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Functional Outcome of Using Megaprosthesis to Extremities Reconstruction After Tumor Resection

K.M.Hussien, G.H.Kazem and M.A.Meselhy
Orthopedic surgery, Dept., Faculty of Medicine, Benha Univ., Benha, Egypt
E-mail: dr.karim.kh@gmail.com

Abstract:

Tumor endoprostheses are increasingly employed in symptomatic metastases of the long bones, and have enabled limb-salvage surgeries in original bone and soft tissue sarcomas. The themes of the chosen studies substantially matched the primary research issues presented in a consensus conference, with the survival result of orthopaedic implants being the most regularly voiced research question. Research on endoprosthetic tumour repair should also look at possible preventive approaches, since numerous studies have reported on the possibility of deep infections. In this brief review, we want to critically examine the current research on reconstructive surgery with megaprostheses. This literature review aimed to synthesise the most recent findings on cancer endoprostheses by analysing publications published over the last three years. In this article, we want to take a critical look at the existing literature on reconstructive surgery with megaprostheses. We detail the development of megasprosthetic implants, whether they are appropriate for usage, and what happens before and after surgery so that the general orthopaedic surgeon may become acquainted with a procedure often reserved for specialty hospitals.

Keywords: Functional outcome, Megaprosthesis, Extremities Reconstruction.

1. Introduction

Five-year survival rates have improved for several forms of primary sarcoma with the introduction of potent chemotherapeutic drugs [1].

Amputation is no longer the orthopaedic surgeon's exclusive contribution to the treatment of primary bone tumours [2], thanks to the rapid rise in popularity of limb-salvage surgery.

Surgical approaches for saving limbs with aggressive sarcomas and in limb reconstruction have become possible because to advancements in the design of megaprosthesis and developments in chemotherapy regimens [3].

Large skeletal and soft tissue deficiencies are left after the severe dissection required for the appropriate removal of tumour tissue. These flaws cannot be covered by conventional prostheses [4].

Megaprostheses have come a long way, with recent advancements including more durable materials, more realistic designs, antimicrobial silver coating, and methods to better integrate with the host bone [5].

Prior to the advent of modular prostheses, patients were fitted with specialised implants to replace the proximal or distal humerus, or sometimes the complete humerus, in the upper limb [6].

To replace the proximal femur, distal femur, complete femur, proximal tibia, distal tibia, and entire tibia, similar implants have been designed. The soft tissue sleeve is typically deployed and secured directly over the prosthesis in the majority of these designs.

The majority of bone abnormalities nowadays are treated by modular megaprostheses reconstruction, which is associated with a greater complication rate due to the larger size of the bone and soft tissue defects involved [7].

2. Patients and Methods

- Systematic literature review studies for using of Megaprosthesis for patients of all ages with large bone defect

2.1. Inclusion criteria:

- Age group: patients of all ages with large bone defect

2.2. Exclusion Criteria:

- Non English papers.
- Non human trials.
- Articles with no clinical data.
- Duplicates

2.3. Methods

- We Searched of Medline (PubMed), the Cochrane Library ,google scholar and Cumulative Index to Nursing and Allied Health Literature (CINAHL) for literature of functional outcome of using megaprosthesis for bone defect reconstructions done in peroid between 2010 till december 2021
- We used key words to generate sets for the following themes: orthopedic megaprosthesis ,reconstructions of large bone defects .Studies that clearly not related to our research question immediately excluded.

2.4Patient group:

