others recommend not hurrying with astragalectomy. Charles L Saltzman, 2005 and Hans-Joachim Riesner at all (2017) adhere to the same views [19,27]. This tactic, in our opinion, increases the suffering of the patient as well as the cost of the treatment process.

On the other hand, with a fracture of the talus according to the classification of fracture of the talus of the Weber / Marti IV or Hawkins III type, a large percentage of subsequent complications and repeated surgeries, makes some authors suggesting an immediate performance of an operation to remove fragments of the talus followed by TCA or performing arthrodesis according to Blair [28,29].

The use of autografts in order to eliminate the shortening after removal of the talus has been proposed by a number of authors [30,31,32]. It is clear that such operations are very traumatic and require long-term fixation which slows down the process of social rehabilitation for patients and is absolutely unacceptable in the presence of infection.

If astragalectomy for fractures of the talus or its aseptic necrosis is debated, then with its total osteomyelitis or septic necrosis, this operation is beyond doubt. The presence of an infectious focus excludes any internal fixation after the removal of talus. In this situation, most authors agree that the limb should be fixed with external fixation devices [33,34,35].

Some suggest eliminating the shortening caused after **astragalectomy** by the bilocal osteosynthesis according to the Ilizarov method [25,36,37,38,39].

The TCA operation consists of several sequential procedures - surgical approach, debridement, which is accompanied by astragalectomy, creation of a bed for the contact of the distal end of the tibia and calcaneus and the anterior edge of the tibia and navicular bones, their alignment and stabilization - osteosynthesis, wound closure. The less traumatic operation, the more chances for success of the treatment - this is the axiom. Therefore, the main difference in the surgical procedures of various authors comes down to reconstruction or to the methods of creating a bed for contact between the distal end of

the tibia and the calcaneus. The simpler this stage of the operation, the less traumatic the operation is. M. G. Dennison et al (2001) after astragalectomy suggested resecting the distal end of the tibia and part of the calcaneus. The shortening was eliminated by osteotomy upper third of the tibia and bilocal osteosynthesis according to the Ilizarov method [15]. Fixation in the apparatus was carried out for an average of 10.7 months. The average lengthening was 3.5 cm. The authors point to a large number of various complications in the course of treatment that occur in the bilocal osteosynthesis. Weber M. et al, (2002) published the results of treatment of 6 patients, who were treated in almost the same way. A slight difference was noted during the resection of the calcaneus. The average time spent in the apparatus was 12 months [40]. At the same time, the authors point out the absence of similar procedures in the literature. Good results have been obtained; however, similar problems associated with prolonged treatment in the apparatus have been described. Edgardo R. Rodriguez et al (2015) resected the distal end of the tibia in the form of a wedge, and create a V-shaped bed on the calcaneus, then the tibia wedge was inserted into the above-mentioned bed and the limb was stabilized with the Ilizarov apparatus [41]. The authors note that 25% of patients experienced non-fusion. In contrast to the above operations, at this stage of the operation we only use a chisel to create a transverse bed on the calcaneus of about 5 mm and a rasp to cut the anterior and posterior angles of the tibia and navicular bones. These manipulations are less traumatic and exclude intraoperative shortening of the tibia and calcaneus bones and, in contrast to the above authors, is less traumatic.

Conclusion

Thus, we can say that astragalectomy is an operation that has become a part of the resource fund of modern orthopedics. The main problem after removal of the talus is the choice of the method for fixation, achieving fusion and correction of shortening. So autoplasty with bone tissue and partial resection of the talus, especially during an infectious process, are fraught with infection and sequestration. Monolocal and bilocal osteosynthesis for correction of limb shortening is a long-term procedure. The proposed method of operation allows to eliminate the purulent-inflammatory process and restore the ability to support the limb, less traumatic and reducing the negative consequences that occur after removal of the talus.

The proposed method of TCNA is universal and can be used in patients with various pathologies of the talus.

Declarations

Disclosure statement: No benefits have been or will be received from a commercial party related directly or indirectly to the subject matter of this article.

Conflict of interest: On behalf of all authors, the corresponding author states that there is no conflict of interest.

Ethical Committee of HB Guven Clinic approved this research.

All authors have given their consent to participate in the work

All authors gave their consent to the publication of the article

Authors input: Chingiz Ali-Zade 1, idea author, surgeon, article editor, Huseyn Aliyev² - surgical assistant, analysis of clinical material, statistical processing, Farhad Alizada³- literature analysis, article design. *All authors read and approved the final manuscript.*

The authors declare that all clinical materials are available.

