Review Article

Functional Outcome in Endoprosthetic Replacement around the Knee: A Narrative Review

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Abstract

In general, most comparative studies have reported that successful limb salvage surgeries have better functional outcomes than amputations. This is largely due to the advances in surgical techniques and adjuvant therapy which allows reconstruction such as endoprosthetic replacements (EPR). Clinician-reported outcome measures and patient-reported outcome measures have been utilised to evaluate the benefits of orthopaedic surgical procedures. The most widely used measures in the field of orthopaedic oncology are the Musculoskeletal Tumour Society Score and the Toronto Extremity Salvage Score. The Jury is still out on the evidence basis for the functional outcome of EPR, especially around the knee joint. There is a need for more randomised control trials, systematic reviews or meta-analyses to critically appraise and formally synthesise the best available evidence to provide a statement of conclusion on the functional outcome of EPRs.

Keywords: Functional outcome, knee, periprosthetic, replacement

Introduction

Historically, the surgical treatment of bone and soft-tissue tumours around the knee joint involved the resection of the affected part to cure the disease. This may require the sacrifice of the soft tissues, nerve supply and vascular supply in many cases resulting in an amputation of the limb. However, in the past few decades, limb salvage surgery has supplanted amputation as the preferred surgical treatment for patients with extremity musculoskeletal neoplasms.[1,2]

In general, most comparative studies have reported that successful limb salvage surgeries have better functional outcomes than amputations.[3,4] This is largely due to the advances in surgical techniques and adjuvant therapies which allow the preservation of the patients' limbs without compromising the oncological outcome. The limb salvage surgeries have been further enhanced by the advances in endoprosthetic or megaprosthetic reconstruction (endoprosthetic replacement [EPR]) which involves segmental replacements to restore function, correct the deformities caused by these tumours and allow early access to chemotherapy or radiotherapy when required by these patients.[5,6]

Conventionally, various surgical techniques have been used to salvage the limb from amputation after resection of extremity musculoskeletal tumours.

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These include the use of autografts, allografts, prosthetic implants and modified amputations.[7] The use of EPR started in most tertiary bone tumour centres in the late 1970s, initially with the custom-built endoprostheses. The on-table challenges encountered with the use of the custom-built prosthesis have led to the development of the modular endoprostheses which allow for implant trials on the table, providing wider options for the surgeon.[8]

The initial method of intramedullary fixation of the EPR was cementation with polymethylmethacrylate cement. However, uncemented hydroxyapatite-coated varieties have been developed in recent years. There has also been an improvement in the hinge mechanism from a fixed hinge to the rotating platform variety to reduce early loosening.[7,9]

The knee joint is a common anatomical site for the occurrence of bone tumours requiring major resection and reconstruction.[10] In previous studies, researchers identified a predilection for

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the region of the knee for large and aggressive bone tumours. Osteosarcoma, particularly, commonly occurs in the long bones of the extremities near the metaphyseal growth plates.[11,12]

Previous report in a small cohort of patients (24 patients) who had endoprosthetic reconstruction around the knee suggested that although knee function was reduced in patients with proximal tibia replacements compared with distal femoral replacements, both the groups had an efficient gait and were active in the community at a mean follow-up period of 13 years.[13]

Regardless of the enormity of the soft-tissue dissection and bony resection from these surgeries, many patients who had EPRs were as active as patients who have had standard total hip and knee replacement surgeries.[14]

Functional Outcome Measures

Clinician-reported outcome measures and patient-reported outcome measures (PROMs) have been utilised to evaluate the benefits of orthopaedic surgical procedures. The most widely used clinician-reported outcome measure for EPR around the knee is the Musculoskeletal Tumour Society (MSTS) Score.[15]

The MSTS scoring system was developed in 1993 as a disease-specific evaluation measure in evaluating the physical function in patients with musculoskeletal tumours; its reliability has been tested and validated in many studies and in different health-care settings.[16-20]

The MSTS system assigns numerical values (0–5) for each of six domains including intensity of pain, degree of function, emotional acceptance, the need for walking aids, walking distance and residual gait pattern of the patients.

The demographic information and a patient's satisfaction component are also included. A numerical score and percentage rating is calculated to allow for comparison of results. Initial field testing of this scoring system in 220 patients reported a low interobserver variability. MSTS score has been adopted by the International Society for Limb Salvage to facilitate end result comparison of musculoskeletal tumour reconstructions.[21]

However, recent reports have suggested that the MSTS score may have a serious limitation as a measure of the general health-related quality of life because it is a physician-reported outcome measure. In general, clinician-reported outcome measures may overestimate function as compared to the patient-perceived scores. These studies suggested that the MSTS score may be better utilised in combination with PROMs.[22,23]

PROMs are standardised, validated questionnaires completed by patients. This allows the evaluation of patients' perceptions of their own functional status and well-being. Initially designed for evaluation in clinical trials of a new treatment, PROMs are now used more widely to evaluate patient perspectives of the care outcomes. PROMs are designed to measure either patients' perceptions of their general health or their perceptions of their health in relation to specific disease conditions.[24]

The methodological qualities of PROMs have been evaluated rigorously by the Consensus-based Standards for the Selection of Health Measurement Instruments (COSMIN) initiative. The results of this consensus study reached in the Delphi rounds were utilised in the construction of the COSMIN checklist. This checklist contains 12 domains for the evaluation of PROMs methodological quality. The standards assessed include internal consistency, reliability, measurement error, content validity, structural validity, hypotheses testing, cross-cultural validity, criterion validity, responsiveness, interpretability and generalisability.[25,26]

