

Femoral distal-end fractures treatment using the Ilizarov circular frame

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ABSTRACT

AIM: The distal femur fractures are usually results of high energy injuries, pathological or periprosthetic fractures. The aim of this report is to describe the indications of Ilizarov external fixator (IEF) device as a suitable surgical treatment for these severe injuries, to describe the construct design and to evaluate the results in 16 patients treated using this method.

MATERIAL AND METHODS: 16 patients were assessed, (8 women - 8 men), with a range of 21 to 85 years of age. The fractures were of AO type 33-A1, 2, 3 & 33-C1, 2, 3. In two patients the fractures were periprosthetic. Two patients presented with nonunion and failure of the previously applied osteosynthesis respectively. In these patients knee bridging was deemed necessary. The IEF construct design featured a twin ring module for the supracondylar fracture fragment in the majority of the cases.

RESULTS: The mean hospitalization time was 7 days and the postoperative follow up was 6 - 52 months. Complete union was achieved in all cases without the need of reoperation in any case. The tibial part of the construct was removed after 4-8 weeks postoperatively and the femoral part of the construct was removed after 18 weeks respectively. The average time to union was 18 weeks. There were neither deformities, nor osteoarthritic lesions in the longest follow up cases. The range of motion of the knee was satisfactory in all cases.

CONCLUSION: The treatment of distal femur fractures of AO types 33-A1, 2, 3 & 33-C1,2,3 using the IEF is highly effective and it is our belief that this is the preferable method for the management of the above described injuries. This method shows numerous advantages, such as adjustment of the joint alignment, respect of soft tissues due to less invasive technique, early mobilization and no need for a second anesthesia and operation for IEF removal. The method shows no major complications apart from the common problem of pin site infection which in the majority of cases is easily managed with wound dressing, antibiotics administration or relocation of the pins.

KEY WORDS: distal end femoral fractures; surgical treatment; Ilizarov circular frame

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1. Introduction

Fractures of the distal femur represent 3-4% of femoral fractures and approximately 0.4% of all fractures. Their epidemiological curve in relation to age and gender shows a typical bimodal distribution, with a first peak for young males in their third and a second for elderly women in their seventh decade respectively. The mean age of all patients with such fractures is 60 years, while over 50% of fractures occur in patients over 65 years. The fractures are twice more frequent to women than men, while 55% of the fractures are intra-articular [1, 2]. The most commonly used classification is this of AO / OTA, depending on the location and the comminution of the fracture namely: 33-A1,2,3 extra-articular, 33-B1,2,3 partial articular, 33-C1,2,3 complete articular (**Fig. 1**) [3]. A separate category of distal femoral fractures are the periprosthetic fractures, over a previously applied total knee arthroplasty, which are usually classified according to the displacement of the fracture and the stability of the femoral component by Lewis & Rorabeck (**Fig. 2**) [4,5]. Pathological fractures of this type related to neoplastic lesions of the distal femur can also occur. Fractures in elderly people are usually low-energy injuries such as falls on a flexed knee and occur in an osteoporotic bone, while young patient's fractures are high-energy injuries as car or industrial accidents and falls from a great height. Fractures in young people are usually intra-articular and highly comminuted, accompanied approximately in 20% with ligamentous injuries. As a result of violent injuries, these fractures can be part of complex lesions around the knee, that is with a coexisting fracture of the proximal tibia ("floating knee"), in association with dislocation of the knee or as second or third degree open fractures, with associated vascular injury. The treatment of these serious injuries is quite challenging and an increased rate of complications such as infection, septic nonunion in 7-13% (25-30% in open fractures), non-septic nonunion (in 10-14%), a significant reduction of the range of motion in 35% and posttraumatic arthritis of the knee up to 50% [1].

