Congenital Fibular Deficiency: Total Knee Arthroplasty with Extraarticular Deformity

A Case Report

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Abstract

Case: A total knee arthroplasty (TKA) was performed on a 35-year-old man with congenital fibular deficiency and a 20° varus and 28° antecurvatum tibial deformity of the left lower limb.

Conclusion: One-stage TKA and correction of the extraarticular deformity by means of intraarticular bone resections and a standard soft tissue release were performed to restore the limb's mechanical axis. Patients with congenital fibular deficiency present a wide range of limb deformities because of bone deficiencies or treatment sequels, which might require a specific surgical technique and small-sized implants to obtain good results during a TKA.

Congenital fibular deficiency (fibular hemimelia) has an incidence of 7.4 per 1 million births, and it is the most common long-bone deficiency[1]. The severity of clinical and radiographic abnormalities includes a broad spectrum of deformities. They range from those who lack clinical findings to mild limb length discrepancy, absence or vestigial fibulae, gross limb shortening, and foot and ankle deformities[2,3].

Proximally, shortening of the femur and an hypoplastic lateral femoral condyle are commonly found. An anterior or anteromedial bow is frequently present in the shortened tibia. Distally, foot and ankle deformities are common and include equinovalgus, tarsal coalition, absence of the lateral rays, and ankle instability[4]. The anterior cruciate ligament and posterior cruciate ligament are frequently absent, but clinical instability requiring surgical treatment is rare[5].

Recent advances in limb lengthening have enhanced the interest in limb salvage, increasing the indication of treatment for more complex cases, which can ultimately result in sequels such as femoral or tibial deformities[6].

A successful total knee arthroplasty (TKA) is based on the restoration of the mechanical axis and joint's neutral alignment[7]. Numerous reports have linked TKA malalignment with increased loads, poor functional outcomes, and failure[8,9]. TKA principles in patients with limb length discrepancy do not vary with those of the common population, correct prosthesis implantation, restitution of the limb's mechanical axis, and the achievement of joint stability by means of soft-tissue balancing[10-13].

Femoral and tibial deformities can occur either in the coronal, sagittal, and axial planes or in a combined fashion[14,15]. Therefore, deciding the appropriate surgical technique according to each case is mandatory to restore the limb's axis during a TKA[16-19].

Regarding the patients' leg length discrepancy and other deformities, the main objective after a TKA is to obtain parallel tibiotalar joints.

Finally, there is consensus about that beyond 30° of tibial deformity, the correction by means of intraarticular bone resections (IBR) and standard (on demand) soft-tissue release can cause a complex knee instability because of iatrogenic injury of the collateral ligament insertions, and instead, an osteotomy should be performed to correct the deformity[20-22].

To the best of our knowledge, there are no previous reports of TKA in patients with extraarticular deformity because of fibular hemimelia.

The patient was informed that data concerning the case would be submitted for publication, and he provided consent.

Case Report

We present a 35-year-old man with terminal fibular postaxial longitudinal hemimelia of the left lower limb, with 10.6 cm shortening (Fig. 1-A and 2-A). The patient has a femoral, tibial, and fibular shortening combined with a hypoplastic lateral femoral condyle, equinovalgus, lateral foot column absence, and ankle instability, corresponding to a Type I-B of the Achterman and Kalamchi Fibular Hemimelia classification[4]. He presented with severe left knee pain and a maximum walking distance of 200 m with cane assistance and using a 10 cm supplement in

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Keywords: congenital fibular deficiency, fibular hemimelia, TKA, extraarticular deformity