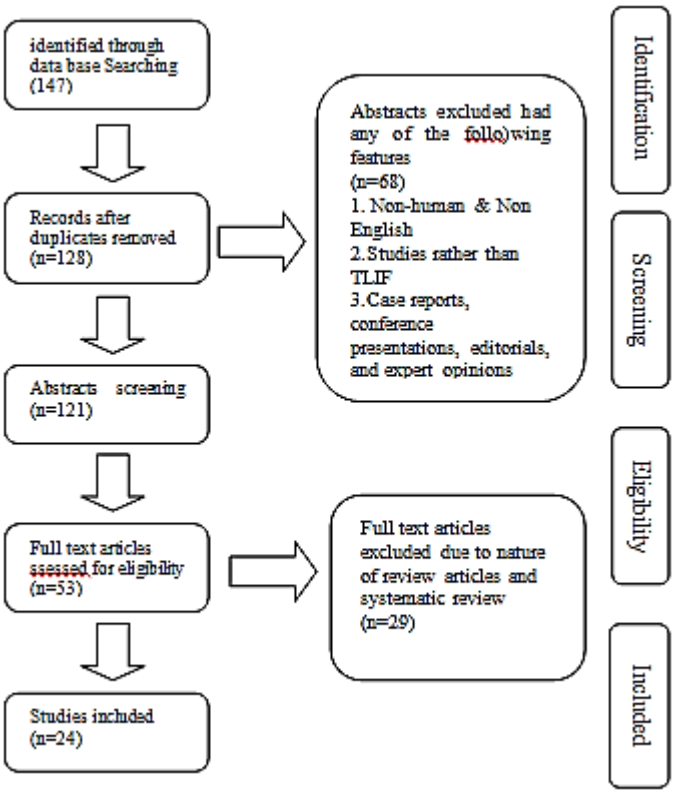

Fig. (1) Flow diagram showing selection of articles**.**

3.Results

1.Tumour endoprostheses in the shoulder girdle

Five studies were identified dealing with tumour endoprostheses around the shoulder girdle.

In a study by Min et al, the functional outcome of patients with scapular hemiarthroplasty following total scapulectomy for tumours was investigated. The ROM, with average shoulder abduction of 45.3° and flexion of 65.7°, was relatively better than in the abovementioned studies on proximal humeral resections followed by endoprosthetic reconstruction. Moreover, rotator-cuff reconstruction was associated with a better postoperative function and improved MSTS score.

Table (1) Tumour endoprostheses in the shoulder girdle.

Publication	Results
Min L et al. Int Orthop 2017 [8]	Six chondrosarcomas, four osteosarcomas, two Ewing sarcomas, two myelomas, and one malignant fibrous histiocytoma (MFH) patients who underwent scapular hemiarthroplasty following total scapulectomy were included in the retrospective study (2011-2014). There were no infections, dislocations, pressure ulcers, wound healing problems, or mechanical failures during the average 3.4-year follow
Maclean S et al. J Shoulder Elbow Surg 2017 [9]	Six chondrosarcomas, four osteosarcomas, two Ewing sarcomas, two myelomas, and one malignant fibrous histiocytoma (MFH) patients who underwent scapular hemiarthroplasty following total scapulectomy were included in the retrospective study (2011-2014). There were no infections, dislocations, pressure ulcers, wound healing problems, or mechanical failures during the average 3.4-year follow
Schmolders J et al. Int Orthop 2017 [10]	Reconstruction for (semi-)malignant tumours (n = 9) and metastases (n = 21) following intra-articular excision of the proximal humerus in 30 patients treated with MUTARS (implantcast GmbH, Buxtehude, Germany); mean follow-up of 2.2 years; 96% limb survival during this time period.

Wang B et al. Int Orthop 2015 [11]	Following proximal humeral bone tumour resection in 18 patients treated with endoprosthesis polypropylene (PPP) mesh composite, the mean follow-up duration was 4.7 years, and the mean MSTS score was 66.7% at last follow-up. The average range of motion (ROM) was 36 degrees for abduction and 39 degrees for shoulder flexion.
Fujibuchi T et al. J Shoulder Elbow Surg 2015 [12]	Twelve patients were treated with PPP solely connected to soft tissues, whereas nine patients had a proximal humeral endoprosthesis hung by polypropylene (PPP) mesh in bone. Shoulder instability occurred in 4/12 patients who had the traditional approach (33.3%) but in 0/12 individuals who used the bone-suspended approach.

1)Tumour endoprostheses in the pelvis

Tumor endoprostheses and pelvic prosthesis reconstruction were the subject of three separate research efforts. Liang et alinvestigation .'s of the results of hemipelvic excision included 35 patients who had 3D-printed pelvic endoprostheses inserted. There were nine patients who had problems (25.7%), including seven who had trouble recovering from wounds and two who dislocated their hips. Similar to Wang et al., this research looked at the results of 11 patients who had 3D-printed hemipelvic endoprostheses made specifically for them. At the most recent follow-up, the mean MSTS score was 64.0%, which is similar to the 53.9% recorded.