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Figures

Figure 1

Scheme of conventional- A and new operation- B of tibio-calcaneal-navicular arthrodesis after astragalectomy.

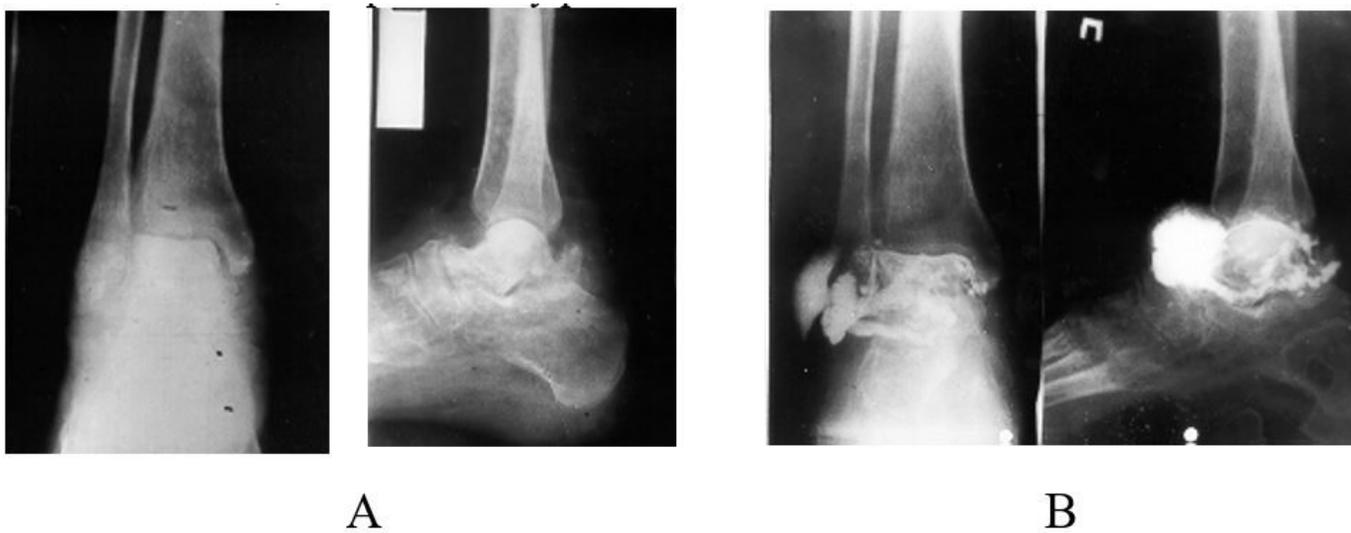


Figure 2

The X-rays - A and fistulography – B of the patient X.

The fistulography shows that contrast material fully wraps up the necrotizing talus.