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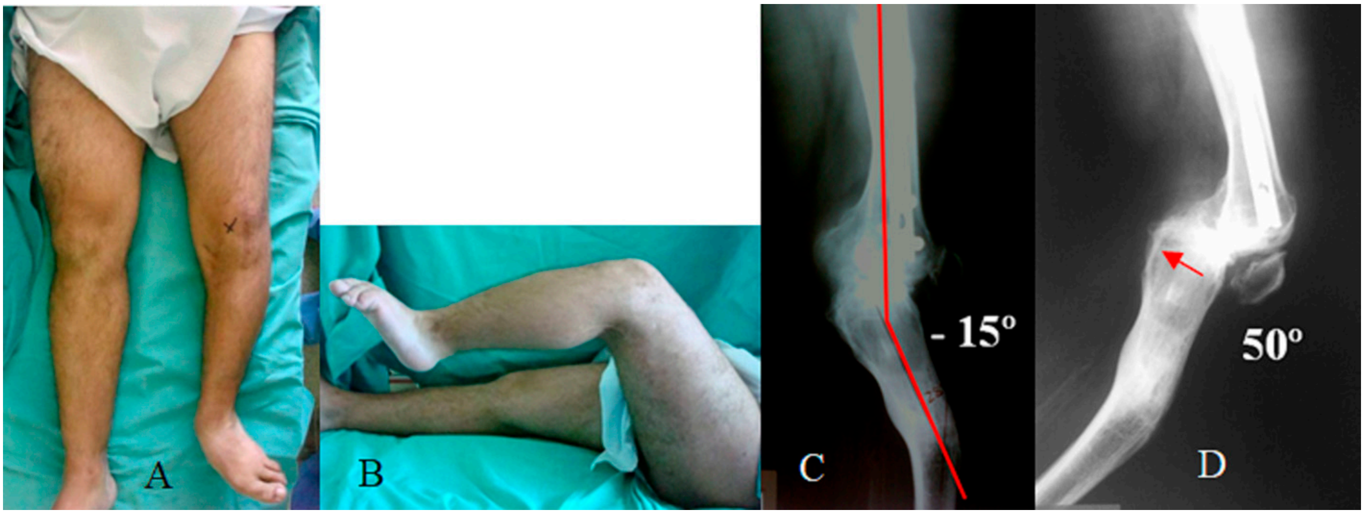

Fig. 1

Figs. 1-A and Fig. 1-B 35-year-old man with terminal fibular hemimelia of the left lower limb. Presents a 10.6-cm shortened limb with tibial and equinovalgus deformity. **Figs. 1-C and Fig. 1-D** Knee range of motion of 65° (−15° to 55°), posterior tibial subluxation, and patella baja.

his left shoe. Physical examination showed a stable knee, with a range of motion of 65°, from −15° in extension to 55° in flexion (Fig. 1-C and 1-D).

Surgical Treatment Background

At the age of 18 years, the patient went through a 12-cm lengthening treatment on his left tibia, which resulted in a proximal tibial deformity. Subsequently, the patient had undergone retrograde femoral nailing because of a fracture by the age of 34 years.

Radiographic Findings

The antero posterior (AP), lateral, and panoramic x-rays showed severe knee osteoarthritis with posterior tibial subluxation and patella baja (Figs. 1 and 2) and a deviation of the limb's mechanical