2. Material and Methods

The patients: This study includes 17 fractures in 16 patients, 8 men and 8 women, aged 21 to 85 years. All

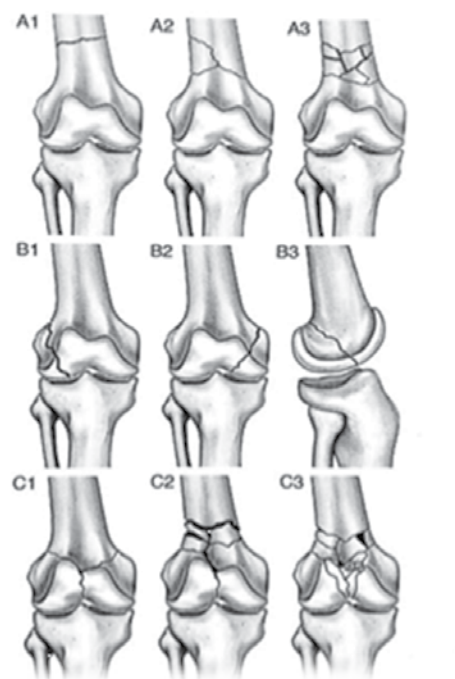


Fig. 1. AO classification of distal femoral fractures

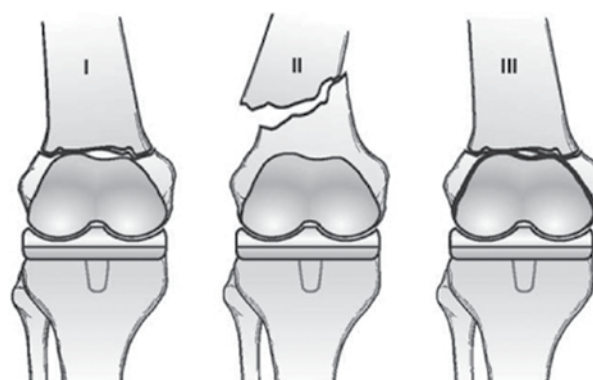


Fig. 2. Lewis & Rorabeck classification of distal femoral fractures following a TKR

fractures were either extra-articular AO type 33-A1,2,3 or intra-articular AO type 33-C1,2,3. Two patients presented with periprosthetic fractures following total knee arthroplasty and two patients presented with nonunions and failure of the applied fixation. One fracture was accompanied with a fracture in the ipsilateral proximal tibia ("floating knee"). In one patient a 33-A3 type fracture occurred below a DHS plate.

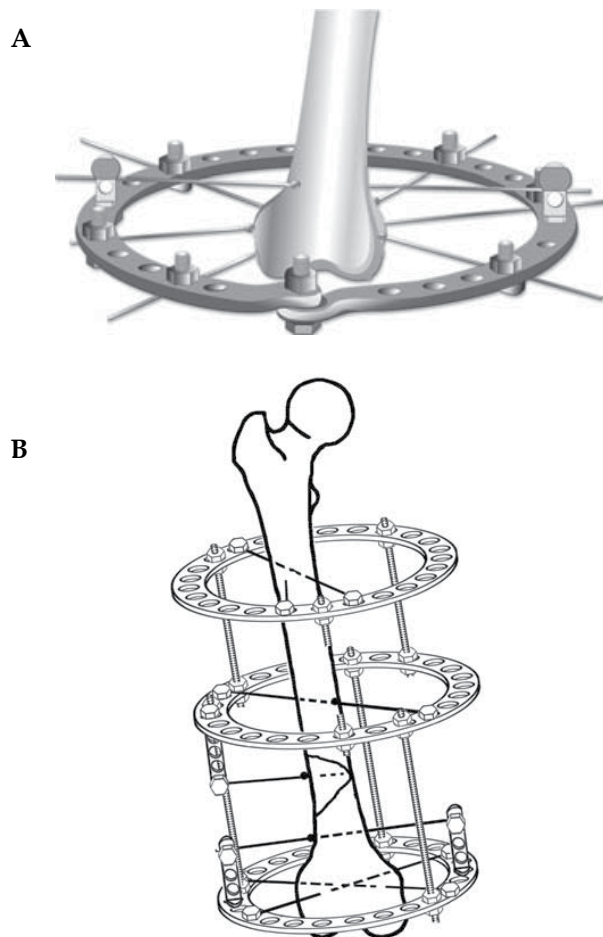


Fig. 3. femoral frame, (a,b)

The construct and the surgical technique: The application of the frame started in all cases with placement of the distal femoral part, using a twin-ring in most cases and the connecting rods parallel to the anatomic axis of the femur (**Fig. 3**) [6,7]. In all fractures bridging of the knee for 4-8 weeks was considered necessary (**Fig. 4**) [6]. The rings stabilization was achieved using fine wires in combination with half-pins. The placement of fine wires and half-pins and the fracture reduction assessment was done using a C-arm image intensifier. The mean operative time was 70 minutes.

