Gait & Posture 40 (2014) 333–340

Contents lists available at ScienceDirect

Gait & Posture

journal homepage: www.elsevier.com/locate/gaitpost

Review

The effect of femoral derotation osteotomy on transverse plane hip and pelvic kinematics in children with cerebral palsy: A systematic review and meta-analysis

Christopher P. Carty [a,b,*], Henry P.J. Walsh [a], Jarred G. Gillett [a,c], Teresa Phillips [a], Julie M. Edwards [a], Michael deLacy [a], Roslyn N. Boyd [c]

[a] Queensland Children's Gait Laboratory, Royal Children's Hospital, Brisbane, Australia
[b] Centre for Musculoskeletal Research, Griffith Health Institute and School of Allied Health Sciences, Griffith University, Gold Coast, Australia
[c] Queensland Cerebral Palsy and Rehabilitation Research Centre, the University of Queensland, Brisbane, Australia

ARTICLE INFO

Article history:
Received 20 February 2014
Received in revised form 21 May 2014
Accepted 31 May 2014

Keywords:
Cerebral palsy
Osteotomy
Gait
Systematic review

ABSTRACT

The purpose of this study was to systematically review the current literature to determine the effect of a femoral derotation osteotomy (FDRO) on hip and pelvic rotation kinematics during gait compared to no intervention in children with spastic cerebral palsy (CP). We performed a systematic search for prospective and retrospective cohort studies of children with CP, who were treated with a FDRO, and were assessed with pre and post surgery three-dimensional gait analysis. Medline, CINAHL, EMBASE, the Cochrane Library and Web of Science were searched up to December 2013. Data sources were prospective and retrospective studies. Mean differences were calculated on pooled data for both pelvic and hip rotation kinematics. Thirteen of 196 articles met the inclusion criteria (5 prospective, 8 retrospective). All included studies were of sufficient quality for meta-analysis as assessed using a customised version of the STROBE checklist. Meta-analysis showed that FDRO significantly reduced pelvic retraction by 9.0 degrees and hip internal rotation by 17.6 degrees in participants with unilateral CP involvement and hip internal rotation by 14.3 degrees in participants with bilateral CP involvement. Pelvic symmetry in children with unilateral spastic CP is significantly improved by FDRO. Patients with bilateral involvement do not improve their transverse plane pelvic rotation profiles during gait as a result to FDRO, although this result should be interpreted with caution due to the heterogeneous nature of these participants and of the methods used in the studies assessed.

1. Introduction

Internal hip rotation (IHR) is common in children with cerebral palsy (CP) and is a major contributor to an intoed gait [1]. The consequences of IHR include knocking or rubbing of the knees, increased occurrence of trips and falls, and altered foot pressure distribution, which may result in pain and excessive shoe wear [2,3]. The underlying mechanism of IHR in children with CP is a combination of dynamic and static factors. Dynamic factors are due to spasticity, abnormal tone, contracture, and/or muscle imbalance in the adductor, hamstring, gluteal and tensor facia lata muscles [4–11]. The static factor is an excessive femoral anteversion angle that reduces the mechanical advantage of muscles that cross the hip joint (i.e. hip abductors and glutei) leading to less efficient muscle contribution to forward propulsion during gait [6,12]. The reduction in mechanical advantage is commonly referred to as lever arm deficiency because the increased femoral anteversion results in a reduced coronal plane hip abductor moment arm. To compensate, patients commonly internally rotate the hip to maximise the hip abductor moment arm and subsequently the contribution of these muscles during gait.

The established orthopaedic intervention to address IHR in children with CP is single event multilevel surgery (SEMLS), which involves simultaneous correction of the dynamic and static contributors to the IHR. The accepted orthopaedic intervention to correct excessive femoral anteversion in children with CP is a femoral derotation osteotomy (FDRO), which can be performed at a proximal (intertrochanteric) [13] or distal (supracondylar) [3] level with comparable post surgical gait outcomes [3,14]. The literature

* Corresponding author at: Queensland Children's Gait Laboratory Level 2, Coles Building, Royal Children's Hospital Herston road, QLD, 4029 Australia. Tel.: +61 419761984.
E-mail addresses: Christopher_carty@health.qld.gov.au, c.carty@griffith.edu.au (C.P. Carty).

http://dx.doi.org/10.1016/j.gaitpost.2014.05.066
0966-6362/

provides good evidence for correction of IHR during gait one to three year post SEMLS [3,14–18], emerging evidence that correction is sustained in the long term [16,17,19], and some suggestion that children who have surgery after the age of 10 years have better retention [16,20].