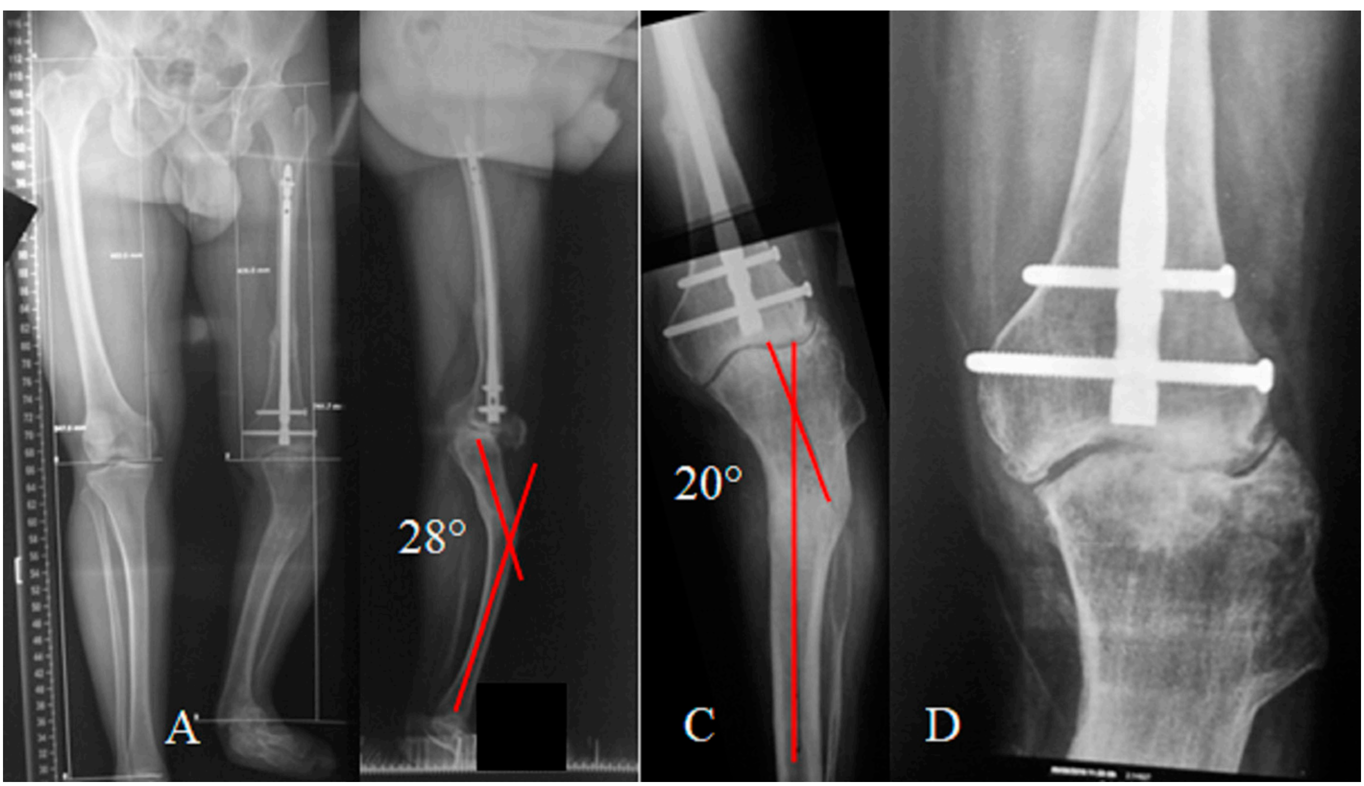

Fig. 2

Fig. 2-A Panoramic x-ray of both limbs. **Figs. 2-B and Fig. 2-C** Varus and antecurvatum deformity measurement. **Fig. 2-D** Severe knee osteoarthritis.

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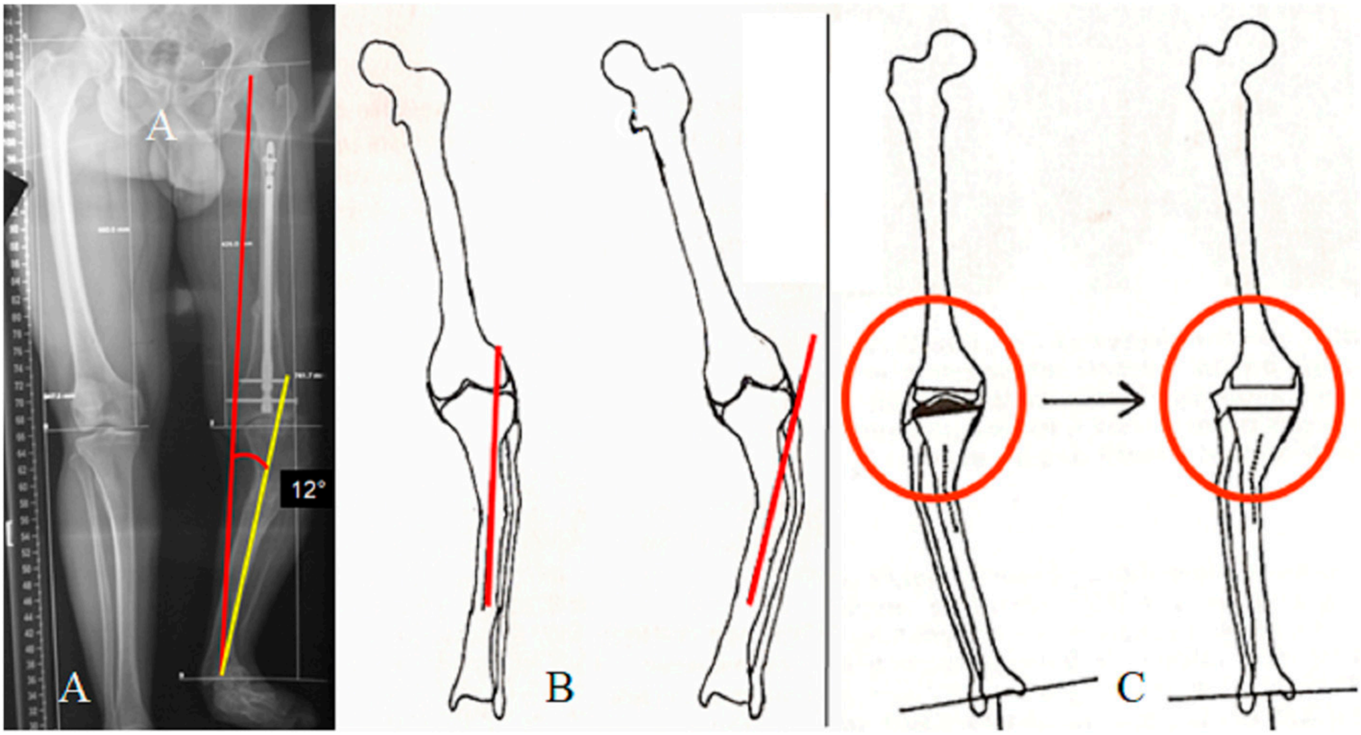