Postoperatively a second generation cephalosporin was administered for 24 to 48 hours and all patients were given low molecular weight heparin for 5 weeks. All patients were prescribed the same post-

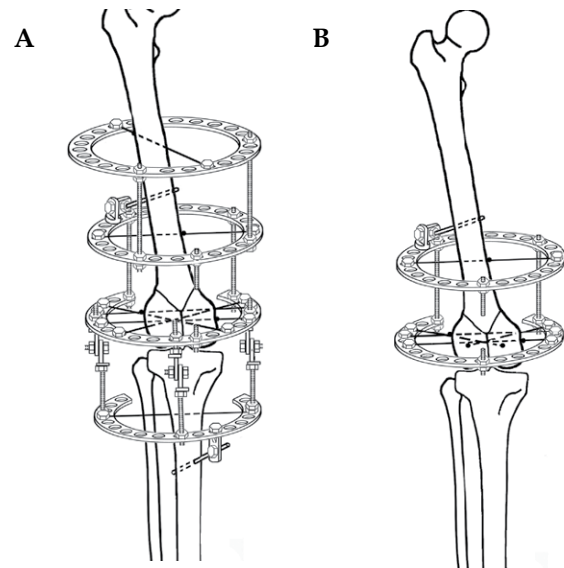


Fig. 4. bridging of the knee (a) and removal of the tibial part of the frame 4-8 weeks later (b)

operative physical therapy protocol (mobilization of hip - ankle and early low-weight bearing).

As healing time was defined the time from the operation to the removal of the device and full weight bearing. Hospitalization time, healing time and the major and minor complications were recorded. Bone healing and functional outcome were evaluated using the ASAMI scale (**Table 1**).

3. Results

The mean hospitalization time was 7 days. Follow-up (clinical and radiological) ranged from 6-52 months. The tibial part of the frame was removed after an average time of 5 weeks (4-8 weeks), whereas the femoral part after 18 weeks. The mean time to union was 18 weeks. Complete union of fractures was achieved in all patients with no need of reoperation in them.

Major complications (neurological, deep vein thrombosis, pulmonary embolism, compartment syndrome) were not developed in any patient. Among minor complications (pin tract infection, knee stiffness, depressive illness, delayed union, nonunion, septic nonunion, axis disorder, shortening more than 1.5 cm) only pin tract infections presented in 3 patients, which were treated conservatively