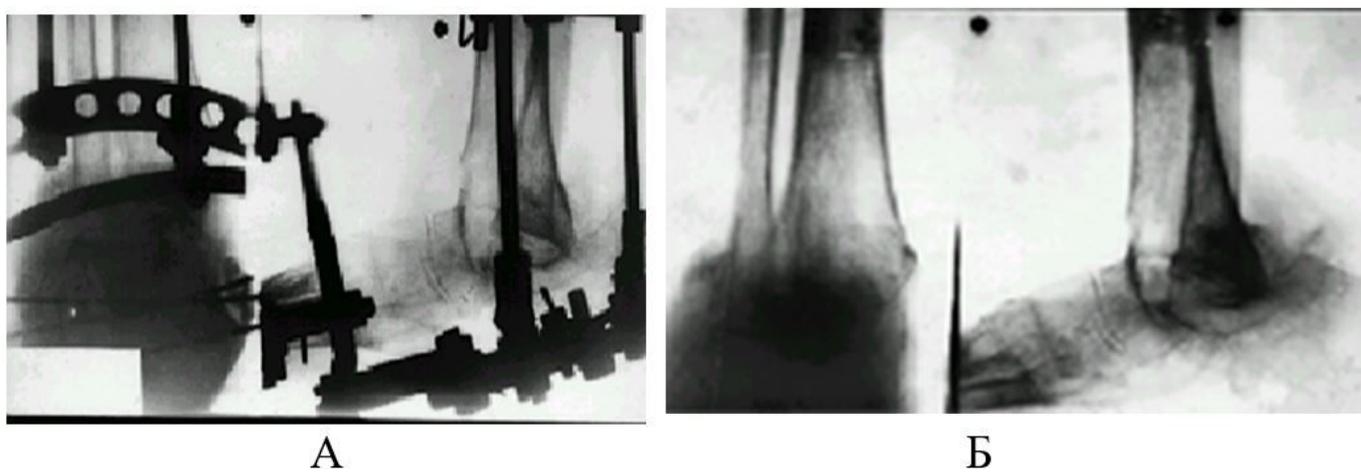


Figure 3

X-ray pictures of patient X in the process of treatment – A, and after removal of fixator -B.

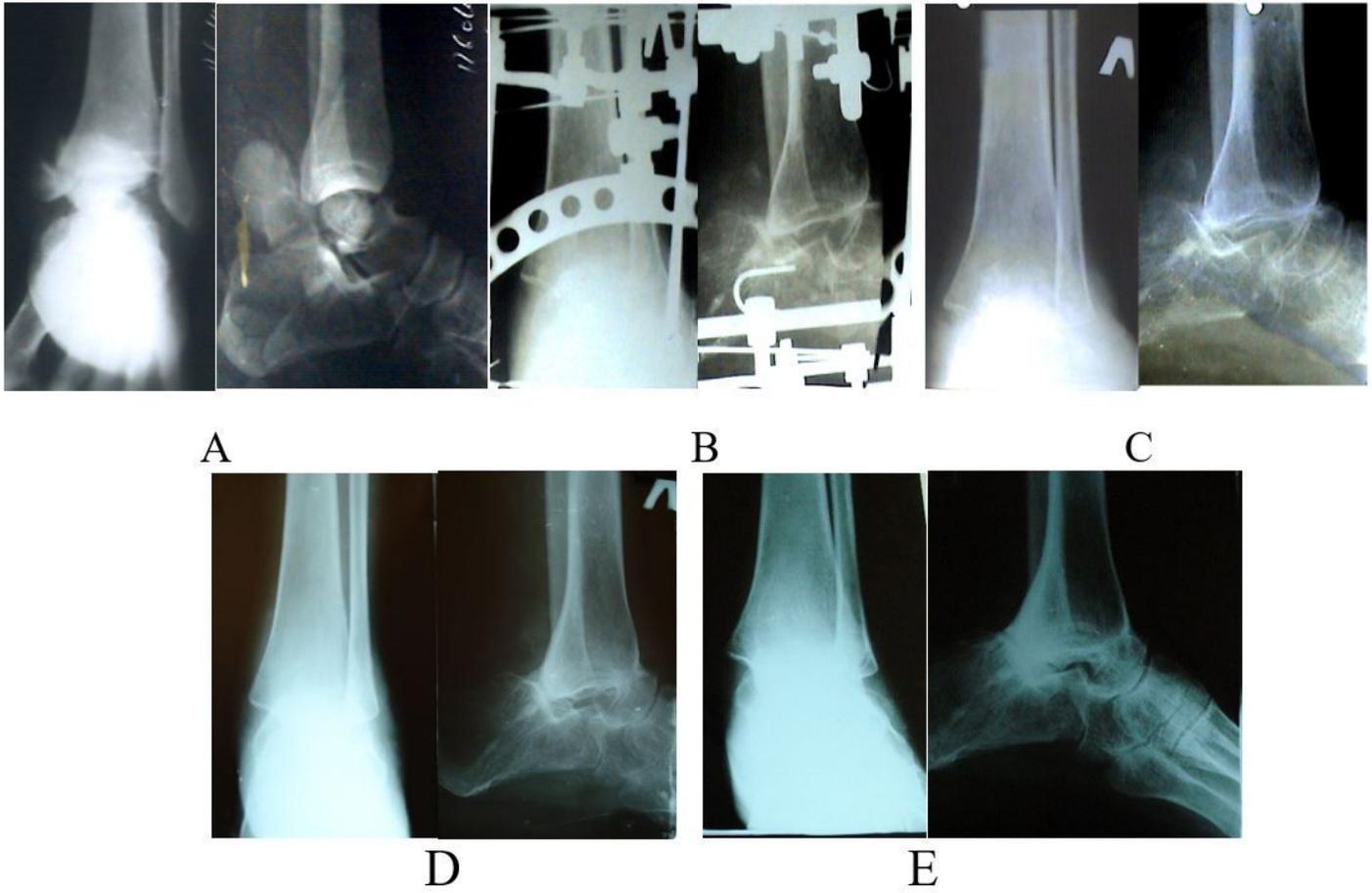


Figure 4

X-ray pictures of Patient with closed fraction-dislocation of the talus (duration 2-days) - A; after astragalectomy - B; after the treatment - C; a year after the operation - D; 4 years after the operation - E.