Fig. 3

Figs. 3-A and Fig. 3-B Mechanical axis deviation of 12°. **Fig. 3-B** For proximal tibial cut planning, the tibial shaft axis distally to the deformity is used. If the line passes inside the tibial plateaus, the correction can be made through IBR without compromising the knee stability. If it passes outside of the tibial plateaus, an osteotomy at the deformity is recommended. **Fig. 3-C** Tibial varus deformity will need a greater resection of the lateral tibial plateau, which might generate ligament imbalance and require an aggressive soft-tissue release to obtain symmetrical flexion and extension gaps. IBR = intraarticular bone resection.

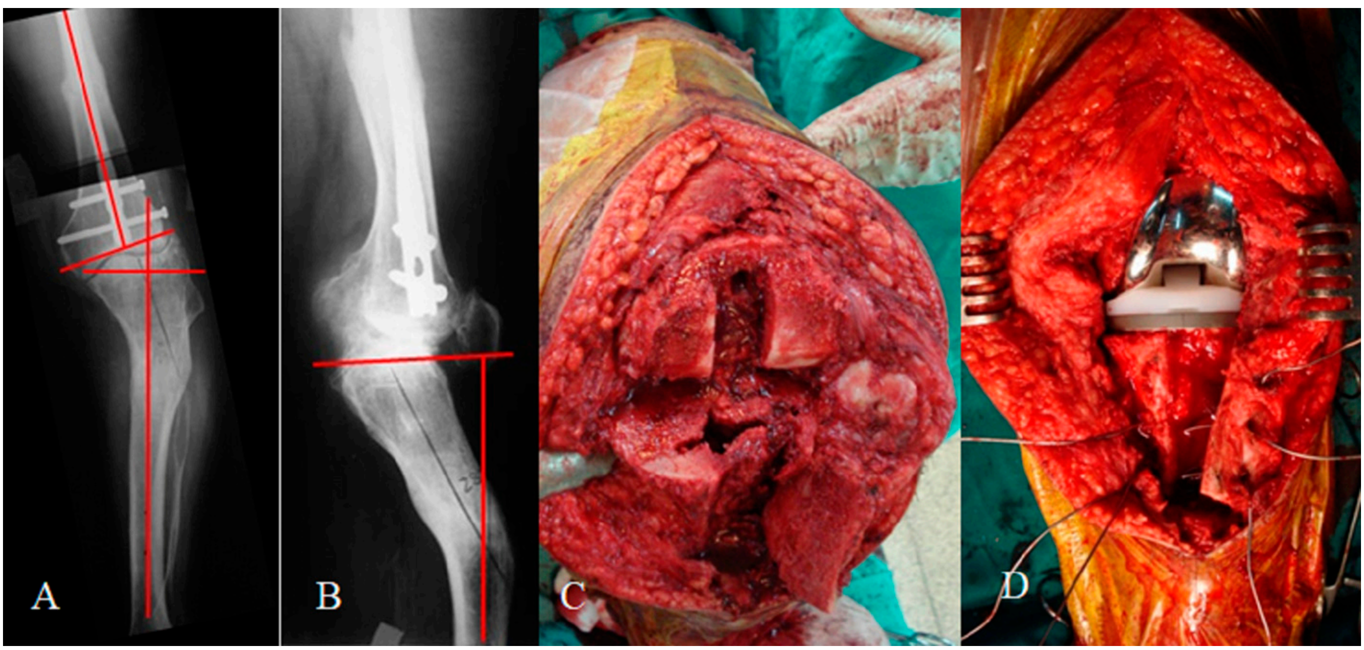

Fig. 4

Figs. 4-A and 4-B Tibial IBR must be made at 90° to the axis of the tibial shaft distal to the deformity while considering the posterior slope. **Figs. 4-C and 4-D** The anterior tibial tuberosity osteotomy was performed to get access to the joint. IBR = intraarticular bone resection.