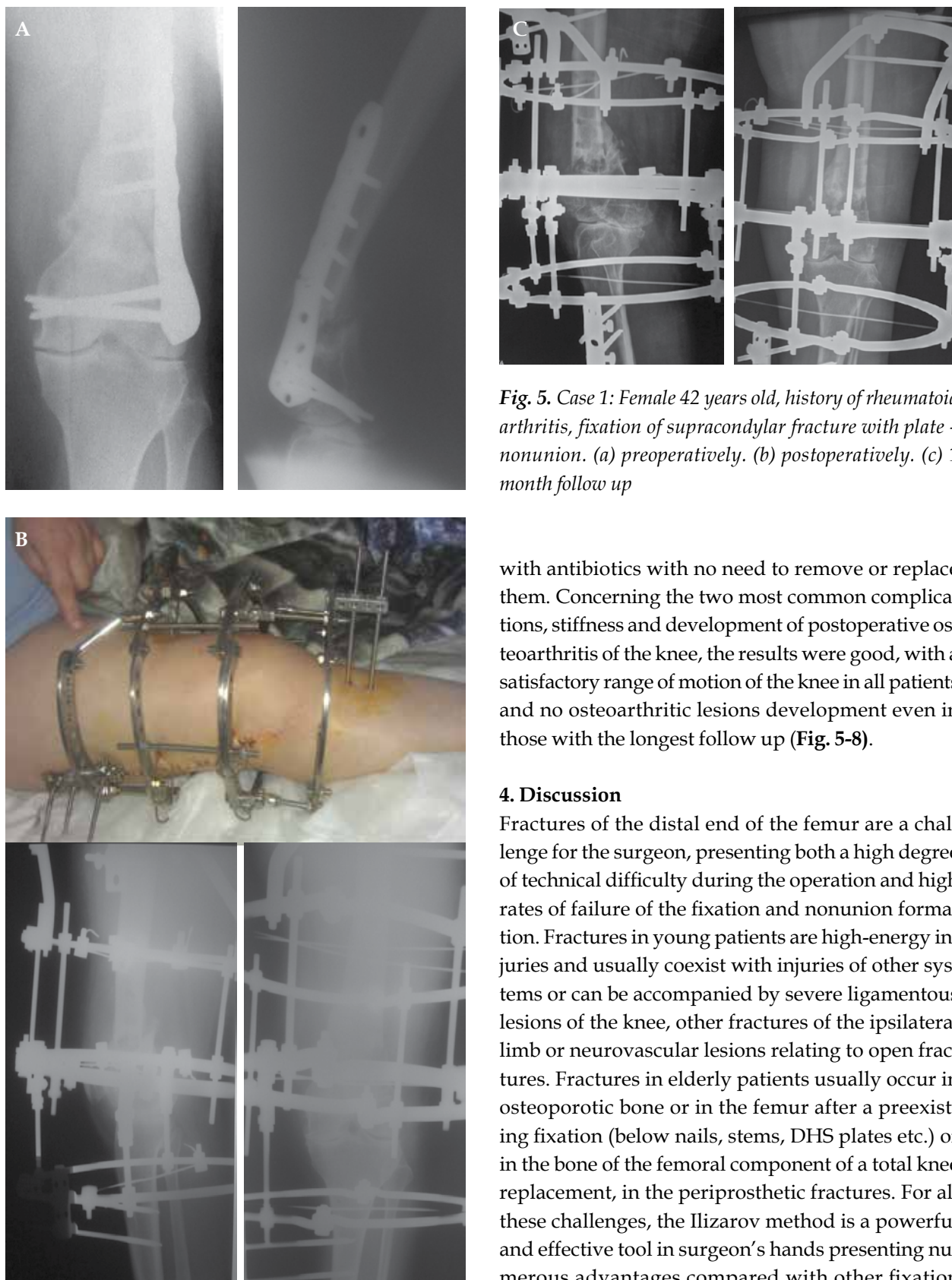


Fig. 5. Case 1: Female 42 years old, history of rheumatoid arthritis, fixation of supracondylar fracture with plate – nonunion. (a) preoperatively. (b) postoperatively. (c) 1 month follow up

