



# Proximal femoral elongation using distraction osteogenesis: it is possible to perform in patients with a previous massive bone allograft of the distal femur?

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## Background

Primary bone sarcoma frequently locates around the knee, mainly in the distal femur. Surgical en-block resection of this bone in young patients will affect the growing plate with the following limb discrepancy. For the group of patients younger than 10 years, different surgical alternatives have been reported, including above knee amputation, rotationplasty or expandable prostheses with or without contralateral epiphyseodesis. Another reconstructive alternative includes massive allografts. Biological reconstruction has the advantage to restore bone stock but definitively will generate limb discrepancy in the future. However, it is possible to carry out a lengthening procedure to equalize the length of the limb, avoiding the fixation of the contralateral growth cartilage.

## Questions/Purposes

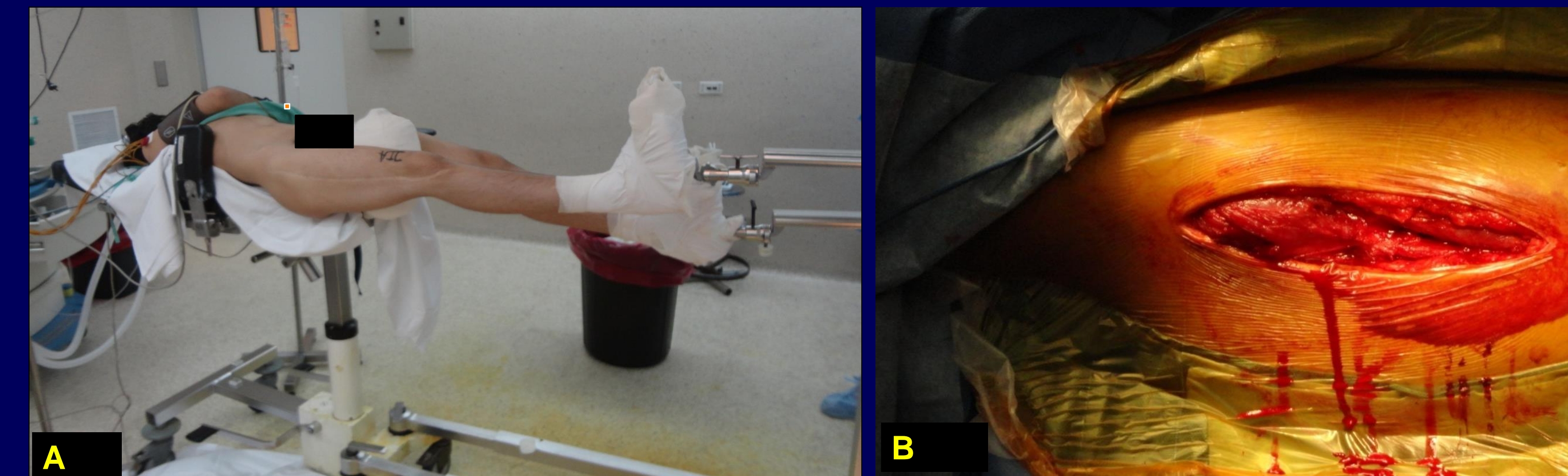
The aim of this study was to review the surgical technique for proximal femoral elongation using distraction osteogenesis, in patients with a limb discrepancy after the loss of the distal femur growth cartilage secondary to a tumor resection and to bone allograft reconstruction; and we asked what is (1) to the short-term clinical and radiological results, (2) The final functional score.

