Foot Orthoses for people with Autism Spectrum Disorder

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Research question: Do foot orthoses provide a benefit to ambulation for people with Autism Spectrum Disorder?

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Requestor: Nawaal s47F - personal p

Endorsed by: Melinda s47F - personal privacy

Cleared by: Melinda s47F - personal privacy

1. Contents

2. Summary

There is a lack of evidence for the effectiveness of foot orthoses for people with Autism Spectrum Disorder (ASD). However, there is some indication that foot orthoses can assist in treating and managing conditions associated with ASD. Foot orthoses may help reduce toe-walking. There is very little evidence that orthoses can assist with mobility in people diagnosed with Developmental Coordination Disorder (DCD), a condition associated with ASD. However, there is evidence that foot orthoses assist with the management of pain and associated function for a variety of other conditions such as flat feet, high arches, bunions, juvenile idiopathic arthritis, rheumatoid arthritis and knee pain. Quality of studies vary.

3. Motor difficulties for people with Autism Spectrum Disorder

ASD is a neurodevelopmental disorder characterised by difficulties in social interaction and social communication, including restrictive, repetitive, and inflexible patterns of behaviour [1,2].

DSM 5 notes that people with ASD can often also experience motor deficits such as clumsiness and problems with gait (1). Motor deficits are included as ‘additional features supporting diagnosis’, though there is a growing body of evidence supporting the idea that motor deficits are a core feature of ASD [1,3,4,5].

In a study of 11,814 participants, Bhat et al find 86.9% of children with ASD are at risk of motor impairments. Zampella et al report that up to 76% of children with ASD meet the diagnostic

criteria for DCD. DCD is a motor disorder characterised by motor skills substantially below what is expected at a person's age [5]. People with ASD are at greater risk of low muscle tone (hypotonia) and apraxia [3,6].

Of particular interest is the prevalence of motor deficits that can affect gait. An earlier study on the prevalence of motor deficits in children with ASD finds 19% present with toe-walking, 9% with a gross motor delay and 2% with reduced ankle mobility [Table1,3]. A later study finds 68% of children with ASD have some form of gait abnormality [Table2,6]. Children with ASD are at higher risk of toe-walking [3,6,7]. Estimates of the prevalence of toe walking in people ASD range from 9% [8] to 20% [3,9,10]. A 2015 review found considerable disagreement over the specifics of a pattern of gait in people with ASD, concluding that deviations in gait are a common symptom of ASD [11]. This heterogeneity is echoed by Dufek et al, who observe that the participants in their study displayed varied patterns of gait but generally showed an increase in gait abnormalities [12].

Table 1. The prevalence of motor deficits in ASD.

The prevalence of motor deficits in ASD

Motor[a] deficits	Age groups (years)	Hypotonia	Apraxia	Toe-walking	Reduced ankle mobility[b]	Gross motor delay
Presence	All	79 (51%)	53 (34%)	30 (19%)	4 (2%)	14 (9%)
	2–6	52 (63%)	34 (41%)	21 (25%)	2 (2%)	10 (12%)
	7–18	27 (38%)	19 (27%)	9 (13%)	2 (3%)	4 (6%)
Absence	All	75 (49%)	101 (66%)	124 (81%)	150 (98%)	140 (91%)
	2–6	31 (37%)	49 (59%)	62 (75%)	81 (98%)	73 (88%)
	7–8	44 (62%)	52 (73%)	62 (87%)	69 (97%)	67 (94%)

[a] Numbers represent the number of children (percent of all children in the specific age group or all age groups) with or without the motor deficit.
[b] All the four children with reduced ankle mobility had history of toe-walking.

Table 2. Gait abnomalities in children with Autism.

Gait abnormalities in children with autism and their typically developing matched peers (percent).

Gait abnormalities	Children with autism ($n = 38$)	Peers ($n = 38$)
Wide-based	33	0
Apraxic	33	0
Posturing	25	11
Clumsy	20	0
Any abnormality (excluding toe-walking)	58	11
Toe-walking (observed on video only)	33	3
Any toe-walking (in office or on video)	45	3
Any gait abnormality (including any toe-walking)	68	13

Motor deficits in children can impact social interaction and communication [5]. However, that motor deficits are present in individuals with ASD does not indicate that they necessarily experience the deficit as an impairment or that they require a specific kind of support. As shown in Table 1, prevalence of motor deficits tends to reduce with age. Although this is likely not the case for people diagnosed with DCD [29]. Dietz and Khunsree argue that evidence for the harm of toe-walking is lacking and that beyond social stigma toe-walking may ultimately be a benign condition [13]. On the contrary, Herrin and Geil argue that there are short and long term harms to toe-walking including:

- decreased walking velocity due to decreased stride length and cadence

- greater risks for falling
- greater effort than normal gait
- contracted Achilles tendon
- equinus position of the foot/ankle complex
- lumbar spine hyperlordosis
- deformities of bones and soft tissues in the feet
- abnormal adult gait [14].

Leyden, Frung and Frick note that some biomechanical and gait changes have been noted in people toe-walking for years, though they temper this with the observation that long term consequences of toe-walking are generally unknown [8]. Mediating this disagreement to some extent, we can point out that some toe-walkers exhibit this behaviour more and some less, i.e. many people who toe-walk also show standard gait at times. In one study, participants walking barefoot displayed toe-walking behaviour in 36% of steps [15]. I have not found research to link frequency of toe-walking behaviour with real functional impact (ie. research linking percentage of tow-walking footfalls with substantial mobility deficits).