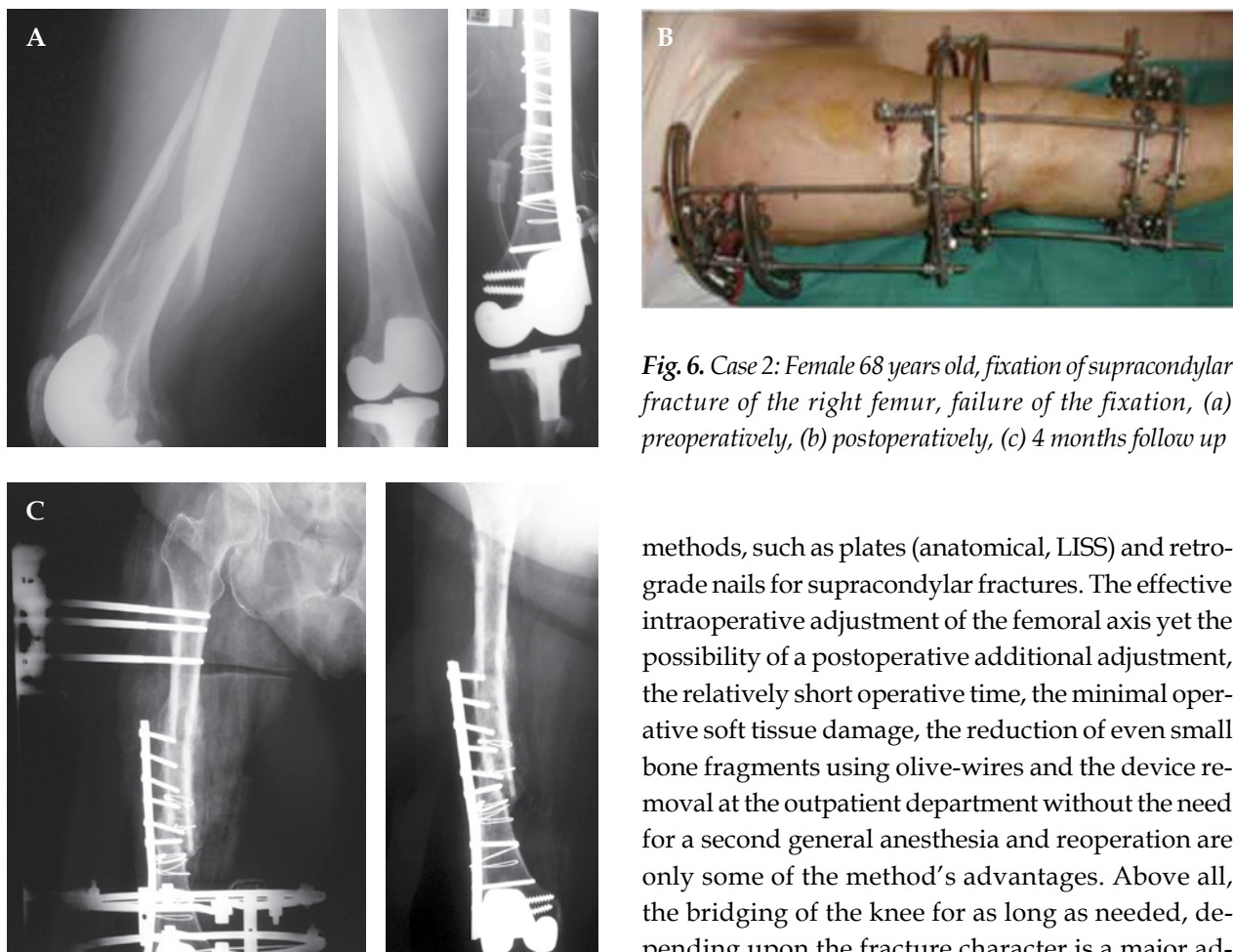
with antibiotics with no need to remove or replace them. Concerning the two most common complications, stiffness and development of postoperative osteoarthritis of the knee, the results were good, with a satisfactory range of motion of the knee in all patients and no osteoarthritic lesions development even in those with the longest follow up (Fig. 5-8).

4. Discussion

Fractures of the distal end of the femur are a challenge for the surgeon, presenting both a high degree of technical difficulty during the operation and high rates of failure of the fixation and nonunion formation. Fractures in young patients are high-energy injuries and usually coexist with injuries of other systems or can be accompanied by severe ligamentous lesions of the knee, other fractures of the ipsilateral limb or neurovascular lesions relating to open fractures. Fractures in elderly patients usually occur in osteoporotic bone or in the femur after a preexisting fixation (below nails, stems, DHS plates etc.) or in the bone of the femoral component of a total knee replacement, in the periprosthetic fractures. For all these challenges, the Ilizarov method is a powerful and effective tool in surgeon's hands presenting numerous advantages compared with other fixation

TABLE 1. *Evaluation of the outcomes using the ASAMI scale*

Bone results		
excellent	union, no infection, deformity $<7^\circ$, limb-length discrepancy <2.5 cm	8
good	union + any two of the following: absence of infection, $<7^\circ$ deformity and limb-length inequality of <2.5 cm	8
fair	union + only one of the following: absence of infection, deformity $<7^\circ$ and limb-length inequality <2.5 cm	1
poor	nonunion / re-fracture / union + infection + deformity $>7^\circ$ + limb-length inequality >2.5 cm	–
Functional results		
excellent	active, no limp, minimum stiffness (loss of $<15^\circ$ knee extension / $<15^\circ$ dorsiflexion of ankle), no reflex sympathetic dystrophy (RSD), insignificant pain	6
good	active, with one or two of the following: limp, stiffness, RSD, significant pain	10
fair	active, with three or all of the following: limp, stiffness, RSD, significant pain	1
poor	inactive (unemployment or inability to return to daily activities because of injury)	–
failures	amputation	–



methods, such as plates (anatomical, LISS) and retrograde nails for supracondylar fractures. The effective intraoperative adjustment of the femoral axis yet the possibility of a postoperative additional adjustment, the relatively short operative time, the minimal operative soft tissue damage, the reduction of even small bone fragments using olive-wires and the device removal at the outpatient department without the need for a second general anesthesia and reoperation are only some of the method's advantages. Above all, the bridging of the knee for as long as needed, depending upon the fracture character is a major ad-