## Patients and Methods

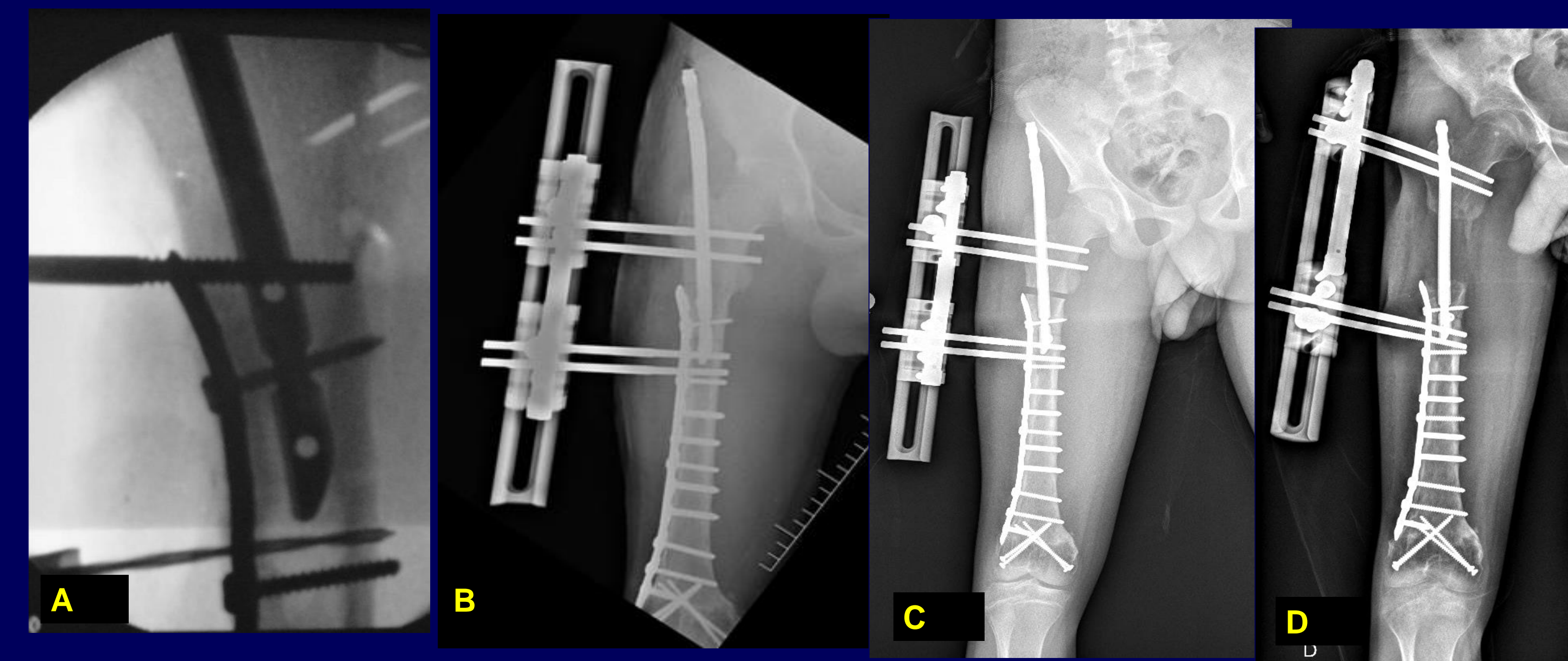
Between 2011 and 2018, 5 patients with limb length discrepancy secondary to a tumor resection and reconstruction with massive bone allograft of the distal femur, were treated with a proximal femoral elongation using distraction osteogenesis with an intramedullary nail. One patient was treated at other institution so excluded from the analysis. A total of 4 patients were included in this study. The mean age was 14 years (range 13 to 15). The mean limb discrepancy was 7 cm (range 6-8). Clinical data, including patient demographics and patient reported outcome scores, were collected prospectively. All patients were evaluated clinically and radiographically, using the Paley scoring system, which is based on range of motion of the knee, amount of lengthening, gait, axial deviation, pain, and ability to perform everyday activities. The scores were rated as excellent (95–100 points), good (75–94 points), fair (40–74 points), or poor (less than 40 points). We compare preoperative and final functional status with MSTs functional score.

