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Excellent functional outcomes are achieved following joint sparing resections and custom prosthetic reconstruction for extremity bone sarcomas.

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Background

Preserving the native joint in patients with extremity bone sarcomas has the obvious advantage of preserving motion and retaining stability. Reconstruction of the resected segment using precision planning and custom prosthesis allows us to reconstruct the defect accurately. The application of Computer Assisted Surgery and Cutting guides has allowed us to perform very distal joint sparing resections as well. The immediate skeletal stability allows early rehabilitation and better extremity function. However concerns regarding growth, stability and survival of the juxta articular segments of bone and the impact on extremity function need to be assessed.

Questions/Purposes

We therefore asked

- 1) what are the functional results of joint sparing prosthetic reconstructions;
- 2) what are the complications associated with these prostheses; and
- 3) what is the viability and growth of the small remaining bone fragments.

Patients and Methods

We treated 12 cases of primary bone tumors between Jan 2006 to Jul 2014. Patients ranged from 5-24 years (Mean age 12). There were 10 patients with high grade osteosarcomas 2 with low grade osteosarcoma. The distal femur was involved in 7 patients, the proximal tibia in 3 and in two patients the tumor extended from the subtrochanteric region to the distal femoral condyles necessitating a double-joint sparing surgery. The osteosarcoma patients were treated with neo-adjuvant chemotherapy. Preoperative CT / MR images were imported into a 3D planning software (MIMICS) to assess the tumor extent and plan bone resections with adequate margins, sparing the articular ends. Custom prostheses were designed and manufactured to bridge the resection defect and matched the residual juxta articular bone. Seven patients had minimally invasive extendable joint sparing prostheses. All surgeries were executed using 3D planning software and intra-operative guidance,

using either Navigation or patient specific Instruments.

Immediate active mobilization and early weight bearing with a protective brace was allowed postoperatively.

Functional results were assessed according to MSTTS score. Complications were classified according to the International Society of Limb Salvage (ISOLS) classification system. The authors followed up all patients at a dedicated tumor clinic. Radiographs were obtained on a regular basis to evaluate osseous integration, complications if any and to ascertain the viability or growth of the remaining distal fragments.

Results

At a mean FU 4.7 year (0.4-9.3), the mean MSTTS score was 28.7 (20-30).

We noted 2 type 2A early prosthetic failures; only 1 in the proximal femur with a short segment fixation; and another stem loosening in the proximal femur. Both were due to inadequate bone formation at junction and they were revised with new custom components. We also noted 4 type 3A mechanical failures. All were extendable prostheses. Two growing prosthesis developed collapse of the extendible part. Surgical exploration and the insertion of C-collars were necessary to prevent further collapse. In one, the telescopic shaft of the prosthesis fractured 6 years after surgery; this required revision of the fracture component. In another, the anti-rotation pins within the telescoping shaft failed and a special component was added to control the rotation. There were 2 Type 5A complications: one patient died of lung metastases 5 months after surgery; one developed bone metastases with metastasectomy 5 years after surgery and lung metastases 7 years after surgery. He is still alive and undergoing palliative care. None of our patients developed infections. Successful lengthenings and limb length equalization was maintained in 7 patients with extendable prostheses.

Bone scans and serial radiographs indicated that the small remaining juxta-articular fragments (a mean length of 1.5cm, range 0.5 to 5 cm) remained viable in all and showed radial growth in skeletally immature patients.

Conclusions

The medium term functional results of custom joint sparing prosthetic reconstructions are excellent without compromising oncological results. With 3D surgical planning and computer-assisted surgery, the small remaining articular fragments were viable and could integrate into specially-designed custom implants. The retained native joints and ligaments provided good limb functions with unhindered activities. This may impose significant mechanical strains on the connecting components of

extendable prostheses (57% mechanical failure in this study).

Prosthetic reconstruction following joint sparing resections allows excellent extremity function. However, precise planning of the resection and accurate placement of a matched prosthesis using guided surgery are critical to successful outcomes. Extendable joint sparing prostheses require a design with better strength to tackle the rise in mechanical strain.