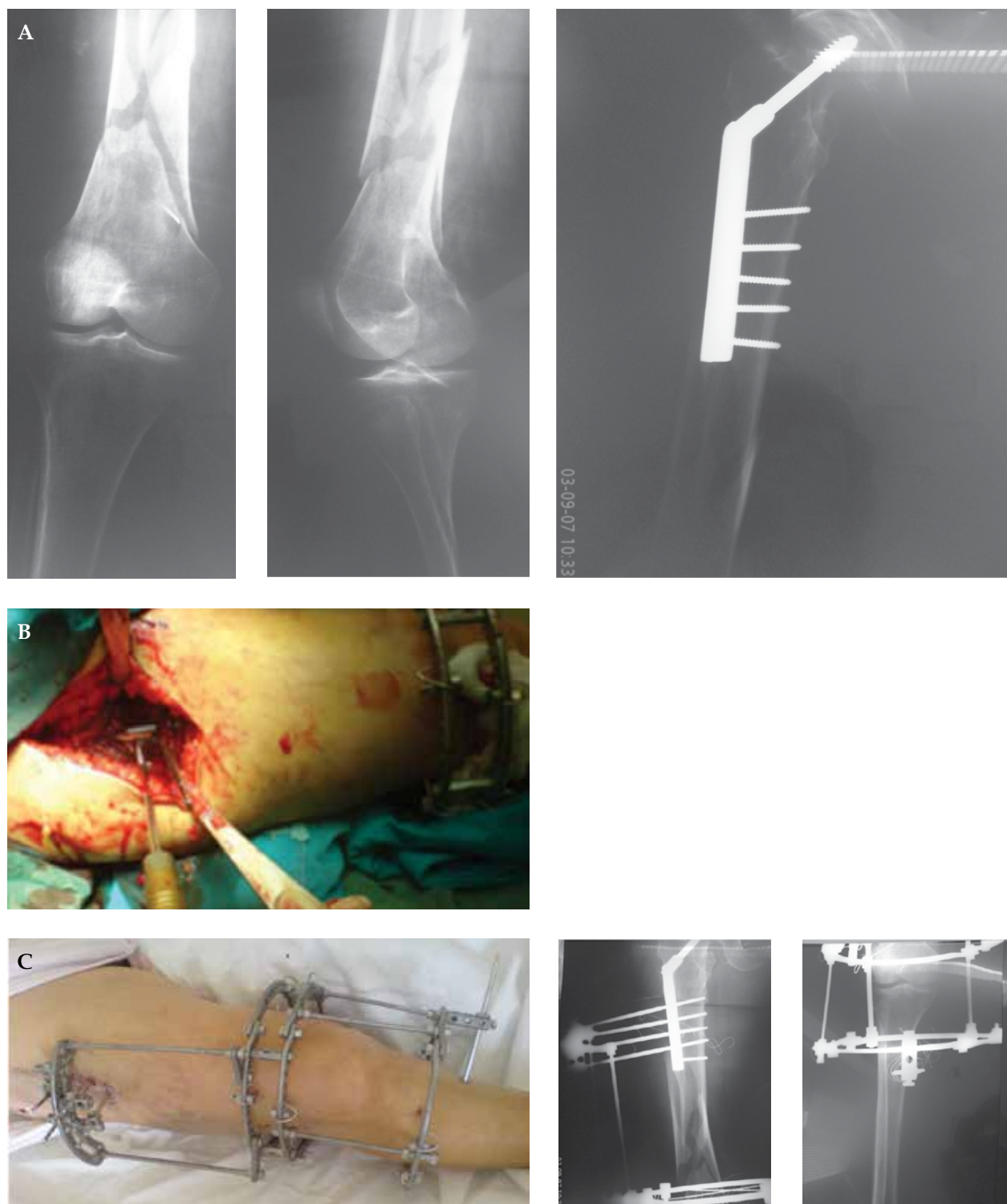


Fig. 7. Case 3: Female 72 years old, right supracondylar periprosthetic femoral fracture (below DHS). (a) preoperatively. (b) intraoperatively. (c) postoperatively

