



Review

Objective clinical measurement of physical functioning after treatment for lower extremity sarcoma – A systematic review

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Abstract

Background: Physical impairments and activity restrictions cause significant morbidity after surgery for sarcoma. Yet objective assessment of key components of balance, gait and physical activity (PA), using valid and reliable outcome measures, is lacking in routine clinical practice.

Purpose of review: We therefore performed a systematic review to identify studies quantifying balance, gait and PA in clinically useful ways, after treatment for lower extremity sarcoma.

Patients and methods: Relevant articles quantifying balance, gait and PA in patients who underwent surgery for lower extremity bone or soft tissue sarcoma were identified from Medline, Embase, Scopus, and Web of Science up to February 2016. Results were compiled by principal research findings, objective measures used, their ability to detect differences between important clinical groups, change over time and reliability.

Results: Eighteen articles were included. Surgery had a significant impact on outcomes ($p < 0.05$). A wide range of measures and concerns about accuracy of measurement were noted, as gait and PA measures did not discriminate between distinct clinical groups such as limb sparing surgery and amputation, and did not detect changes over time. Few studies investigated reliability ($n = 1$) and sensitivity to change ($n = 4$).

Conclusion: There is a deficit of studies quantifying balance, gait and PA in patients with lower extremity sarcoma. Studies did not use consistent, valid and reliable instruments. There is an urgent need to develop novel objective measures of physical functioning in this patient group to encourage evidence-based clinical care.

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Keywords: Balance; Gait; Physical activity; Activity restrictions; Functional outcomes; Musculoskeletal cancer

Introduction

Sarcomas are a heterogeneous group of rare cancers arising in bone and soft tissues, in almost any anatomical location, and with an estimated incidence of 27,908 new cases per year in Europe.¹ About 84% are soft tissue sarcomas (STS), the incidence of which increases with age, and 14% are bone sarcomas (BS), which occur more

frequently in children and adolescents.¹ Multi-modality treatment for lower extremity sarcomas includes chemotherapy, radiotherapy and major surgery.^{2,3} Although 85% of patients undergo limb sparing surgery (LSS), many face complications such as implant failure, limb shortening, wound healing, and infection,⁴ sometimes demanding multiple revision surgeries. In some cases amputation (AMP) is necessary.

Survivors of childhood cancer (also referred to as childhood cancer survivors, CS) face significant long term activity restrictions, education and employment problems following extensive surgery.^{5,6} On the other hand, older survivors of adult cancer (also referred to as adult cancer survivors, AS) commonly develop impaired balance and gait due to the combined effect of pre-existing comorbidities and surgery on the

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locomotor system.⁷ Poor balance and gait renders patients inactive, thereby further increasing health risks; for example: risk of falls, exposing them to serious consequences of fractures, disability and loss of independence,^{8–10} ultimately jeopardising overall quality of life (QoL).^{11,12} Therefore quantifying balance, gait and physical activity (PA) levels in the pre-operative, early post-operative and rehabilitation period, can present clinicians with important information about the severity and nature of physical limitations. This can help identify “at risk” patients, suitable for targeted interventions and early rehabilitation referrals, which is key to enhanced recovery.¹³ Furthermore, as new techniques develop for the surgical treatment of extremity sarcomas, better measures of physical functioning are needed for their objective evaluation.

Although traditional measures of physical functioning (functional outcomes) in sarcoma survivors, the Toronto Extremity Salvage Score (TESS),¹⁴ and the Musculoskeletal Tumour Society Scoring System (MSTS)¹⁵ measure disability and impairments like joint range of movement, muscle strength, joint stability, pain, deformity, functional activity and emotional acceptance, respectively, they do not capture any objective information on balance, gait and PA. Moreover, TESS relies on subjective recall and does not relate to objective data about gait and PA,¹⁶ posing a difficulty in understanding underlying interactions. In spite of increasing research into balance, gait and PA in recent years,^{17–19} common barriers to clinical translation are high costs or that devices are cumbersome and inaccurate.

Cost-effective clinically useful accurate, valid and reliable outcome measures are urgently needed to ensure effective clinical management.²⁰ Useful measures would accurately detect differences between distinct treatment groups (for example LSS vs AMP), shed light on interactions with important clinical factors (for example: joint range, muscle strength), measure the impact of treatments (chemotherapy, surgery, rehabilitation) over time and show reliability in repeat measurements.^{21,22} Therefore, the aim of this paper was to systematically review the literature to identify studies quantifying balance, gait and PA in patients treated for lower extremity sarcoma, using methods which are likely to be easily translated into routine clinical practice.

Specific objectives are:

1. To identify methods used to quantify balance, gait or PA in patients after treatment for sarcoma, with the potential for translation into busy clinic settings.
2. To investigate whether these measures have been tested for validity, reliability and sensitivity to change.

Methods

Search strategy

We identified relevant studies by searching four electronic databases, Medline, Embase, Scopus, and Web of

Science up to February 2016. An initial search combined four main search terms using the Boolean “AND” operator: 1) Bone neoplasms OR Soft tissue neoplasms 2) Physical functioning 3) Extremities 4) Measurement ([Appendix A](#)). After reviewing eligible articles, additional search terms covering the three physical functioning domains of balance, gait and PA were identified, and a second search implementing these terms was undertaken to ensure no relevant articles were missed ([Appendix B](#)).

Selection of studies

Search results from each database were imported into EndNote bibliographic management software (Thomson Reuters, Endnote version X7). The titles and abstracts of these references were screened by two independent reviewers (SF and CG) and appropriate articles selected. Differences in opinion were resolved by consensus. Additional hand searching of reference lists of included articles and excluded reviews identified further studies for inclusion ([Fig. 1](#)). Studies were selected using the eligibility criteria outlined.

Inclusion criteria

1. Primary research investigating objective measures of postural balance, gait and physical activity in patients treated for lower extremity bone or soft tissue tumours.
2. Devices which have the potential to be used in routine busy clinical settings

Exclusion criteria

1. Conference proceedings or non-journal articles such as commentaries whose methodology is not clear.
2. Non-English articles
3. Articles reporting upper extremity tumours only.
4. Case report/case reports
5. Full text not available.
6. Articles reporting devices difficult to use in a busy clinical setting (for example gait laboratory, EMG systems).
7. Review articles (secondary research)

Data extraction

The data extraction tool was prepared by the 2 independent reviewers, based on clinical information, and the psychometric properties of outcome measures. The tool consisted of 2 main tables. The first table comprised the patient population, demographics, treatments, instruments used to capture outcomes, objective measures used and main results/conclusions of the study ([Table 2](#)). The second table comprised psychometric properties, including validity, reliability and sensitivity of change of balance, gait and PA measures in these studies ([Table 3](#)). Data were extracted by the first independent reviewer (SF) using the tool and were reviewed, by a second independent reviewer (CG), to ensure accuracy.

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