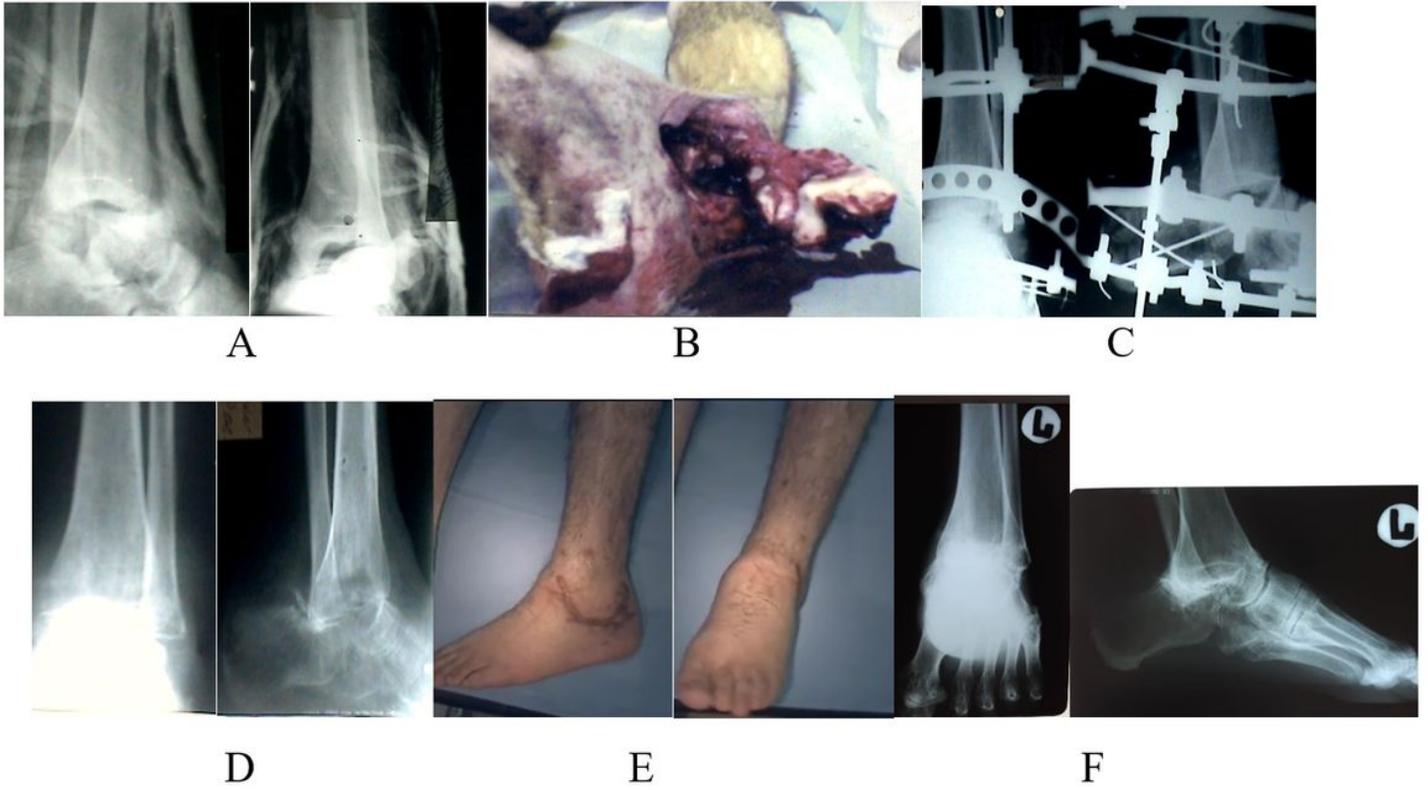


Figure 5

X-Ray- A and ankle view- B of a patient with an open fracture - dislocation of the talus; after astragalectomy- C; X-ray -C and ankle view- D after the end of treatment; X-ray after 14 years- F.