Table (2) Tumour endoprostheses in the pelvis.

Publication	**Results**
Liang H et al. Bone Joint J 2017 [13]	35 patients treated with 3D-printed pelvic endoprostheses between 2013 and 2015 (three iliac prostheses, 12 standard hemipelvic prostheses, 20 screw-rod connected hemipelvic prostheses) implants used for osteosarcoma (n = 11), chondrosarcoma (n = 9), Ewing sarcoma (n = 6) and others (n = 9) – wide margins in 15 patients (42.9%), marginal in 14 (40%) and intralesional in six (17.1%)
Wang B et al. Int Orthop 2015 [14]	six patients included treated for a malignant pelvic tumour involving regions I/II/IV with a hemipelvic prosthesis (LDK, Co. Ltd., Haidian, Beijing, China) – mean postoperative MSTS score was 53.9% – stress tests were performed at a force of 400 N when sitting and standing on two feet
Yong Z et al. Int Orthop 2011 [15]	8 patients , The follow-up ranged from 10 to 54 months (27 months on average). Overall survival rate was 62.5%

1)Tumour endoprostheses in the proximal femur

Table (3)

Publication	**Results**
Li D et al. Int Orthop 2018 [16]	extra-articular resection of osteosarcoma (n = 7), chondrosarcoma (n = 7), undifferentiated pleomorphic sarcoma (UPS; n = 3) and malignant peripheral nerve sheath tumour (MPNST; n = 1) in hip/proximal femur – pelvic defect reconstructed by modular hemipelvic endoprosthesis, proximal femur reconstructed by using custom-made or modular prox. femoral endoprosthesis
Stevenson JD et al. Bone Joint J 2018 [17]	proximal femoral replacement without acetabular resurfacing reviewed in 100 patients treated between 2003 and 2013 – 74 procedures for metastases, 20 for primary bone tumours and six for myeloma – follow-up > one year in 49 patients (mean: 3.6 years), of whom six had Grade 1 acetabular wear and two Grade 2 acetabular wear; the others had normal acetabular wear
Gorter J et al. Int Orthop 2017 [18]	10 patients treated between 2005 and 2014 with a PTTF retrospectively included – mean follow up of 5.3 years, with an implant, limb and prosthesis survival of 90%, 100% and 80%, respectively
Drexler M et al. Bone Joint J 2015[19]	65 patients treated with bipolar proximal femoral endoprostheses for tumours (most commonly osteosarcoma, n = 20) – mean follow-up of 9.1 years, after which degenerative changes in the acetabulum were seen in three patients (4.6%), heterotopic ossifications in 17 (26%) and prosthetic head protrusion in nine patients (13.8%)
R Van Rooyen et al. Eur J Orthop 2016 [20]	109 tumor patients (age range 16–86 years) who underwent proximal femoral reconstruction with the MRP megaprosthesis from 2002 to 2011. There were 70 patients with metastases, 34 patients with bone sarcomas, and five patients with hematological malignancies141

Five studies dealing with tumour enoprostheses of the proximal femur could be included in our review , Of note, Li et al obsrved a mean MSTS scre of 93.0% for patients treated with hemipelvic and proximal femoral endoprostheses, although significantly more structures had to be sacrificed in their procedures , nterestingly, according to Stevnson e al, only eight out of 49 patients treated with unipolar (*n* = 64) and bipolar (*n* = 36) endoprostheses without acetabular resurfacing showed acetabular wear after a minimum follow-up of one year, not exceeding Baker Grade 2.

Tumour endoprostheses in the knee region

Six articles were identified dealing with tumour endoprostheses around the distal femur and proximal tibia , in the cohort of Holm et al, most complications observed in this study on 50 patients with megaprostheses of the knee joint and total femur were due to deep infection (*n* = 19). Twenty-seven stem fratures (12.2%) were repoted by Hauer et al in a study involving 221 patients treated with the Kotz Modular Femoral Tibial Reconstruction System (KMFTR®; Stryker Inc., Rutherford, NJ, USA).[25]

Table (4) Tumour endoprostheses in the knee region.

