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Review

Efficacy of clinical gait analysis: A systematic review

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ABSTRACT

The aim of this systematic review was to evaluate and summarize the current evidence base related to the clinical efficacy of gait analysis. A literature review was conducted to identify references related to human gait analysis published between January 2000 and September 2009 plus relevant older references. The references were assessed independently by four reviewers using a hierarchical model of efficacy adapted for gait analysis, and final scores were agreed upon by at least three of the four reviewers. 1528 references were identified relating to human instrumented gait analysis. Of these, 116 original articles addressed technical accuracy efficacy, 89 addressed diagnostic accuracy efficacy, 11 addressed diagnostic thinking and treatment efficacy, seven addressed patient outcomes efficacy, and one addressed societal efficacy, with some of the articles addressing multiple levels of efficacy. This body of literature provides strong evidence for the technical, diagnostic accuracy, diagnostic thinking and treatment efficacy of gait analysis. The existing evidence also indicates efficacy at the higher levels of patient outcomes and societal cost-effectiveness, but this evidence is more sparse and does not include any randomized controlled trials. Thus, the current evidence supports the clinical efficacy of gait analysis, particularly at the lower levels of efficacy, but additional research is needed to strengthen the evidence base at the higher levels of efficacy.

1. Introduction

The appropriate role of gait analysis in clinical care remains controversial. Proponents argue that gait analysis provides important information needed to optimize the care of patients with complex walking problems [1]. Opponents counter that, although gait analysis is a useful tool for research, as a clinical tool it adds unnecessary cost without providing any proven benefits to individual patients [2]. Consequently, the utilization of gait analysis is highly variable [3]. Whether or not gait analysis is used is largely determined by individual physician preference, availability of motion analysis services, and insurance coverage, which is also highly variable. The uneven utilization and reimbursement are at least partially due to differences in interpreting the evidence related to the efficacy of clinical gait analysis.

Evaluating the clinical impact of a diagnostic test is complex because diagnostic tests have an indirect effect on patient outcomes [4,5]. By influencing the treatment decision-making process, gait analysis may affect patient management and, consequently, patient outcomes. Fryback and Thornbury have proposed a widely used framework for evaluating the efficacy of a diagnostic test [4,5]. This framework organizes evidence of efficacy into a hierarchy of levels ranging from technical data acquisition to treatment decision-making to patient and societal outcomes. This framework was first used to evaluate magnetic resonance imaging, but can also apply to diagnostic tests in general [6,7]. It is widely used in medical technology assessments such as those conducted by the United States (U.S.) Agency for Healthcare Research and Quality (AHRQ) Technology Assessment Program, which provides information contributing to coverage decisions by the U.S. Centers for Medicare and Medicaid Services and insurance carriers [6,7]. In this review, we utilize this framework to evaluate clinical gait analysis.

The aim of this systematic review was to evaluate and summarize the current evidence base related to the clinical efficacy of gait analysis. As noted above, the review was performed using the established framework developed by Fryback and Thornbury [4,5]. Evidence of efficacy is needed by patients,

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The effect of gait analysis on patient outcomes is less well established. No data are available from randomized controlled trials, and prior to 2002 there was only a single study in this area [15]. In recent years, however, a number of cohort comparisons and case-control studies have examined the relationship between gait analysis and patient outcomes. These studies have consistently found that gait and functional outcomes are superior when gait analysis is done and treatment follows gait analysis recommendations. More specifically, function improves when surgery is done and is consistent with gait analysis recommendations, function is maintained when no surgery is done as recommended by gait analysis, and function deteriorates when surgery is recommended by gait analysis but not done or other surgeries are done.

At the societal level, only one published study was found on the cost-benefits or cost-effectiveness of gait analysis [25]. This study reported that patients who had received pre-operative gait analysis had more surgeries done initially, but fewer subsequent surgeries. The reduced incidence of surgery was achieved without increasing costs and presumably resulted from the gait analysis enabling the surgeons to perform single-event multi-level surgery (SEMLS) [26]. Since this was a retrospective study performed at a single center, additional research is needed to corroborate this result and to further investigate the societal impact of gait analysis. An additional abstract has indicated that SEMLS facilitated by gait analysis is much less costly than performing the same procedures in a staged manner, even after the costs of the gait analysis test are taken into account [27].

The current examination of efficacy focuses on the ability of gait analysis to affect the care of an individual patient who receives the test. This review does not consider another possible benefit of gait analysis, which is its role as an educational tool to improve the decision-making skills of a treatment provider such as an orthopaedic surgeon. For example, reviewing quantitative gait analysis data on patients pre- and post-operatively may provide feedback to surgeons so they can learn from their mistakes and successes to be able to provide better care for future patients. In addition, seeing gait analysis data from one patient may improve a surgeon's ability to treat another patient with similar problems, even without gait analysis data from the second patient. This type of educational efficacy was not included in the current review.

This review attempted to be as comprehensive as possible, but it is likely that some relevant articles were missed. A starting date for the literature review had to be chosen, and the year 2000 was selected to capture most of the relevant literature. Because of the small number of studies in levels 3–4 and above, two earlier articles of historical significance (Lee et al. [15] and DeLuca et al. [9]) were included to make the review of higher level articles more complete. It is possible that other articles were missed because they preceded the start date of the search or because they were not captured by the keywords investigated.

It should be noted that limited evidence for the higher levels of efficacy, including lack of evidence from randomized controlled trials (RCTs), does not mean gait analysis is not effective. To the contrary, the existing evidence suggests that gait analysis is effective at all levels studied, including the patient outcome and societal levels. The main weakness of the current evidence base is the limited number of studies at the higher levels of efficacy and the lack of RCTs. The lack of data from RCTs is not unique to gait analysis. Randomized trials of clinically available procedures are often difficult to justify due to ethical concerns. Surgeons who use gait analysis clinically are often reluctant to withhold this service from patients whom they believe would benefit from the test. Also, RCTs of diagnostic tests are complex because many factors affect patient outcomes, such as heterogeneous patient characteristics and the variety of multi-level surgical procedures that often follow gait analysis. Such issues may necessitate the use of alternative study designs [4,5].

In summary, the existing evidence supports the efficacy of clinical gait analysis, particularly at the lower levels of efficacy (levels 1–4). Evidence is sparse at the higher levels of efficacy (levels 5–6), and no data are available from RCTs. However, the evidence that does exist is supportive of gait analysis. Additional research is needed to further investigate the higher levels of efficacy.

Conflict of interest

None of the authors have any financial or personal relationships with other people or organizations that could inappropriately influence this work.

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