## Surgical Technique

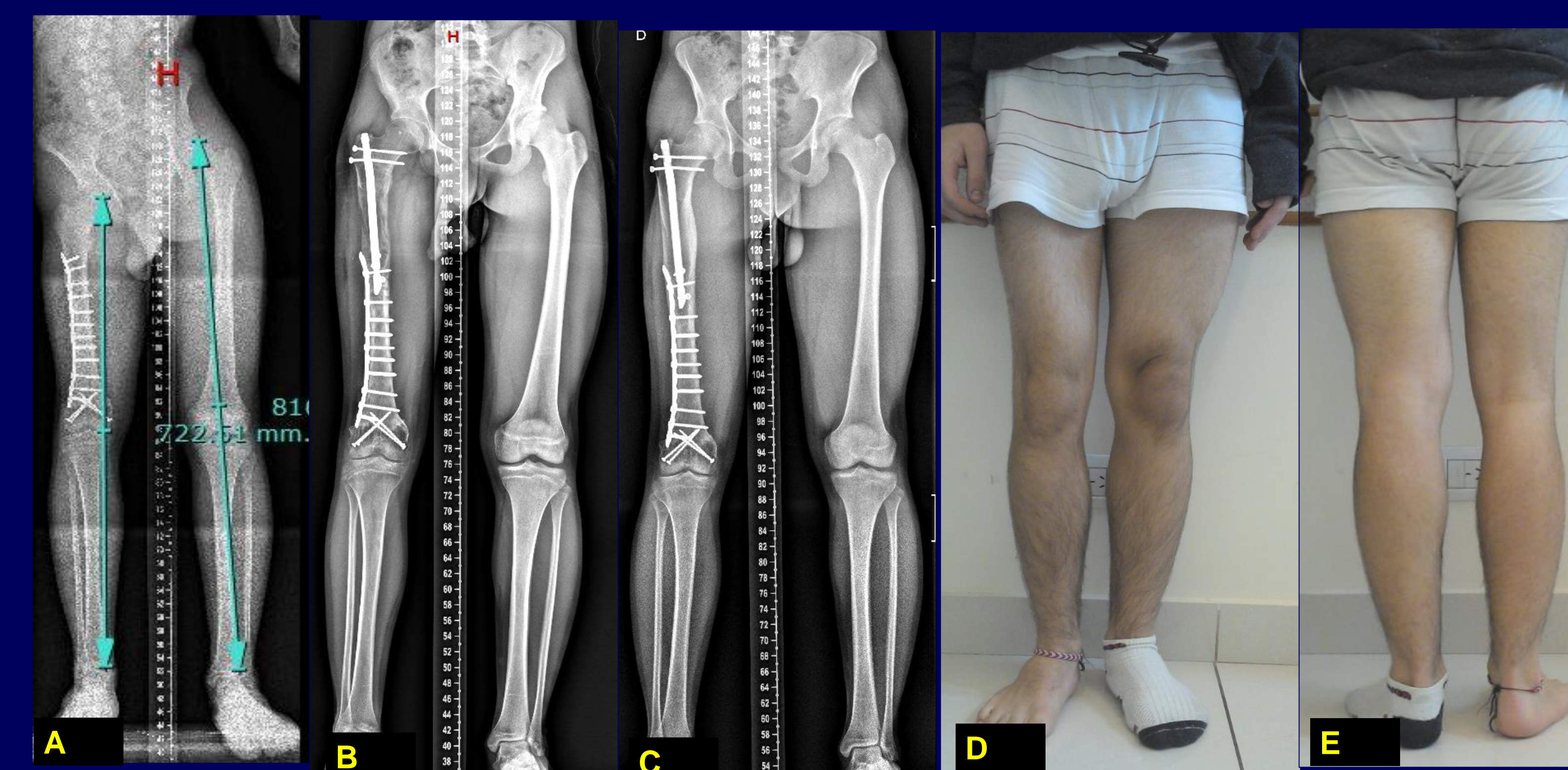
- 1-The patient is placed on the traction table (fig. 2-A)
- 2- Through a lateral approach of the proximal femur (fig. 2-B), the proximal screws are removed from the plate, leaving at least two screws near the osteotomy and in the patient's own femur.
- 3- The proximal femur is reamed to one millimeter larger than the diameter of the desired nail.
- 4- The nail is inserted up to the screws of the plate used for compression between the patient's own femur and the allograft, leaving outside the proximal femur a length of nail equal to the bone lengthening desired.
- 5- With the nail in place, an external fixator is applied for lengthening. All external fixation pins are inserted without coming into contact with the intramedullary nail (fig. 3-A).
- 6- The nail is removed, and the osteotomy is made between the two proximal and the two distal pins of the external fixator (fig. 3-B). The osteotomy must always be performed in autologous bone, never in the allograft.
- 7- The nail is reinserted and locked distally.
- 8- Distraction is begun at a rate of 0.25 millimeter four times a day, seven days postoperatively (fig. 3-C and D).
- 9- After the desired limb length has been achieved, the patient is returned to the operating room for insertion of the proximal locking screws and removal of the external fixator (fig. 4-B)