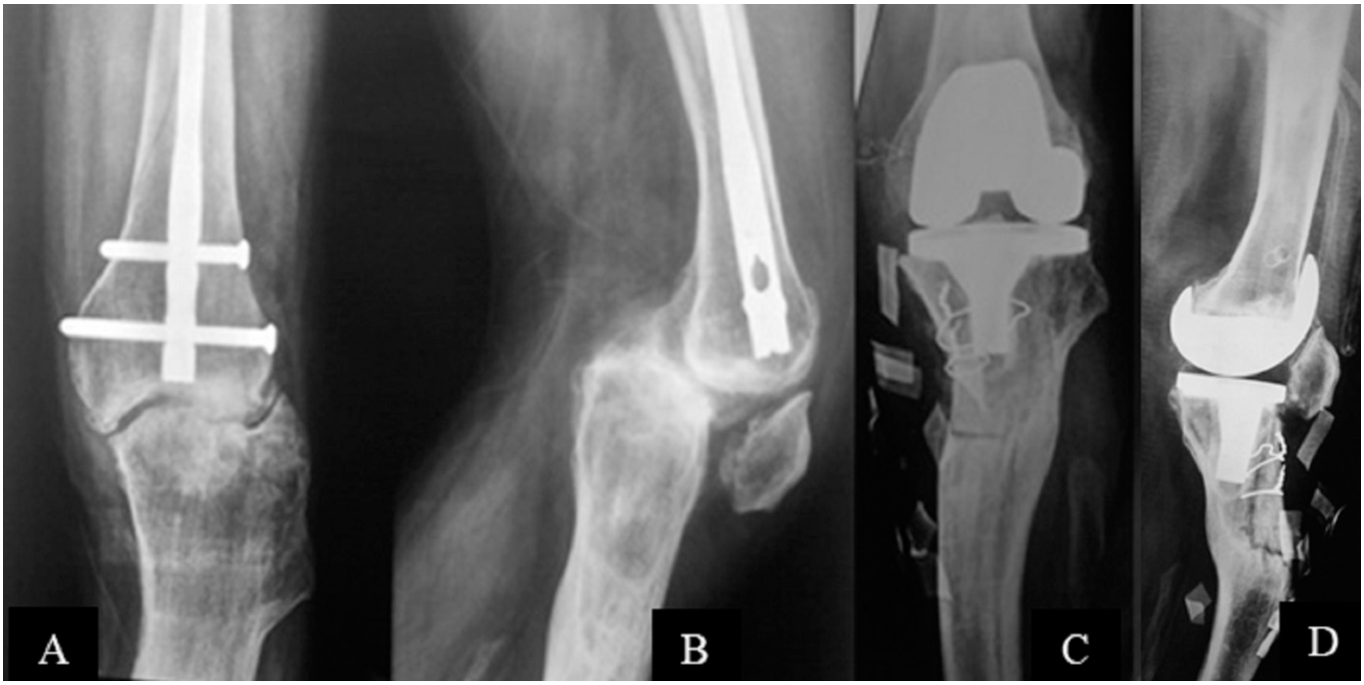

Fig. 5

Figs. 5-A and 5-B Preoperative radiographs. **Figs. 5-C and 5-D** Tibial component placed at 90° of the distal tibial shaft axis in the coronal and sagittal planes. Full extension of the knee recovered.

axis of 12° (Fig. 3). The proximal tibia shows a 20° varus and 28° antecurvatum deformity (Figs. 2 and 4).

Postoperative Follow-Up

A TKA with a posterior stabilized prosthesis was performed through an internal anterior approach and the osteotomy of the anterior tibial tuberosity (Fig. 5). The mechanical axis was corrected 10°, and the anatomical axis was restored to 2° (Fig. 6). To perform the femoral and tibial cuts and to determine the femoral flexion and tibial slope, extramedullary instrumentation was used.