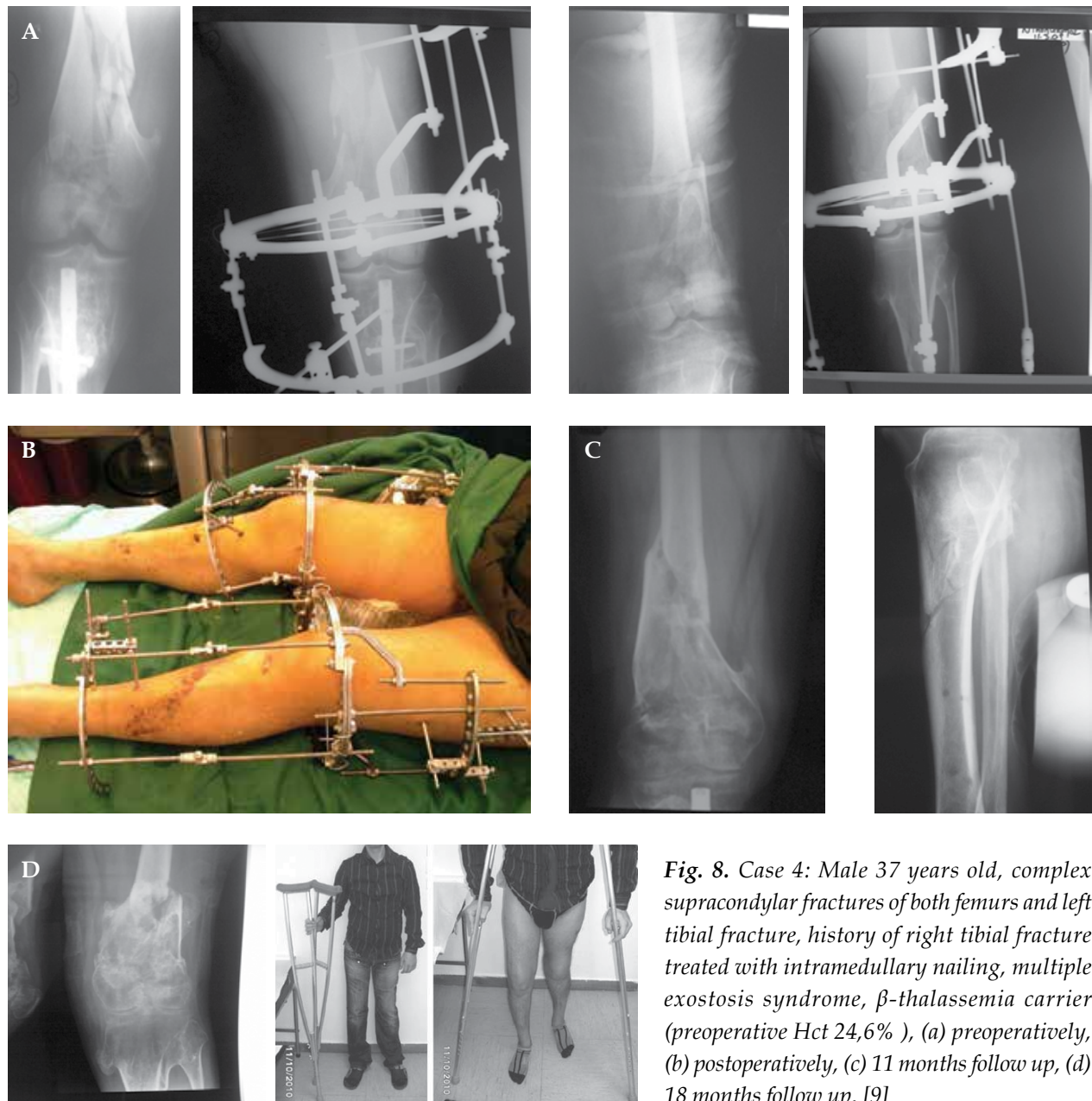



Fig. 8. Case 4: Male 37 years old, complex supracondylar fractures of both femurs and left tibial fracture, history of right tibial fracture treated with intramedullary nailing, multiple exostosis syndrome, β -thalassemia carrier (preoperative Hct 24,6%), (a) preoperatively, (b) postoperatively, (c) 11 months follow up, (d) 18 months follow up, [9]

vantage of the method, often necessary to preserve both the reduction and the stability of the joint, especially in highly comminuted fractures or those which are accompanied by severe ligamentous injuries. The frame construction by the surgeon intraoperatively, its versatility and the numerous possible combinations of the frame components enables the physician to exploit any characteristic of the fracture. In addition, this method minimizes or even eliminates the

patient's need for intra- or postoperative blood transfusion, which is very important for both multi-trauma and elderly patients. Finally this method presents low incidence of complications, commonly the minor and easily treatable complication of pin tract infection [7, 8]. 