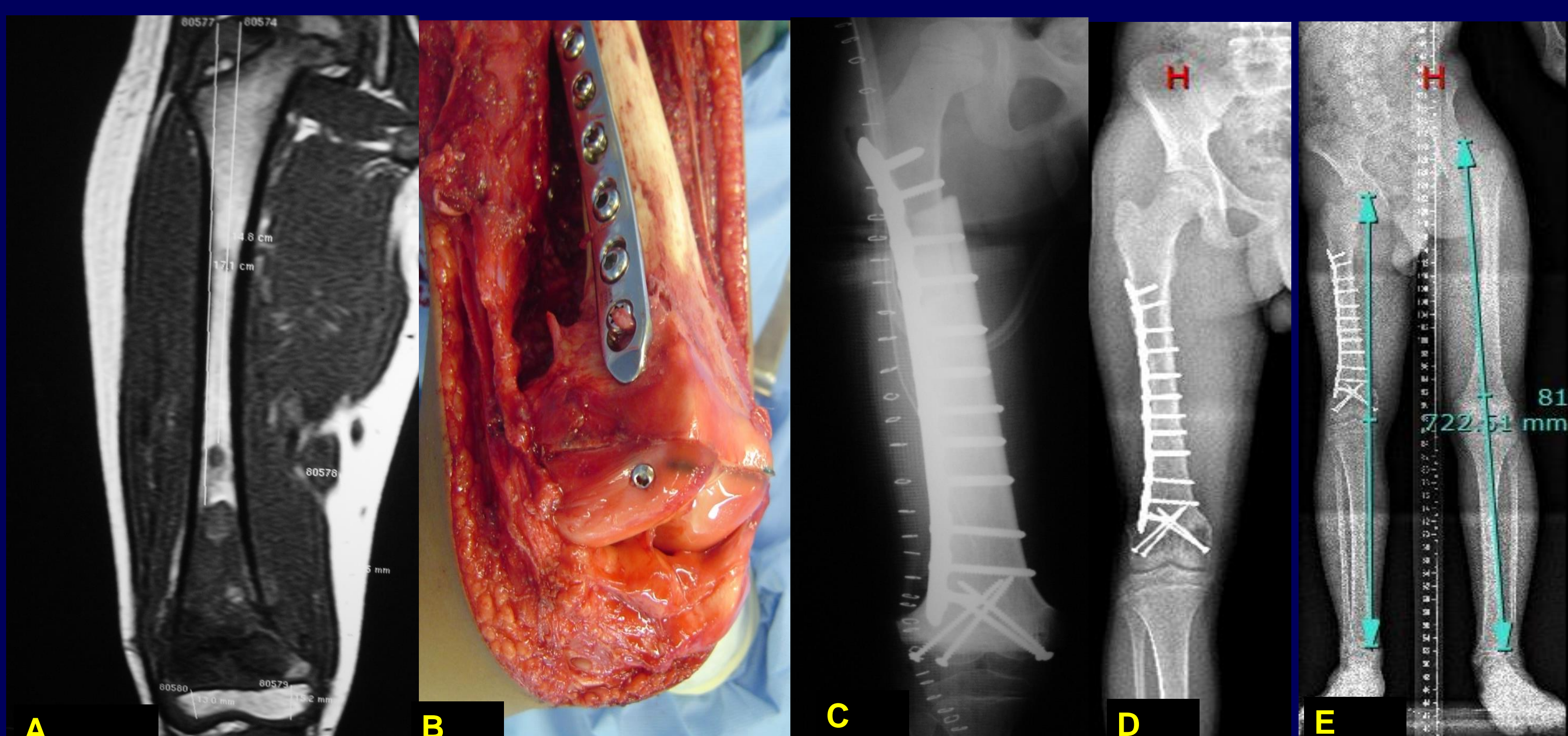
**Figure 2:** Intraoperative images. **A.** The patient is placed on the traction table. **B.** A lateral approach is performed to expose the proximal femur.



**Figure 3:** Anteroposterior radiograph of the femur, showing the proximal femur elongation. **A.** With the nail in place, an external fixator is applied for lengthening. All external fixation pins are inserted without coming into contact with the intramedullary nail. **B.** The osteotomy is made between the two proximal and the two distal pins of the external fixator. **C - D.** Distraction is begun at a rate of 0.25 millimeter four times a day, seven days postoperatively.



**Figure 4:** Radiographic and clinical images demonstrating how the limb discrepancy was corrected. **A.** Anteroposterior lower limb scan radiograph showing a preoperative limb discrepancy of 9 centimeters. **B.** Anteroposterior lower limb scan radiograph showing lengthening (9 centimeters) over an intramedullary nail. **C D an E:** After one year postoperative, the patient showed excellent clinical and radiographically correction of the deformity, with complete bone healing.



**Figure 1:** A 7-years-old man with an osteosarcoma of the distal femur. **A.** MRI of the femur performed at the time of the diagnosis, showing the tumor extension. **B.** Tumor resection with epiphysis preservation and intercalary allograft reconstruction. **C.** Postoperative radiograph after implantation of the intercalary allograft fixed with plate and screws. **D.** 4 years postoperative anteroposterior radiograph of the femur showing allograft integration, with a solid union of the osteotomies. **E.** A 7 years postoperative lower limb scan radiograph showing a limb discrepancy of 9 centimeters.

## Results

The mean follow-up was 4.5 years (2 to 8). The mean lengthening was 6.8 cm. The mean time of external fixation for femoral lengthening was 9 weeks (range: 8 to 11 weeks). At final follow-up, we observed excellent results in all patients, based on Paley's evaluation criteria. Two minor non oncological complications (superficial / pin infection) were reported, and both treated with oral antibiotics. The mean time for radiographic evidence of bone healing was 22 weeks (range: 20 to 25 weeks). We found a significant improvement between preoperative and postoperative MSTs score (21 vs 30 /  $p \leq 0.05$ ).

## Conclusions

Proximal femoral elongation using distraction osteogenesis with an intramedullary nail for patients with limb discrepancy after a distal femur bone tumor resection and allograft reconstruction showed at short-term follow-up, a good clinical and radiological results with no major complication reported. We consider this technique a feasible alternative for pediatric patients to restore the normal limb length and function after oncological resections of the distal femur.