Publication	Results
Ethebehere M et a. J Bone Joint Surg Am 2016[21]	Patellar height was measured using the Insall-Salvati ratio (ISR) and the Insall-Salvati patellar tendon insertion ratio (PTR) immediately postoperatively and at the last follow-up; patients had either a distal femoral (n = 29), proximal femoral (n = 9), proximal tibial (n = 9), or total femoral (n = 8) megaprosthesis; the average In 27 patients (54%), the time between the first operation and the first revision was three years. - system failure in 27 patients (12%), most commonly in the distal femur (n = 21) - total of 221 patients treated with the Kotz Modular Femoral Tibial Reconstruction System (KMFTR, Stryker Inc. Rutherford, NJ, USA) reviewed for implant fracture (112 distal femur, 53 proximal tibia, 40 proximal femur, 13 total femur, three distal femur
Hom CE et al. Int Orthop 2018[22]	108 consecutive patients with mature bone growth as demonstrated by imaging tests had 108 cemented endoprosthetic knee replacements for osteosarcoma resectio.
Hauer TM et al. J Arthroplasty 2018[23]	Patients were followed for a mean of 54 months (range, 31-78 months), and after 23 months, one patient had died from multiple metastases after surgery 247 rotating-hinge hemiarthroplasty. The GMRS stands for the Global Modular Reconstruction System. A minimum of two years of oncologic follow-up was performed (mean, 4 years; range, 2-8 years). The implantation of prosthesis
Zhang C et al. Int Orthop 2018[24]	Patellar height was measured using the Insall-Salvati ratio (ISR) and the Insall-Salvati patellar tendon insertion ratio (PTR) immediately postoperatively and at the last follow-up; patients had either a distal femoral (n = 29), proximal femoral (n = 9), proximal tibial (n = 9), or total femoral (n = 8) megaprosthesis; the average In 27 patients (54%), the time between the first operation and the first revision was three years. - system failure in 27 patients (12%), most commonly in the distal femur (n = 21) - total of 221 patients treated with the Kotz Modular Femoral Tibial Reconstruction System (KMFTR, Stryker Inc. Rutherford, NJ, USA) reviewed for implant fracture (112 distal femur, 53 proximal tibia, 40 proximal femur, 13 total femur, three distal femur
Wang CS et al. J Arthroplasty 2015[25]	108 consecutive patients with mature bone growth as demonstrated by imaging tests had 108 cemented endoprosthetic knee replacements for osteosarcoma resectio.
Pala E et al. Clin Orthop Relat Res 2015[26]	Patients were followed for a mean of 54 months (range, 31-78 months), and after 23 months, one patient had died from multiple metastases after surgery 247 rotating-hinge hemiarthroplasty. The GMRS stands for the Global Modular Reconstruction System. A minimum of two years of oncologic follow-up was performed (mean, 4 years; range, 2-8 years). The implantation of prosthesis

Notably, stem fractures were associated with a significantly smaller stem diameter and a significantly longer extramedullary component. Of note, the patellar height was not associated with ROM, anterior knee pain or extension lag, but generally decreased significantly after the operation (from 1.45 to 1.4 for the PTR (ratio of two lines drawn on lateral radiographic images of the knee)

(Expandable) prostheses in children

Five original articles were identified dealing with expandable tumour endoprostheses in young patients , Gilg et al investigated 51 custom-made growing prostheses (Juvenile Tumour System, Stanmore® Implants Worldwide Ltd, Elstree, England, UK) used for reconstruction of primary bone sarcoma of the femur and proximal tibia in 50 children between 2003 and 2014. Additionally, Torner et al reported on a mean lengthening of 36.4 mm in seven patients receiving a MUTARS® Xpand Growing Prosthesis (implantcast GmbH, Buxtehude, Germany) in the distal femur (n = 6) and proximal femur (n = 1), and a mean MSTS score of 87.7%. Notably, none of the patients in this cohort developed any local recurrence and one deep infection was treated by arthroscopy and antibiotics.

Tabl (5) (Exandable) prostheses in children.

