Review

Real time non-instrumented clinical gait analysis as part of a clinical musculoskeletal assessment in the treatment of lower limb symptoms in adults: A systematic review

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ABSTRACT

Background: The aim of this review was to evaluate and summarise the current evidence on non-computerised or non-recorded real time adult gait assessment conducted within the clinical musculoskeletal setting. It was hoped a protocol for best practice and a framework for further research could be developed from this search.
Research question: Can a protocol for best practice and a framework for further research be established from previous literature relating to non-computerised or non-recorded real time adult gait analysis in a musculoskeletal clinical setting.
Methods: A literature review with no limitation on date of publication was conducted on the 18th February 2017.
Results: The review found no significantly informative papers relating to the search
Significance: The lack of research on the accuracy, reliability and therefore worth of this highly recommended area of musculoskeletal assessment raises concerns over current assessment and treatment pathways. Further work to develop a method by which gait analysis can be routinely employed in musculoskeletal clinics as a diagnostic tool is required, with any new approach undertaking robust methodological testing.

1. Introduction

Clinicians are often recommended to conduct gait analysis as part of a general or lower limb musculoskeletal (MSK) adult patient assessment [1–9]. The analysis of gait may be conducted with or without the use of computerised recording analysis equipment with aims to aid in diagnosis, determine treatment goals and evaluate treatment outcomes [2,6,7,10].

The clinical use of gait analysis is thought to be highly variable [11] not only due to the perceived lack of supporting evidence, but also lack of availability, reimbursement and training [12]. Lower limb MSK clinics are suggested to place more value on the merit of gait analysis due to the increased incidence of literature relating gait dysfunction to lower limb injury and the obligatory use of the lower limb in normal gait [4,5,13,14]. Taro et al. [15] investigated the status of National Health Service (NHS) physiotherapy gait analysis of children and adults within the UK. Their findings showed that although gait analysis made up a major aspect of physiotherapy outpatients practice, there was no systematic use of a standardised gait analysis tool or recognised methodology or protocol.

The gait of children with or without neurological disorders differs from adults and is also often assessed in more specialised paediatric clinics [16,17]. This sample is therefore seen as a separate group than that of adults assessed in a MSK clinical setting, and excluded from this review for this reason.

The terminology used to describe the clinical gait analysis may be misleading to the practitioner working in a therapeutic setting. 'Clinical' gait analysis could be interpreted to mean gait analysis 'pertaining to a clinic'. Whittle [9] stated that 'clinical gait analysis' usually consists of videotape examination, measurement of gait parameters, kinematic analysis, kinetic measurement and electromyography. The term 'clinical gait analysis' therefore does not appear to reflect the assessment undertaken in the majority of therapy clinics or centres, but is more associated with assessments conducted in specialised gait laboratories [2,18]. The accepted definition seems counter intuitive and exclusive to the possible majority of MSK assessments conducted in a clinical setting. For clarity there appears a need for terminology to differentiate between 'clinical gait analysis' and 'gait analysis conducted within most clinics'. For the purpose of this paper the term Clinical Gait Analysis (CGA) includes all gait analysis which requires

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computerised or videotaped recording or analysis, while Real Time Clinical Gait Analysis (RTCGA) pertains solely to gait analysis visually assessed and concluded upon without computerised or recorded aid.

In a systematic review published in 2011, Wren et al. [12] concluded that the existing evidence, although sparse at higher levels of efficacy, supports the worth of CGA. They also state visual, or RTCGA, to be less efficacious than that using computerised gait assessment technology. The supposition is limited to just two investigations. Both of these use specific sample groups, either children with cerebral palsy or amputees [19,20]. These investigations were looking for specific markers to determine surgical approaches, and therefore limited to these sample populations and treatment options. Results may be different from a more general MSK patient population. However, these findings support the apparent consensus regarding RTCGA being the less valid and reliable of the methods available [2,21].

The aim of this systematic review was to evaluate and summarise the methods of RTCGA used in adult musculoskeletal clinics treating the lower limb. It was hoped from these findings a protocol of best practice in a clinical setting could be established and also provide a foundation for further work and investigation if required.

2. Methods

2.1. Search strategy

Search criteria for the systematic review were identified using the Patient, Intervention, Comparison and Outcome (PICO) statement. The literature search was conducted to identify references for RTCGA in a symptomatic lower limb musculoskeletal adult sample with no neurological or amputation related injury or disorder. The data search was conducted on the 18th February 2017 by one reviewer (PH) and databases included were the DelphiS, AMED, CINAHL and MEDLINE. The Boolean operator 'AND' was used to combine terms and the Boolean operator 'OR' was used to link synonyms. The Boolean operator 'NOT' was employed to exclude key terms.