Conflict of interest:

The authors declared no conflicts of interest.

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ΠΕΡΙΛΗΨΗ

ΣΚΟΠΟΣ ΤΗΣ ΜΕΛΕΤΗΣ: Τα κατάγματα του άπω πέρατος του μηριαίου αφορούν κακώσεις υψηλής ενέργειας σε νέους κυρίως ασθενείς, χαμηλότερης ενέργειας σε ηλικιωμένους οστεοπορωτικούς ασθενείς, παθολογικά κατάγματα, είτε περιπροθετικά κατάγματα μετά από ολική αρθροπλαστική γόνατος. Σκοπός της εργασίας είναι ο καθορισμός των ενδείξεων και η εφαρμογή της μεθόδου Ilizarov ως θεραπεία των καταγμάτων αυτών, καθώς και η αξιολόγηση των αποτελεσμάτων σε 16 τέτοιους ασθενείς.

ΥΛΙΚΟ ΚΑΙ ΜΕΘΟΔΟΣ: Μελετήθηκαν 16 ασθενείς (8 γυναίκες - 8 άνδρες) ηλικίας από 21 έως 85 ετών. Τα κατάγματα ήταν τύπου 33_A1,2,3 και 33-C1,2,3 κατά AO. Σε 2 περιπτώσεις τα κατάγματα ήταν περιπροθετικά και σε 2 περιπτώσεις αφορούσαν ψευδάρθρωση με αστοχία προηγούμενου υλικού. Σε όλους τους ασθενείς εφαρμόστηκε γεφύρωση του γόνατος και χρήση διδύμου δακτυλίου στο μηριαίο μέρος του πλαισίου στις περισσότερες περιπτώσεις.

ΑΠΟΤΕΛΕΣΜΑΤΑ: Ο μέσος χρόνος νοσηλείας ήταν 7 ημέρες και ο χρόνος μετεγχειρητικής παρακολούθησης των ασθενών ήταν από 6 έως 52 μήνες. Το πλαίσιο της κνήμης αφαιρέθηκε 4-8 εβδομάδες μετεγχειρητικά, ενώ το αντίστοιχο του μηρού κατά μέσο όρο μετά από 18 εβδομάδες. Ο μέσος χρόνος πώρωσης των καταγμάτων

των ήταν 18 εβδομάδες. Δεν παρατηρήθηκαν παραμορφώσεις, ούτε οστεοαρθριτικές αλλοιώσεις στους ασθενείς με το μακρύτερο χρονικό διάστημα παρακολούθησης. Η κινητικότητα του γόνατος μετεγχειρητικά ήταν ικανοποιητική και δεν παρατηρήθηκε κανένα ασθενές ψευδάρθρωση.

ΣΥΜΠΕΡΑΣΜΑΤΑ: Η αντιμετώπιση των κατάγματων του άπω πέρατος του μηριαίου τύπου 33-A1,2,3 και 33-C1,2,3 με συσκευή Ilizarov είναι επιτυχής και θεωρούμε ότι αποτελεί μέθοδο εκλογής. Τα πλεονεκτήματα αυτής είναι ο έλεγχος του άξονα του σκέλους, ο ελάχιστος χειρουργικός τραυματισμός, η πρόωγη κινητοποίηση καθώς και η αφαίρεση της συσκευής στα εξωτερικά ιατρεία χωρίς να υποβληθούν οι ασθενείς σε επανεπέμβαση. Σημαντικές επιπλοκές δεν παρουσιάστηκαν, παρά μόνο λοίμωξη στο σημείο εισόδου των βελονών, επιπλοκή όμως σχετικά εύκολα θεραπεύσιμη.

ΛΕΞΕΙΣ ΚΛΕΙΔΙΑ: κατάγματα άπω πέρατος μηριαίου, χειρουργική θεραπεία, κυκλικό πλαίσιο Ilizarov