The Toronto Extremity Salvage Score (TESS) is the most widely utilised PROM for assessment after resection and reconstruction of extremity tumours.[10,27] The TESS score was developed in 1996 as a PROM for patients with extremity tumours. The TESS is a detailed questionnaire which utilised the framework of the International Classification of Functioning, Disability and Health Criteria in developing an assessment tool for patients with extremity tumours.[28]

The construct validity of TESS score has been moderately correlated with the MSTS score in previous studies and its use has been reported as a reliable measure that is able to detect changes in patients' performance serially over a period of time.[29] Furthermore, the TESS has been widely validated in different groups of patients after surgery for extremity musculoskeletal tumours. Previous reports have supported its reliability enabling international comparisons of treatment results.[18-20,30,31]

Narrative Review

There are few large centre studies evaluating the functional outcome of EPR after tumour resection in the upper and lower extremities. Hillmann *et al*. (1999) compared patients with EPR and patients who had rotationplasty around the knee; the mean MSTS score was 83% in patients who had EPR around the knee. There was no statistically significant difference in the functional outcome of the two groups of patients.[31] Park *et al*. (2007) reviewed all patients who had EPR for bone destruction after long bone metastases in a large orthopaedic oncology unit; these authors reported that the mean MSTS score and TESS score were 73% and 71%, respectively.[32]

In another anatomic region, Kumar *et al*. in a large series in 2003 reported that the mean TESS and MSTS scores were 72% and 79%, respectively, for patients who had proximal humeral replacement and EPR. Furthermore in the lower limbs, Chandrasekar *et al*. (2009) reported the mean TESS score of 61% for patients with proximal femoral resection and EPR.[33,34]

In a case series of segmental EPR in a resource-constrained setting by Idowu *et al*., the resection lengths, complications and functional outcome measures were noted. Functional outcome measures were graded using the MSTS scoring system, and the

scores were good to excellent in ten patients, moderate in one and poor in one patient. However, the limitation in this study was the small number of cases and the duration of follow-up.

Korim *et al*. performed a systematic review of a single database (MEDLINE) to identify failure rates, mortality and knee scores in patients after EPR for non-neoplastic conditions. The functional outcomes of the patients were not evaluated in this study; the study excluded patients with musculoskeletal tumours. These results may not generally apply to patients treated with EPR after resection of tumours because of the difference in the pathophysiology and prognosis of neoplastic diseases.[3,35]

Haijie *et al*. systematically reviewed the literature for the implant survival rates and complications after EPR around the knee. This study revealed that the survival of an EPR is good on a short-term to mid-term basis (5–10 years), but complications such as aseptic loosening and fractures are more common for 15 years or more after implantation. This study also reported no differences in the survival rates between cemented and uncemented EPR. However, the implants with a rotating hinge mechanism had better survival rates than the fixed-hinge implants.[36]

The limitation of this study includes its failure to evaluate the activity of daily living for these patients using functional outcome measures. Therefore, the systematic review provided no information about the relationship between the type of EPR (distal femur or proximal tibia), mode of fixation (cemented or uncemented), type of hinge mechanism and the functional outcome of patients.

Evidence Basis for Endoprosthetic Replacement

The role of evidence-based medicine in orthopaedic surgery is rapidly growing, so it is the rapid evolution of new surgical techniques and technologies in this specialty. There is therefore the need for more randomised control trials (RCTs), systematic reviews or meta-analyses to critically appraise and formally synthesise the best available evidence to provide a statement of conclusion on the outcome of EPRs. These studies should be rigorous in the approaches to the search strategy, study selection, data collation and data synthesis to minimise errors and arrive at reliable conclusions.

There is no doubt that surgical interventions such as resection of tumours and reconstruction usually involve physical interference with body tissues through manual operations and the use of implanted materials, hence the challenges in performing surgical RCTs. The only true placebo in a surgical trial may be a sham operation which usually raises ethical controversies.[37]

Blinding is also not easily achievable as the surgeon is usually fully aware of the procedure, especially in implant surgery. The variation in skill sets of the surgeons and anaesthetists is a strong mitigating factor in the conduct of a multi-centre surgical randomised control trial. This is because there is usually a learning curve for most clinicians undertaking newer procedures. Moreover, patients undergoing surgical procedures may be unwilling to give consent for randomisation because of the perception that the newer procedure is better than the older ones.[38]

In general, there are few widely used innovative medical devices with the existing evidence from randomised control trials (RCTs). Recent reports by Schnell-Inderst *et al*., Martelli *et al*. and Boudard *et al*. have suggested that RCTs being the 'gold standard' for drugs may not always be feasible for medical devices before its approval for use in patients. This is because the present standard may deny patients of potential benefits from lifesaving innovative devices in the absence of a surgical randomised control trial.

Patients suffering from life threatening illnesses may be deceased before the approval of newer devices is granted while waiting for the result of RCTs.

Therefore, Boudard *et al*. have suggested changes to the European Policy regulating medical devices such that the key requirement would be a demonstration of clinical efficacy and safety before release onto the European market.[39-41]

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Conflicts of interest

There are no conflicts of interest.

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