Overall search limitations were applied only to that of human participants. No historic date to results was set, as it was thought that older research (when technology was less readily available) may still hold valid results. If other than English language papers were found, translation would have been considered. Terms to exclude studies utilising computerised analysis or recording or playback equipment were not excluded at this stage. This is due to the possibility of such technology being used to research the validity of RTCGA. This database search methodology is shown in Fig. 1.

Hand searches of bibliographic references identified additional publications. Grey literature refers to publications on any format not controlled by commercial publishers nor necessarily peer reviewed. Grey literature was included based on an initial search using the terms Gait, walking and locomotion and rerun in conjunction with the terms analysis, assessment or examination to ensure the search had captured

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 1. Gait and Walking
 2. Analy* OR eval* OR Assessment
 3. 1 AND 2
 4. Observation* OR visual OR live OR "Real Time"
 5. 3 AND 4
 6. 5 AND adult
 7. 6 NOT child* NOT paediatr* NOT pediatr*
 8. 7 NOT stroke NOT cerebr* NOT CVA
 9. 8 NOT amput* NOT "muscular dystrophy" NOT sclerosis NOT "brain injury"
    NOT "spinal cord injury" NOT Alzheimer* NOT neuropath NOT neurological
    NOT parkinson*
10. "lower limb" OR "lower extremit*" OR foot OR ankle OR shin OR leg OR knee
    OR thigh OR hip
11. 9 AND 10
12. Musculoskeletal OR orthopaedic* OR orthopaedic* OR therap* OR
    physiotherap* OR podiatr* OR rehab* OR outpatient* OR doc*
13. 11 AND 12
14. Injur* OR pain* or symptom* or trauma*
15. 13 AND 15
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Fig. 1. Database Search. Conducted 18th February 2017.

Table 1
Search inclusion and Exclusion Criteria.

Inclusion Criteria	Exclusion Criteria
Articles investigating visual un-instrumented walking gait analysis as part of a clinical musculoskeletal assessment in the treatment of lower limb symptoms	Methods dependent on the use of computerised analysis or recording and playback equipment[a]
Adults	Assessments specific to amputation or neurological injury or disorder
	Paediatric patients

[a] Studies using the above techniques are excluded unless used for validation of RTCGA.

all relevant sources.

2.2. Selection criteria

Study inclusion and exclusion criteria used to determine articles included in this review are shown in Table 1.

Potentially relevant articles were subject to abstract screening. If deemed suitable, full text screening was then undertaken. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist criteria [22] was used to extract data from identified literature.

2.3. Quality assessment

The Critical Appraisal Skills Programme (CASP) tool was used to evaluate the included papers. The CASP tools are succinct and effectively cover the areas needed for critical appraisal of evidence [23]. Specific CASP checklists have been developed for reviews of randomized controlled trials, systematic reviews, qualitative, case control, diagnostic, cohort, economic designs, and clinical prediction rule [24]

3. Results

Papers were evaluated for inclusion following the PRISMA flow chart, shown in Fig. 2.

A total of 143 papers were identified as a result of the literature search. 139 were identified via electronic literature sources (DelphiS, AMED, CINAHL and MEDLINE) and 4 were from the grey literature or hand searches of bibliographic references. All of these 143 went directly to abstract screening, from which 139 were excluded for not meeting the selection criteria. The primary reason for exclusion was the use of CGA with no relation to validation of RTCGA. There was also a crossover with other exclusion criteria such as less common neurological disorders and also less common locomotion assessment such as walking backwards.

It was proposed the 4 remaining papers may relate to the research question and were worthy of full-text assessment for eligibility

3.1. The gait arms legs and spine (GALS) assessment tool

2 of the remaining 4 articles related to the Gait Arms Legs and Spine (GALS) MSK assessment tool, one a validity study [25] and the other focussing on sensitivity and specificity of the tool [26].

The GALS was developed to assist in the detection of MSK abnormalities after Doherty et al. [27], in a review of 200 patients in a non-acute hospital setting, found assessment of the locomotor system was frequently absent during medial clerking. It is used by consultants, general practitioners and primary healthcare professions [25]. RTCGA is the initial part of the physical assessment, but this is only 1 of 12 areas of examination and only 3 of the 29 total features assessed. The tool combines scores of separate assessments of the arm, legs and spine and so not specifically in relation to the lower limb or gait. Gait is