ELSEVIER

Operative Techniques in
Orthopaedics

The Use of Endoprostheses in Musculoskeletal Oncology

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Endoprosthetic replacements (EPRs) are widely used as reconstructive options for musculoskeletal tumors. They allow rapid and reliable return to full weight-bearing activities and ambulation. Replacements can be done for tumors of the femur, tibia, humerus, radius, ulna, and pelvis. We present the surgical techniques of routine EPRs for tumors of the distal femur, proximal tibia, and proximal humerus, which are the most common sites of primary bone tumors. The most common complications of EPRs including deep infection, aseptic loosening, and dislocation of the proximal humerus are all discussed.
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Introduction

Endoprosthetic replacements (EPRs) for bone tumors have become an accepted and commonly used reconstructive option for orthopaedic oncologists worldwide. They allow rapid and reliable return to full weight-bearing functional activities, which is an important advantage in a group of patients of which 25% will survive less than 2 years.[1] Our unit routinely uses EPRs to treat many musculoskeletal neoplasms and has implanted more than 2500 prostheses to date (Table).

Endoprosthesis for Primary Bone Tumors

Indications

EPR is indicated for malignant bone tumors involving the appendicular and axial skeleton. We have performed replacements for tumors of the humerus, radius, ulna, pelvis, femur, and tibia (Table). Excision of the fibula and the small bones of the hands and feet does not require prosthetic replacement. Benign aggressive lesions such as giant cell tumor of bone may require EPR in the setting of recurrence or extensive soft tissue involvement (Campanacci Grade 3) for local control of the tumor.

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Contraindications

Extensive primary tumors not resectable with an adequate oncologic margin are a contraindication for EPRs. In the presence of metastatic disease, close margin surgery with subsequent EPR may be attempted in an effort to preserve function and quality of life for a patient with an otherwise poor prognosis. In sites where function may be poor and there is the potential for significant complications to arise, amputation should always be considered. This is mostly true of the distal tibia where a transtibial amputation may provide a better outcome than reconstruction with a prosthesis. Alternatives such as biological reconstruction should also be considered.

Preoperative Planning

All suspected and biopsy-proven primary bone tumors are investigated with plain radiographs and magnetic resonance imaging (MRI) scans showing the entire length of the involved bone. Chest computed tomography scans and a whole-body bone scan are the minimum requirements for systemic staging. If a custom implant is to be used, measured radiographs are obtained to guide construction of a custom-made prosthesis once the resection level has been determined preoperatively. Otherwise, a modular device can be built at the time of tumor resection, using the resection specimen as a template.

Tumor resection is planned on MRI scans. In patients who have received chemotherapy, resection is based on evaluation of both prechemotherapy and postchemotherapy scans, the latter being done ideally within 2 weeks of the planned operation date. T1-weighted images are used to evaluate the muscle compartments and anatomical structures whereas

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Table Endoprosthetic Replacements Performed in the Royal Orthopaedic Hospital, Birmingham, UK from 1972-2012 by Site (Total = 2563)

Site	Number	%
Proximal humerus	286	11.2
Mid humerus	10	0.4
Distal humerus	27	1.1
Total humerus	36	1.4
Proximal ulna	3	0.1
Distal radius	6	0.2
Pelvis	114	4.4
Proximal femur	634	24.7
Mid femur	58	2.3
Distal femur	888	34.6
Total femur	82	3.2
Proximal tibia	411	16.0
Distal tibia	8	0.3

T2-weighted images demonstrate the tumor and peritumoral edema. The bony resection level is determined by the extent of intramedullary tumor and edema on the prechemotherapy MRI scans (Fig. 1A). The planned level of resection is generally done 2-3 cm from the nearest involved marrow. At our institution, this planned osteotomy is marked on a proforma, which is sent along with measured radiographs to Stanmore Implants (Elstree, UK) for production of a custom-made endoprosthesis. A prosthesis design plan is provided and confirms the planned dimensions (Fig. 1B). Limb salvage surgery is planned 2-3 weeks after the last cycle of chemotherapy.

The decision as to whether a modular or custom-made implant is used will depend on the location of the resection and in particular the length of remaining bone, the availability of either, and the cost. Modular prostheses do well in many situations but custom-made ones can deal with very unusual locations and short residual lengths of bone to attach the prosthesis to.

We present the surgical techniques of routine intra-articular resections of distal femur, proximal tibia, and proximal humerus tumors, which are the most common primary malignant bone tumors of the long bones. Common associated complications and their management are discussed. Intra-articular tumor involvement or a sarcoma with an associated intra-articular pathologic fracture requires an extra-articular resection for complete tumor removal. Extra-articular resections are uncommonly performed (<5% of all EPRs) and are not within the scope of this article.

Surgical Technique

Distal Femur

Since the 1970s, we have performed distal femoral resections routinely through an anteromedial approach to the distal femur.[2,3] Biopsies are planned through the anterior third of the vastus medialis. The incision for resection incorporates the biopsy tract and extends distally as a medial parapatellar curve

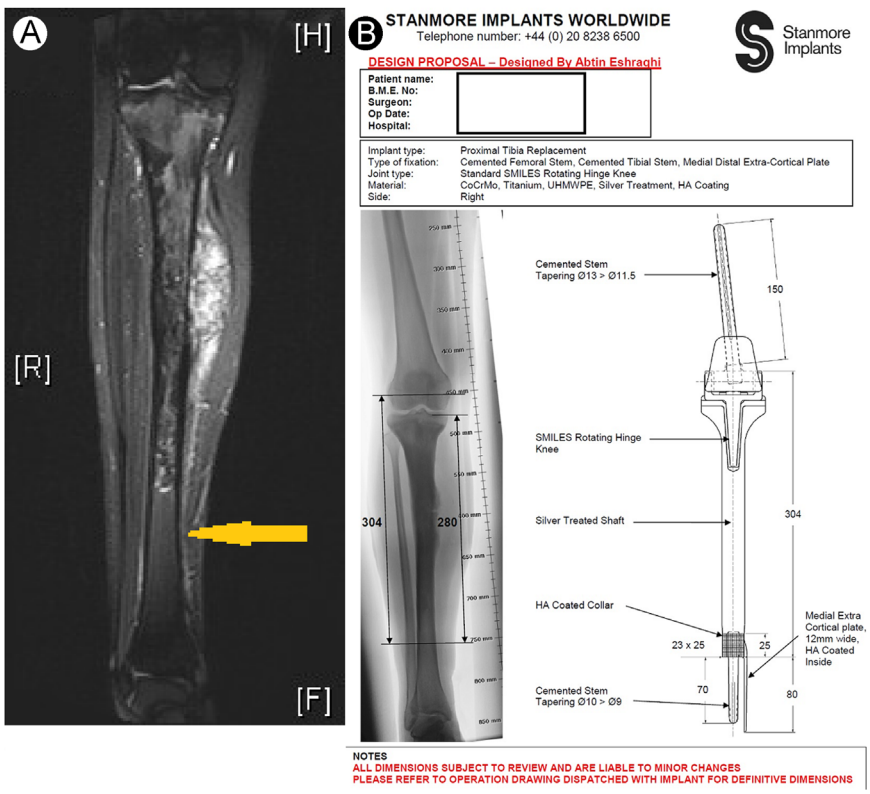

Figure 1 (A) Preoperative T2-weighted MRI scan demonstrating intramedullary extent of tumor and planned resection level (arrow). (B) Design plan of endoprosthesis based on measured radiographs and surgeon's planned resection level. (Color version of figure is available online.)