



Review article

The natural history of crouch gait in bilateral cerebral palsy: A systematic review

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ABSTRACT

Aim: To systematically review the natural history of crouch gait in bilateral cerebral palsy (CP) in the absence of surgical intervention and to review any relationship between clinical variables and progression of knee crouch.

Methods: Relevant literature was identified by searching article databases (PubMed, CINAHL, EMBASE, and Web of Science). Included studies reported on participants with bilateral CP who had 3-dimensional gait analysis on at least two occasions with no surgical interventions between analyses.

Results: Five papers (4 retrospective cohort studies; 1 case report) comprised the final selection. Studies varied in follow-up times and participant numbers. Increased knee flexion over time was reported in the four retrospective studies with two distinct patterns of increasing knee flexion evident. Only the case-study reported improved knee extension between assessments. Four studies demonstrated increased hamstring tightness over time with the biggest increases related to longer follow-up time rather than increase in crouch.

Conclusion and Implications: The existing literature suggests that the natural history of crouch gait is towards increasing knee flexion over time. Future prospective studies of bigger groups are needed to examine the relationship between increasing crouch and clinical variables.

What this paper adds?

Crouch gait is very prevalent in cerebral palsy (CP) and has been shown to increase the forces acting on the knee and the energy cost of gait. It has been suggested that if left untreated this gait pattern can lead to pain, joint deformity, radiological abnormalities and loss of independent gait. This systematic review suggests that, in the absence of surgical intervention, the natural history of crouch gait is towards increasing knee flexion over time. The rate of progression of crouch gait appears to increase in those with knee flexion greater than 20° during gait suggesting that this might be an indicator for more urgent intervention. While studies have shown that not all those who walk in crouch have short hamstrings, this pattern is typically treated with surgical lengthening of this muscle group. This systematic review found that while hamstring tightness increased over time, this appeared to occur secondary to walking in crouch rather than contributing to the progression of this pattern.

However, the results should be interpreted with caution due to the limited number of studies meeting the inclusion criteria of this systematic review as well as the methodological limitations of the included studies. This review highlights that longer term follow ups of larger numbers are needed to examine the multi-factorial nature of crouch progression in CP. Any further study should include assessment of function and participation in conjunction with gait analysis in the laboratory.

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1. Introduction

Cerebral Palsy (CP) refers to a group of clinical presentations due to an insult to the developing brain. It is the most common cause of motor deficiency in young children and has recently been reported to occur in 2.1 per 1000 live births (Oskoui, Coutinho, Dykeman, Jette, & Pringsheim, 2013). The associated motor deficiency usually leads to muscle spasticity, weakness and joint contractures which have a significant effect on gait and it is generally accepted that some of these patients lose their walking ability as they get older (Andersson & Mattsson, 2001). Numerous gait presentations are associated with CP but crouch gait is one of the most common pathological patterns, with a reported prevalence of 72%–76% in this population (Wren, Rethlefsen, & Kay, 2005). Crouch gait is defined as excessive flexion of the knee throughout the stance phase of gait (Law, 2014). This flexed knee posture during gait leads to excessive forces and demands on the knees (Steele, Demers, Schwartz, & Delp, 2012; Steele, van der Krogt, Schwartz, & Delp, 2012) and increases the energy cost of gait (J. Rose, Gamble, Medeiros, Burgos, & Haskell, 1989). It is thought that if left untreated crouch often leads to knee and low-back pain (Jahnsen, Villien, Aamodt, Stanghelle, & Holm, 2004), bone deformities (Kerr Graham & Selber, 2003) and ultimately can lead to significant radiological abnormalities (O'Sullivan et al., 2010; O'Sullivan, Walsh, Kiernan, & O'Brien, 2010) and loss of independent gait (Opheim, Jahnsen, Olsson, & Stanghelle, 2009).

For these reasons improving knee extension in stance phase is an integral aim of multi-level orthopaedic surgery in CP. Crouch has typically been treated with surgical lengthening of the hamstrings. Studies have reported improved knee function following hamstring lengthening though increased anterior pelvic tilt is a common finding after such surgery (DeLuca, Ounpuu, Davis, & Walsh, 1998; Dreher et al., 2012; Kay, Rethlefsen, Skaggs, & Leet, 2002; Park et al., 2009; Sung et al., 2013).

However, studies based on computer musculo-skeletal modelling have suggested that not all those who walk in crouch have short hamstrings (Arnold, Liu, Schwartz, Ounpuu, & Delp, 2006). For this reason more recent treatment has focused on augmenting the power of the knee extensors (Joseph, Reddy, Varghese, Shah, & Doddabasappa, 2010) and the need for hamstring lengthening has been questioned (Healy, Schwartz, Stout, Gage, & Novacheck, 2011). Extension osteotomy of the femur with or without patellar tendon shortening provides an alternative means of surgically correcting flexed knee gait. This technique has shown comparable effects compared to hamstring lengthening but also leads to increased anterior pelvic tilt (Klotz et al., 2016; Sossai et al., 2015).

A recent systematic review examined the effectiveness of management of crouch gait in CP. Of the 30 papers included which addressed orthopaedic surgical interventions, 27 addressed the effects of hamstring lengthening and only three investigated extension osteotomy and patellar tendon advancement/shortening (Galey, Lerner, Bulea, Zimble, & Damiano, 2017). This review highlighted that hamstring lengthening remains the only well supported intervention even though surgical practices have evolved beyond this simplistic approach. One of the difficulties in assessing the effectiveness of surgical intervention in CP is that studies tend to be small, retrospective and uncontrolled (Galey et al., 2017; McGinley et al., 2012). Understanding the natural progression of pathological gait in CP in the absence of surgical intervention is therefore important to provide a baseline against which any intervention can be assessed. However, to date, few gait studies have focused on the natural history of walking in children and young adults with CP and the need for larger clinically based prospective studies of walking in CP using objective gait analysis data has been highlighted (Opheim, McGinley, Olsson, Stanghelle, & Jahnsen, 2013).

The primary aim of this systematic review was to determine the natural progression of knee flexion during gait in adults and children with bilateral spastic ambulant cerebral palsy, GMFCS I-III. A secondary aim was to review measures of hamstring tightness to examine any relationship between this clinical variable and the progression of crouch gait.

2. Methods

The protocol for this review was according to the preferred reporting items for systematic reviews and meta-analyses (PRISMA) statement (Moher et al., 2015) and was registered with the PROSPERO register of systematic reviews (<http://www.crd.york.ac.uk/PROSPERO>, registration number CRD42016035766). The PRISMA checklist is attached as Appendix B in Supplementary material.

2.1. Search strategy

A literature search was conducted using the following databases from inception to October 2017- Pubmed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Excerpta Medica Database (EMBASE), and Web of Science.

The search term strategy, allowing for syntactical differences between data-bases, was as follows: “Cerebral Palsy” OR “spastic diplegia” OR “diplegia” AND “knee” OR “crouch” OR “crouch knee” OR “flexed knee gait” AND “kinematics” OR “biomechanics” OR “walking” OR “gait analysis” OR “gait disorders” OR “gait.” All terms were searched in both titles and abstracts.

2.2. Inclusion criteria

Published studies in the English language on the progression of crouch gait in CP were included if they met the following criteria:

- 1 Retrospective and prospective cohort and observational studies of adults or children;
- 2 They reported on ambulant participants with bilateral cerebral palsy;
- 3 Assessment included 3-dimensional gait analysis on at least two occasions to include knee flexion angle;
- 4 No surgical interventions between gait analyses.

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