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Allograft-prosthetic composite versus megaprosthesis in the proximal tibia—What works best?

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ABSTRACT

Modular megaprosthesis (MP) and allograft-prosthetic composite (APC) are the most commonly used reconstructions for large bone defects of the proximal tibia. The primary objective of this study was to compare the two different techniques in terms of failures and functional results.

A total of 42 consecutive patients with a mean age of 39.6 years (range 15–81 years) who underwent a reconstruction of the proximal tibia between 2001 and 2012 were included. Twenty-three patients were given an MP, and 19 patients received an APC. There were nine reconstruction failures after an average follow-up of 62 months: five in the MP group and four in the APC group ($p = 0.957$). The 10-year implant survival rate was 78.8% for the MP and 93.7% for the APC ($p = 0.224$). There were no relevant differences between the two groups in functional results. Both MP and APC are valid and satisfactory reconstructive options for massive bone defects in the proximal tibia. In high-demanding patients with no further risk factors, an APC should be considered to provide the best possible functional result for the extensor mechanism.

Introduction

Resection of bone tumours, failed total knee replacements and failed previous reconstructions can lead to an important osseous defect of the proximal tibia. The main concerns for the surgeon are the sparse soft tissue coverage and, more importantly, restoring the patellar tendon insertion to achieve a functioning extensor mechanism. In most cases a knee arthrodesis can be avoided and the preservation of the joint leads to better functional results. There are three different techniques to reconstruct the knee articulation: an osteoarticular allograft, a modular and custom-made megaprosthesis (MP) or an allograft-prosthetic composite (APC) [1]. Osteoarticular allografts are associated with high long-term failure rates [2]. In our experience, osteoarticular allografts are a valid method of biological reconstruction in children to preserve the uninvolved half of the joint, but often they have to be replaced with a definitive implant after the end of growth. Modular and custom-made MP is a straightforward surgical technique and is easy to assemble intraoperatively. The postoperative rehabilitation programme and the time until full weight-bearing are short. Furthermore, the economic costs and the infrastructure required are less compared to allograft devices from a bone bank. However, the main disadvantage of MP is the sacrifice of the insertion of the extensor mechanism, which requires a fixation of the tendon to the metallic surface afterwards [3–5]. In contrast, the APC restores the bone stock of the tibia and, therefore, leads to a better load distribution. The allograft also enables the biological reattachment of the patellar tendon to the tibia, which leads to good functional results [6,7]. The resurfacing of the allograft by a prosthetic device avoids the long-term joint destruction associated with osteoarticular allografts. APC appears to combine the advantages of prosthetic and biological devices in restoring the proximal tibia [5,6,8].

The aim of this study was to compare (1) implant survival, (2) complications and (3) functional outcome between MP and APC in patients who underwent resection of the proximal tibia.

We hypothesised that APC of the proximal tibia should provide better functional results than MP, at the expense of a higher complication rate.

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Methods

Patients

A consecutive case series of 42 patients who underwent proximal tibial resection and reconstruction between 2001 and 2012 was reviewed retrospectively. All patients were treated in one institution by the same surgical team. The work was approved by the local ethics committee and all patients gave informed consent to participate in the study. The patients were divided into two groups according to the applied reconstruction technique: in 23 patients (group 1) the osseous defect of the tibia was replaced with an MP and in the remaining 19 patients (group 2) an APC was used. More detailed characteristics of both groups are shown in Table 1. The most common primary malignant tumour in both groups was osteosarcoma, followed by chondrosarcoma and Ewing's sarcoma. All benign bone lesions were diagnosed as giant cell tumours except for one desmoplastic fibroma in the APC group (group 2).