Internal hip rotation can develop unilaterally (spastic hemiplegia or asymmetrical bilateral involvement) or bilaterally (participants with bilateral involvement). Children with unilateral involvement have been reported to compensate for IHR by retracting their pelvis on the impaired side to normalise the foot progression angle [21], however, other authors have found no significant change in pelvic rotation postoperatively and suggest that pelvic rotation may be a primary deformity caused by pelvic obliquity, spinal deformities and/or muscle imbalance at the hip and pelvis [22]. Currently there is no consensus in the literature regarding the effect of FDRO on pelvic rotation during gait in children with unilateral and/or bilateral CP involvement. This lack of agreement is due to limited participant numbers, different inclusion criteria and different analysis techniques across previous studies. The purpose of this study was to systematically review the current literature to determine the effect of FDRO (unilateral or bilateral) on hip and pelvic rotation kinematics during gait compared to no intervention in children with spastic CP. We hypothesise that FDRO will be affective in addressing internal hip rotation and transverse plane pelvic asymmetry in children with unilateral and bilateral spastic CP.

2. Materials and methods

2.1. Search strategy

In order to identify the key papers on this topic, a comprehensive search was undertaken of the following computerised databases: Pubmed (1980-December 2013), CINAHL (1982-December 2013), EMBASE (1980-December 2013), the Cochrane Library (1993-December 2013) and Web of Science (1980-December 2013). The search strategy used included MeSH terms and text words for 'cerebral palsy' AND 'osteotomy' AND '(biomechanics OR gait OR locomotion OR kinematics)'. References from key papers were also scanned to ensure that all key studies were included.

2.2. Inclusion criteria

Inclusion criteria stipulated that studies incorporate a pre and post surgery three-dimensional gait assessment of children with specified unilateral or bilateral CP who were treated with a femoral de-rotation osteotomy (Population - CP patients, Intervention - femoral derotation osteotomy, Comparison - pre and post surgery, Outcome - hip and/or pelvic kinematics during gait). For studies that were excluded see the study flow diagram (Fig. 1).

2.3. Study collection and quality evaluation

The titles and abstracts of papers retrieved in the initial searches were screened independently by the three authors (CC, TP and JE) after removing duplicates. Assessments were included following agreement by all three raters, and any conflicting viewpoints were discussed until a consensus was reached. Full text articles were then sought and the independent screen process was repeated by the three authors. Quality assessment was undertaken independently by three authors (CC, TP and JE) using a customised version of the STROBE checklist for cohort studies [23], whereby questions 6b, 12c, 12d and 22 were removed due to irrelevance to the studies assessed. The STROBE checklist provides recommendations on the reporting of observational research. Items in the checklist relate to title, abstract, introduction, methods, results and discussions sections of articles providing best practice guidelines [23]. Studies scoring above 70% on the checklist were considered to have adequate internal validity for quantitative meta-analysis. Conference abstracts were excluded.

2.4. Data extraction

Data extracted from each study included population demographics, surgical details including type of femoral de-rotation, indication for FDRO and any potential surgical procedures that may confound the kinematic relationship between FDRO and pelvis

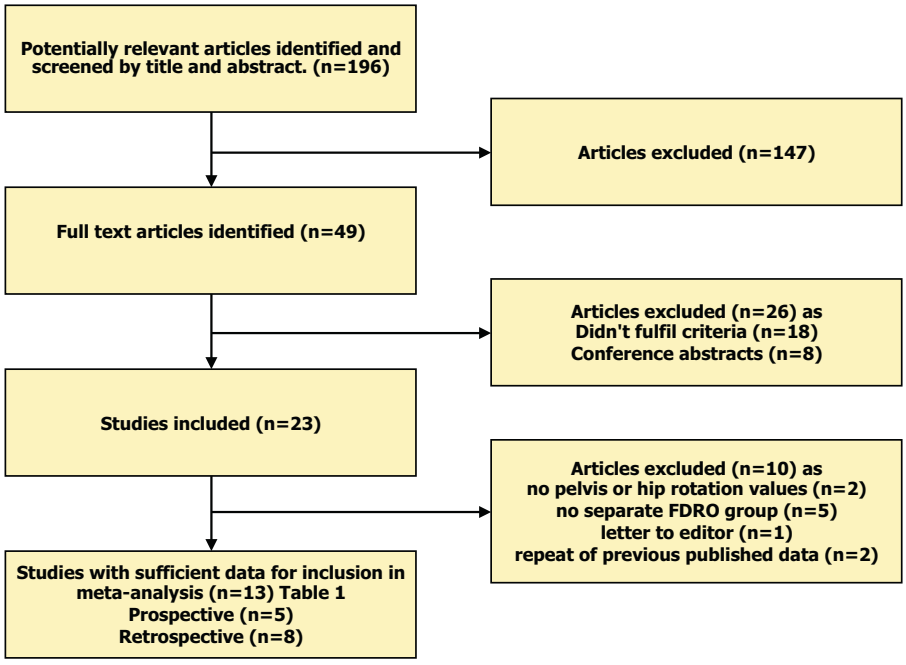

Fig. 1. Systematic search strategy results.