At the 1 year postoperative follow-up, the patient achieved a range of motion of 85° (0° to 85°) with a Knee Society Score[23,24] of 89 points (Videos 1). At 7 years of follow-up, the patient walks without assistance and does stairs using a 10-cm supplement in his left shoe (Videos 2), and he is satisfied with the knee outcome.

Discussion

The treatment of fibular hemimelia aims to achieve equal limb length, with a plantigrade, stable, and flexible foot. To obtain this, patients should be carefully screened for limb deformities and their treatment should be highly individualized[25,26].

Most patients with fibular hemimelia will require surgical treatment of the deformities. When planning a TKA in these patients, the surgeon must consider the deformities and previous surgical treatment sequels as serious technical challenges[27].

TKA proper alignment is considered one of the key factors involved in the long-term outcome[23]. It is also important to optimize both the mechanical and shear stress of the bearing surfaces and the bone-prosthesis interface[28]. Furthermore, the correct alignment balances the loads transmitted through the soft-tissue envelope, which is an important aspect of the suitable functioning of the knee joint[29].

The surgeon's aim during TKA is to achieve an optimal alignment of the prosthesis components, restoring the knee joint alignment to be within 3° of mechanical axis[29,30]. Failing to achieve these principles has been linked with poorer prosthesis survivorship and worsens outcomes[7,27,31-34].

Most extraarticular deformities can be corrected with IBR associated with soft-tissue balance. Correct preoperative clinical and radiographical evaluation and appropriate surgical planning are mandatory to define the adequate femoral and tibial bone resections and to anticipate and avoid most of the complications related to the arthroplasty. Postoperative TKA instability because of an iatrogenic injury of the collateral ligaments during IBR is one of the most serious ones[17,35,36].

AP and lateral radiographs should be taken with an extended knee in neutral rotation to correctly evaluate the impact of the deformity in the limb axis (Fig. 2), plan the IBR, and measure the implant size (Figs. 3 and 4)[14,17].

During such evaluation, the limb's mechanical axis is outlined. On patients with varus extraarticular deformities, this axis is deviated medially from the center of the knee (Fig. 3), and in valgus deformities, it is deviated laterally. To evaluate the extraarticular deformity, the angle formed by the axis of the