Publication	Results
Torner F et al. Int Orthop 2016[27]	Involvement of an uncemented non-invasive growing prosthesis in the surgical treatment of femoral tumours in seven children (mean age 9.8 years), average follow-up of 65.3 months, average bone resection length of 18 cm (distal femur) and 24 cm (proximal femur), and a mean Musculoskeletal Tumour Society (MSTS) score of 26.3 following rehabilitation.
Gilg MM et al. Bone Joint J 2016[28]	Between 2003 and 2014, 50 kids had a total of 51 growing prostheses. Most of them were for the distal femur (n = 40), but there were also tibia (n = 6), entire femur (n = 4), and proximal femur (n = 1) prosthesis. - 47 patients (92.2%) had osteosarcoma, and 4 patients (7.8%) had Ewing sarcoma, both of which need reconstructive surgery.
Arteau A et al. J Bone Joint Surg Am 2015[29]	A total of 23 kids who had an expandable distal femoral endoprosthesis implanted between 1994 and 2012 were included; all of them had their proximal tibial physis preserved after surgery (aside from the tibial stem's insertion point); 71 kids who had an extendible prosthesis and a follow-up of more than 2 years were analysed; 12 kids were declared DOD (16.9%) at the most recent follow-up; and the mean
Schinhand M et al. J Bone Joint Surg Am 2015[30]	After resection for malignant bone tumours (14 osteosarcomas, 1 Ewing sarcoma), 15 children were treated with the repiphysis expandable prosthesis; five patients died with the prosthesis in situ or underwent amputation before five years of follow-up, leaving ten long-term survivors; of the ten long-term survivors, nine underwent revision of the implant for mechanical failure.
Staals EL et al. Clin Orthop Relat Res 2015[31]	Involvement of an uncemented non-invasive growing prosthesis in the surgical treatment of femoral tumours in seven children (mean age 9.8 years), average follow-up of 65.3 months, average bone resection length of 18 cm (distal femur) and 24 cm (proximal femur), and a mean Musculoskeletal Tumour Society (MSTS) score of 26.3 following rehabilitation.

4. Discussion

Functional results, complications, and long-term follow-up of cancer endoprostheses used in orthopaedic oncology were the main points of the research included in this study. Functional results, often measured by the Mini-Mental State Examination (MSTS) score, showed no substantial heterogeneity across trials involving the same anatomical areas. When it comes to cancer endoprostheses around the shoulder girdle, different types of repair result in different MSTS scores (from 60% to 80%; some patients got a Trevira® tube). As a side note, the authors found no change in range of motion (ROM) between the Trevira® and non-Trevira® groups, with both groups averaging 38 degrees of flexion, 35 degrees of abduction, and 15 degrees of external rotation. Alternatively, a 12.0% infection risk was reported for proximal humeral endoprostheses after cancer surgery; alternatively, patients having mesh reconstruction had a considerably higher MSTS score than those who had just soft tissue restoration (80% vs. 66.7%; p = 0.001).

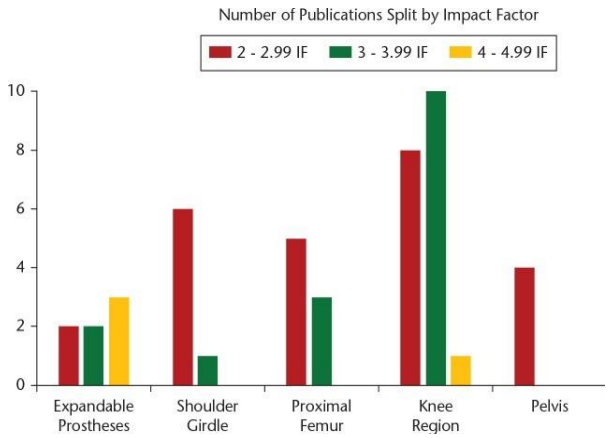

Fig. (2) Numbr of publications split by impat factor in the respective six categoris.

After then, studies switched to investigating prosthetic reconstruction of the pelvis as a treatment option for cancer. The range for periacetabular resections (53.9-64.0%) was greater than the range for hemipelvic resections (53.9%-64.0%) on the MSTS scale. Both sitting and standing stress tests were administered to patients, and researchers considered both objective and subjective data. Normal stress distribution in the pelvis occurs around the acetabulum, the arcuate line, the sacroiliac joint, and the sacral midline while a person is sitting or standing. After a pelvic reconstruction, however, this pressure is put on the connecting rods of the acetabular component and the pedicle rods' proximal end. This highlights the need for new implants to account for the elevated peak loads inherent in the repaired pelvis.

