

## Is it the expandable prosthesis the only reconstructive option after distal femur resections in children with high-grade bone sarcomas?

Laura Campanacci, Davide Donati & Marco Manfrini

**a. Background:** Skeletal reconstruction after resection of bone tumors in the lower extremity of children remains a challenge. Equal limb length at maturity and good functional outcome are the main goals. Reconstruction depends on tumor volume, on relation between tumor and physis, and on patient's age

**b. Questions/Purposes:** The distal femur physis usually contributes approximately 60% of the limb's growth. Except using expandable prostheses, is it possible to reduce the final LLD using biological reconstructions? Is it possible to standardize the type of reconstruction based on the resection level?

**c. Patients and Methods:** From 2000 to 2014, 275 patients below age 13, affected by high grade bone sarcomas were surgically treated at authors' institution. In 106 of them the tumor involved the lower half of the femur. Two patients had an amputation and 8 a rotation-plasty through an extra-articular distal femur resection. In the 96 limb salvaged there were 76 intra-articular distal femur resections and 20 intercalary distal femur resections. The lower level of intercalary resections depended on how close was the tumor to the physis. We identified 3 different situations for meta-diaphyseal tumors:

Group A: 12 cases. Tumor proximal enough to perform intercalary allograft fixed with screws proximal and distal to the physis

Group B: 5 cases. Osteotomy still proximal to the physis but screws only in the epiphysis

Group C: 3 cases. Tumor very close to physis, requiring osteotomy through or distally to it.

The authors reviewed the characteristics and the long-term results of this homogeneous series of 96 limb-salvaged cases, according to the different type of resection and reconstructions.

**d. Results,** In the 76 distal femur intra-articular resections, reconstruction was obtained by:

- distal femur megaprotheses in 70 cases: 6 modular adult-type prostheses, 28 modular prostheses with custom sliding tibial stem, 36 custom expandable prostheses (5 mechanical and 31 magnetic)
- arthrodesis (cement, rod and plates) in 1 case (multiple lung metastases at presentation);
- osteoarticular massive bone allograft (MBA) in 3 cases (all age 9)
- allograft-prosthetic hemiarticular composite in 2 (age 10 and 11);

In the 20 intercalary resections, reconstruction was always obtained by MBA (8 associated with vascularized fibula graft), fixed by long periarticular plates with epiphyseal screws.

At a mean follow-up of 72 months (12 - 174 months), 59 patients (61%) are alive (57 NED and 2 AWD) and available for the radiological and functional analysis through MSTs evaluation.

During follow-up the 59 long survivors (LS) experienced several procedures planned to deal with the longitudinal growth issue:

- non surgical procedures in magnetic expandable prostheses (146 Day-hospital procedures in 21 LS)
- minimally invasive lengthening for mechanical expandable prostheses (20 procedures in 4 LS)
- one step surgical lengthening of modular prostheses (4 LS)
- contralateral knee epiphysiodesis (2 in intercalary reconstructions, 4 in prosthetic reconstructions)
- epiphyseal screw removal after the healing of distal osteotomy (in all the intercalary reconstructions)
- Intramedullary expandable nailing (1 intercalary reconstruction)

But in LS, also several complications occurred with many surgery needed for revisions of implants:

- Mechanical complications with total revision of the implant (10 expandable prostheses, 1 modular prosthesis, 1 osteoarticular MBA)
- Mechanical complications with partial revision of the implant (2 expandable prosthesis)
- Infections with total revision of the implant (1 expandable prosthesis, 1 modular prosthesis)
- Revision of synthesis because delayed union, fracture or axial deformity (6 LS with intercalary MBA)

43 LS reached the skeletal maturity at the latest FU: functional outcome according to the MSTs system was good or excellent in 33 of them (77%); 9 had intercalary MBA, 1 allo-prosthetic composite and 23 prostheses. In this group of patients the final LLD was 0 to 2.5 cm (av 2.3 cm).

**e. Conclusions:** In growing patients with bone sarcomas, reconstruction after distal femur resection may find different solutions either prosthetic or biological. In children younger than 5 years and in very large tumors, type IIA rotation-plasty still represent the first option; between 5 and 9 years, if the tumor involves the physis and no metastases are visible, custom expandable prostheses are appealing but after 9 years modular prostheses with smooth tibial stem or distal femur composite prostheses may represent an effective and cheaper alternative. In selected cases, when the tumor is in the femoral meta-diaphysis and the physis is not involved, an intercalary resection may be feasible, and biological reconstruction may be performed with success.