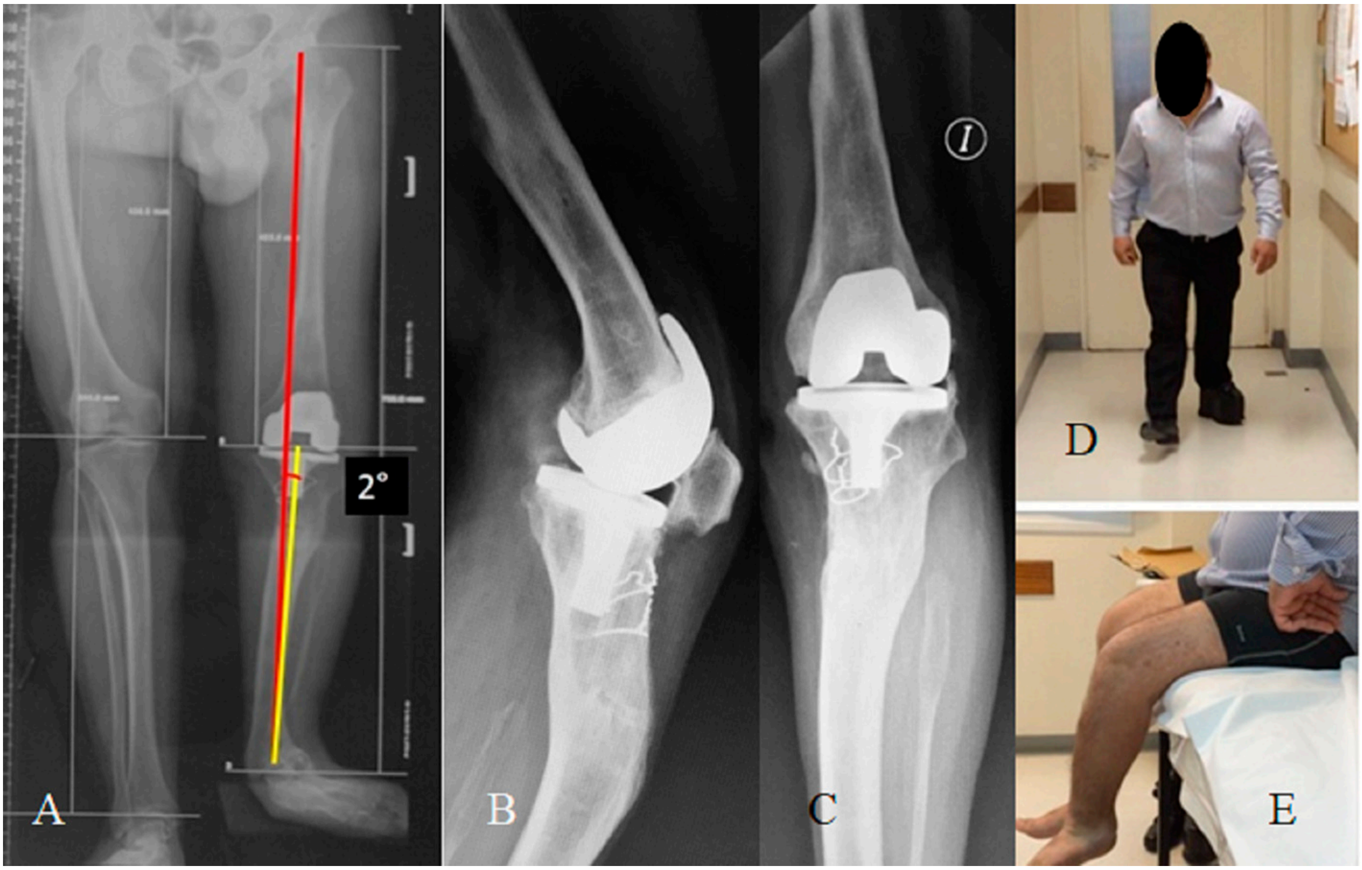

Fig. 6

Fig. 6-A Postoperative panoramic x-ray. The limb mechanical axis was corrected 10° and is within the accepted range. **Figs. 6-B and 6-C** 7-year-AP and lateral x-rays. **Fig. 6-D** The patient walks without assistance. **Fig. 6-E** 85° of knee flexion.

shaft at both sides of the deformity is measured (Fig. 2-B and 2-C). Tibial varus deformities will require a greater resection of the lateral plateau and valgus deformities of the medial plateau[13,32,33]. This resection creates asymmetrical flexion and extension gaps, producing a ligament imbalance that must not be underestimated (Fig. 3). To avoid joint instability, a standard on demand soft-tissue release on the concave side of the deformity must be performed[15,28,37].

The distal femoral bone resection must be planned at 90° of the femoral mechanical axis. Proximal tibial bone resection must be made, regarding the coronal plane, at 90° to the axis of the tibial shaft distal to the deformity, with the corresponding posterior tibial slope (Fig. 4) and considering the tibiotalar joint alignment[21,22,38]. All these bone resections can be performed with the extramedullary instrumentation.

Wang et al.[37] reported 7 patients with an average of a 20° tibial varus deformity (range 12°-30°), treated by means of medial soft-tissue release and lateral tibial plateau resection. They reported good results using posterior-stabilized prosthesis in all cases.

Complex knee instability should be taken into consideration when the deformity exceeds 10° in the tibial or femoral coronal plane[9,27,39]. Most of the publications point out that IBR is the first treatment option for patients with tibial deformities of up to 30° in the coronal plane[27,40,41]. Beyond this limit, IBR might affect ligament attachments or generate an extension gap too asymmetrical and difficult to compensate through soft-tissue release. In these cases, an extraarticular osteotomy must be considered, as well as the use of a constrained or hinged implant[13].

In agreement with Sculco et al.[42], surgeons performing a TKA in the setting of an extraarticular deformity should be prepared to release the surrounding soft tissue in addition to the IBR and also be ready to use a constrained implant when needed.

Conclusion

Performing a TKA in patients with osteoarthritis associated with an extraarticular deformity exceeding 10° is an uncommon situation and must be thoroughly evaluated. Patients should also have an individualized approach because planning is essential to avoid and overcome multiple complications during the surgery and to improve the prosthesis outcome in both the short term and the long term.

Because of the wide range of congenital and acquired deformities presented by patients with congenital fibular deficiency, small implants should be used to expect a successful result from a TKA. The planning and surgical techniques are the same as in patients with an extraarticular deformity without this congenital condition. ■

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