Let's discuss about tumour endoprostheses for the proximal femur now. In instance, no association was found between the absence of a capsular repair and a reduced risk of instability,, Research on the efficacy of hemiarthroplasty for pathological femoral fractures indicated that some patients required to have the treatment updated to a total hip arthroplasty due to chondro-osseous wear and strain on the prosthesis. While aseptic loosening and infection rates were comparable for fixed- and rotating-hinge prosthesis, component failure only occurred in the latter. A rotatory hinge system was associated with a significantly higher mean MSTS score for the patient population studied. Most implant failures were brought on by infections. Some researchers observed that postoperative function was somewhat better for individuals whose tumours were placed in the distal femur than in the proximal tibia. This disparity may be due to the fact that resecting tumours from the proximal tibia typically necessitates reconstructing the extensor mechanism. Patients who received endoprostheses were more likely to require revision surgery owing to mechanical failure, whereas those who received osteoarticular allografts were more likely to need surgery due to infection. In individuals who had their systems not cemented, osseointegration occurred in 64% of cases. Uncemented systems are similarly suitable, with the extra advantage of shorter surgery time, in tumour patients with a poor general condition, and the average surgical time was reduced by 26 minutes when implanting an uncemented system. When comparing cemented and uncemented systems, there was no significant difference in revision rates (9.6% vs. 5.4%, respectively; p = 0.399). Interesting new findings about the effectiveness of knee cancer endoprostheses after surgery. Insall-Salvati ratio (ISR) and Insall-Salvati patellar tendon insertion ratio (PTR) were used to evaluate relative patellar height immediately postoperatively and at the conclusion of the study period.

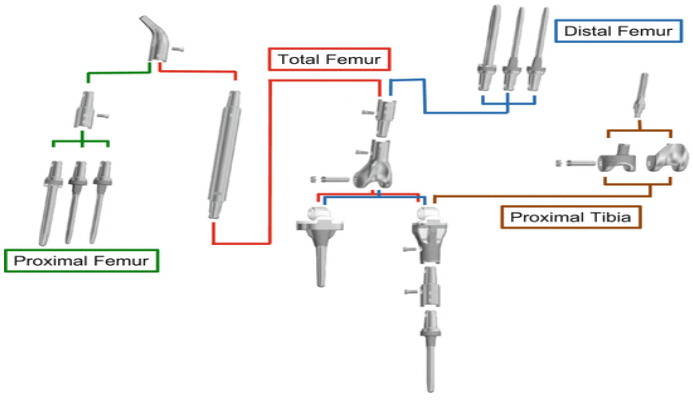

Fig. (3) Modular prosthesis for the reconstruction of the bone defect**.**

It is important to note that while patellar height decreased significantly (from 1.45 to 1.4 for the PTR (ratio of two lines drawn on lateral radiographic images of the knee, Patients who had knee reconstruction using modular tumour endoprostheses were evaluated to see whether they were able to resume their previous sports performance levels. It's worth noting that the total number of sporting events played increased during the year. Some patients ultimately need revision operations, although this did not slow them down. Surprisingly, the stated median MSTS score was 90.0%. Include other research on the topic of leg-length inequality and expandable tumour endoprostheses in young patients. Although the proximal tibial epiphysis was unaltered beyond the insertion site of the tibial stem in 65% of individuals, it developed more slowly than the contralateral epiphysis. Complication rates were somewhat lower, averaging 2.6% per patient. Scores on the MSTS averaged 88.3%, which is an interesting finding. The Repiphysis® technology was employed in the later experiments, and no statistically significant worsening of outcomes was found. Infection and local recurrence were shown to be associated with a decreased risk of amputation.

5. Conclusion

Restoration of major skeletal abnormalities or replacement of poor quality bone formerly often necessitated amputation as the sole option. Megaprostheses, which were developed later and are capable of rebuilding extensive bone abnormalities, prevented the need for amputation of the limb in many cases. Research in the next years should also concentrate on ways to lessen the prevalence of often seen consequences including deep infections of tumour endoprostheses and periprosthetic fractures, which represent a serious risk to both orthopaedic surgeons and their patients.

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