Surgical technique

The rotating hinged modular prosthesis system (Megasystem C; Waldemar LINK GmbH, Hamburg, Germany) was used in both groups. The average resection length of the proximal tibia in the APC group was 12.4 cm (range: 5–28 cm) and the tibial stem of the megaprosthesis was cemented in 10 of the 23 patients (43.5%) in this group. In the remaining 13 patients (56.5%) a press fit anchorage of the prosthesis was achieved. Different techniques were used for fixation of the extensor mechanism during the analysis period (Fig. 1). In the beginning of the case series the patellar tendon was pinched between the prosthesis surface and a plate fixed by screws (Fig. 1-A). After 11 patients (47.8%) this technique was abandoned due to a change in the design of the prosthesis. In the next 12 patients (52.2%) the patellar tendon was fixed directly to the prosthetic device by sutures alone (Fig. 1-B), and in three patients (13.0%) reinforcement by an artificial ligament was added (Fig. 1-C). A rotational medial gastrocnemius flap combined with a split-thickness skin graft harvested from the homolateral thigh was performed in six patients (26.0%). In all these cases primary skin closure was not possible or a severe skin necrosis had to be expected.

The mean resection length in the APC group was 14.4 cm (range: 9–28 cm) and the same reconstruction technique was used for the whole group. The grafts were harvested from cadavers under sterile conditions and stored afterwards at a temperature of −80 °C. For the later reconstruction the preservation of the patellar tendon insertion of the allograft was crucial (Fig. 2-A). The tibial graft was reamed and the long-stemmed prosthesis was fixed inside the graft using antibiotic-loaded cement. The free end of the stem was then implanted in the residual host tibial diaphysis. The prosthesis stem was cemented in 11 patients (57.9%) and a press-fit anchorage was performed in eight patients (42.1%). The graft and remaining host patellar tendons were sutured directly together end-to-end, providing a physiological position of the patella (Fig. 2-B). In two patients (10.5%) the patella and the patellar tendon were resected to achieve adequate margins. In both cases the tibial allograft was previously harvested to preserve the whole extensor apparatus, including the patella. During the reconstruction the allograft quadriceps tendon was sutured with the remaining host tendon.

The same postoperative rehabilitation programme was used for all the patients in the study. All patients received intravenous prophylactic antibiotic treatment for one week postoperatively. The reconstruction of the extensor mechanism was protected with a cast during the first six weeks after surgery, then active and passive motion of the knee was trained with stepwise augmentation of the allowed range of motion (ROM). Full weight-bearing and unrestricted ROM were allowed from 3 months postoperatively.

Measurements

All patients underwent clinical examination and had plain anteroposterior and lateral radiographs taken at 3-monthly

Table 1
Characteristics of the included patients.

	Group 1: MP (n = 23)	Group 2: APC (n = 19)	p-value
Age			
Mean (Range)	37.8 years (15–81)	41.8 years (22–76)	0.535
Sex			
Male	13 (56.5%)	8 (42.1%)	0.536
Female	10 (43.5%)	11 (57.9%)	
Diagnosis			
Malignant bone tumour	14 (60.9%)	7 (36.8%)	0.215
Benign bone tumour	1 (4.3%)	9 (47.4%)	*0.002*
Metastasis	4 (17.4%)	1 (5.3%)	0.356
Failed osteoarticular allograft	2 (8.7%)	1 (5.3%)	
Non-oncological	2 (8.7%)	1 (5.3%)	
Chemotherapy			
Done	11 (47.8%)	2 (10.5%)	*0.017*
Not done	12 (52.2%)	17 (89.5%)	
Radiation Therapy			
Done	3 (13.0%)	0	0.239
Not done	20 (87.0%)	19 (100%)	
Stem fixation			
Cemented	9 (39.1%)	11 (57.9%)	0.352
Uncemented	14 (60.9%)	8 (42.1%)	
Resection length			
Mean (Range)	12.6 cm (5–23)	14.4 cm (9–28)	0.476
Gastrocnemius rotational flap			
Done	6 (26.1%)	0	*0.024*
Not done	17 (73.9%)	19 (100%)	

APC—allograft-prosthetic composite; MP—megaprosthesis.

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