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Review

Gait analysis of patients following total knee replacement: A systematic review

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Abstract

Gait analysis has been used to objectively measure patients' function following total knee replacement (TKR). Whilst the findings of this research may have important implications for the understanding of the outcomes of TKR, the methodology of existing research appears to be diverse and many of the results inconsistent. The objective of this systematic review was to synthesise reported findings and to summarise the methods used by researchers in this field. Eleven articles published in the medical literature that used gait analysis to compare patients following TKR with controls were identified for inclusion in this review. Each article was assessed for methodologic quality and data was compared across studies through the calculation of effect sizes. Consistently large effect sizes showed that patients following TKR walk with less total knee motion during gait and with less knee flexion during swing than controls. Kinetic discrepancies between patients and controls were also identified. The substantial methodologic differences between studies may contribute to the inconsistencies in reported findings for many gait outcomes. Future research is needed to determine the clinical relevance of these findings.

Keywords: Total knee replacement; Gait analysis; Gait; Systematic review; Biomechanics

Contents

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1. Introduction

Total knee replacement (TKR) is a widely used intervention in the management of knee osteoarthritis. The increasing prevalence of TKR highlights the need to appropriately assess post-operative outcome of this procedure [1]. Gait analysis is a tool that has been used by researchers to measure functional outcome following TKR. It has been proposed that gait analysis is valuable in the clinical management of patients undergoing TKR through its ability to monitor forces through the knee [2]. In particular, the adduction moment across the knee has received attention due to its association with TKR component loosening [3].

Despite the potential usefulness of gait analysis, there are marked discrepancies in the research methods that have been reported. Variations in subject characteristics, prosthetic designs and methodology of gait analysis make comparison of findings between studies difficult. Nonetheless, assessment of TKR patients using gait analysis continues to be reported. It is therefore important to identify discrepancies between studies to allow for more appropriate comparison of findings and potentially to assist in directing future research. To date there has been no attempt to systematically review the findings of gait analysis in patients following TKR. The aim of this systematic review was therefore to identify common themes in the methods of research in the gait analysis of TKR patients and to summarise the findings reported in this literature.

2. Materials and methods

2.1. Literature search strategy

A search for articles on gait analysis in patients following TKR was completed in September 2006. The databases of Medline, Cinahl, Embase, Current Contents, Pedro, and The Cochrane Library were searched for full text articles published in English using combinations and variations of the following terms: knee arthroplasty, knee replacement, knee prosthesis, knee implant, gait, locomotion, walking, biomechanics, kinetics, kinematics, angle, moment and torque. These electronic searches were supplemented by cross-checking citations and reference lists of the relevant published studies. Details of all articles returned from the searches were saved for application of the following selection criteria.

2.2. Selection criteria

To be included in the final review, studies had to present original raw data, investigate patients who were at least 6 months following TKR predominantly for osteoarthritis, compare TKR patient data to an unimpaired control population, and describe the kinematic or kinetic characteristics of the knee during level gait with simultaneously collected spatiotemporal data.

These selection criteria were chosen to allow comparison of findings between studies with minimal influence of confounding factors. Studies that did not present original data were excluded to minimise the potential bias of their data in cross-study comparisons. The most common indication for TKR is a diagnosis of knee osteoarthritis (OA) [1]. Since the effect on gait of other indications for TKR remains unclear, only studies where greater than 75% of the sample received a TKR for OA were included. Studies in which patients were assessed less than 6 months following knee arthroplasty were excluded because the patients could not be considered adequately rehabilitated. Only studies that compared the biomechanics of patients to that of a healthy control population were included in this review to allow calculation of effect sizes. As the velocity of a person's walking speed can alter the biomechanics of lower limb joints [4], only studies that reported knee biomechanics with reference to spatiotemporal parameters (speed, stride length or cadence) were included.

These selection criteria were applied to the title and abstract of all articles retrieved in the search of the literature. The full text articles not excluded in this initial selection process were then evaluated for inclusion using the same selection criteria.

2.3. Assessment of methodological quality

The methodological quality of each study was assessed using a validated assessment tool. In a comprehensive search of the literature four possible tools that could assess the methodological quality of non-randomised trials were identified [5–8]. The checklist by Downs and Black was selected for its reported inter-rater and intra-rater reliability [5]. Only the criteria relevant to assessing potential sources of bias in non-randomised studies were applied. In this review, the assessment of methodological quality was principally to identify common themes in the methods used in this field of research.

2.4. Data extraction and analysis

A form was developed to standardise the amount and type of data extracted. A meta-analysis of reported findings was not performed due to the heterogeneity of studies' designs and methods. The effect sizes of patient group mean scores compared to control group mean scores were calculated where sufficient data was reported. The effect size calculator developed by The Curriculum, Evaluation and Management Centre [9] was used for this purpose.

Two reviewers (JAM and an independent non-author reviewer) performed the selection process, assessment of methodologic quality and data extraction to minimise the potential for bias. Disagreements between reviewers were resolved by discussion with a third reviewer (KEW).

3. Results

Eleven studies were accepted for inclusion in this systematic review. Table 1 summarises results from the assessment of methodologic quality for each of these studies. All studies satisfied a similar number of criteria, yet the methodology varied substantially across studies.

Although all studies stated the aim of the research, there were marked differences in the research objectives – four aimed to describe the gait of patients with total knee arthroplasty [10–13] and six aimed to compare different aspects of prosthetic design, pre-operative diagnosis or timing of surgical intervention [14–19]. All but one [17] of the studies described subjects adequately in terms of