While it is clear from the evidence that people with ASD experience problems with gait and motor skills at a higher rate than people without ASD, they do not receive treatment at a higher rate and continue to be under-diagnosed with motor impairments and DCD [3].

4. Effectiveness of foot orthoses

4.1 What are foot orthoses?

An orthosis or orthotic device is an “externally applied device used to compensate for impairments of the structure and function of the neuro-muscular and skeletal systems” [16]. Common lower limb orthoses include:

- Toe – designed to wedge in between toes
- Insoles – able to slip inside shoes, available custom made or prefabricated, can be heel, ¾ length or full length
- Sub Malleolar – covers the whole foot but stopping below the ankle
- Supra Malleolar – covers the whole foot and ankle
- Ankle-Foot – covers all or part of the foot, the ankle and stops just below the knee, can be articulated or solid, lined or padded and with or without a sole
- Knee – covers knee joint and stops above the ankle and below the hip, can be custom moulded or prefabricated

- Knee-Ankle-Foot – covers all or part of the foot, over the ankle and knee and stops just below the hip joint, can be articulated at ankle or knee, fully or partly custom moulded
- Hip – usually covering lower back and hip joint stopping before the knee, custom moulded or prefabricated
- Knee-Hip-Ankle-Foot – covers all or part of the foot, over the ankle, knee and hip but should not obstruct movement of the spine [17,18].

4.2 Effectiveness of treatment

Foot orthoses are a commonly prescribed treatment and management technique for a variety of lower body pain and functional/mobility issues. Orthoses, prescription footwear and physical therapy are often called ‘conservative’ treatments to contrast these with surgical interventions [19].

A 2008 Cochrane review of 11 randomised control trials found evidence that custom made insoles can reduce the pain associated with high arches (pes cavus), juvenile idiopathic arthritis, rheumatoid arthritis and bunions (hallux valgus). The review found mixed evidence that custom insoles reduce pain of plantar fasciitis [20].

Results were mixed for different conditions. Use of custom insoles for at least 3 months decreases pain associated with high arches, improves function and quality of life [20,21]. Children experiencing juvenile idiopathic arthritis can benefit from custom insoles or prefabricated neoprene insoles. Both interventions were more effective than supportive footwear at reducing pain and disability and improving function. After 3 months of use, pain reduction was seen for patients with rear-foot pain associated with rheumatoid arthritis, but no change after 3 years compared with placebo. Improvements to function between treatment and control were not statistically significant. Custom insoles did not reduce pain in the metatarsophalangeal joint associated with rheumatoid arthritis any more than supportive shoes or non-custom orthoses. Custom insoles can help reduce pain associated with bunions. Surgery may be more effective at reducing pain though no statistically significant difference in function was found between the two treatments [20].

A 2011 Cochrane review into use of foot orthoses to treat knee pain found some evidence for a reduction in pain in the short term (6 weeks) but also an increase in problems like blisters and rubbing. There was no statistically significant difference in pain for patients treated with orthoses and those treated with physiotherapy. The patients who had physiotherapy scored higher on functional outcomes. However, the standard of evidence of the reviewed studies was VERY LOW on the GRADE scale [22].

A 2010 Cochrane review into the use of non-surgical treatments for children with flat feet (pes planus) found some evidence that custom made orthoses could assist with the reduction in pain. However the quality of the evidence was compromised by small sample sizes, risk of

bias and difficulty comparing data of the included studies. The authors note there is a lack of high quality evidence on the topic [23]. A later study found some evidence that foot orthoses can improve knee alignment in people with flat feet [26]. The sample size of this randomly controlled trial was quite small at 15 participants.

Foot orthoses, either insoles, full foot or ankle-foot, are often used to treat toe-walking in people with good ankle range of motion and who are deemed capable of gait re-education [7]. Herrin et al found use of ankle-foot orthoses controls toe walking but the effects do not last after treatment. The insole does not work as well as the ankle-foot orthosis but is less restrictive and there is more uptake by children and their parents [14]. The quality of this randomly controlled trial suffers from lack of masking of any kind and stopping the study at 6 weeks instead of 6 months as originally stipulated [7,14]. The authors argue their preliminary evidence supports a 'sequential orthotic treatment', where less restrictive orthoses (insoles) are trialled first and the patient can progressively move to more restrictive orthoses (ankle-foot) as required [14].

4.2.1 Difficulties with determining effectiveness of foot orthoses

Even when high quality studies can be found on the benefits or harms associated with types of foot orthoses, it can still be difficult to draw conclusions about the effectiveness of foot orthoses in general. Orthoses designed for the same purpose come in different styles, use different design and manufacture methods and can be made from a variety and combination of materials including plastic, foam rubber, leather, cork, carbon fibre, and metal [17]. For example, results for one type of custom moulded carbon fibre insole may not generalise to other types of insole. Many studies do not specify the type of foot orthosis used [24]. Available research uses different measures of effectiveness, making findings difficult to aggregate. Much of the research focusses on pain reduction and only secondarily on functional outcomes and quality of life. Much of the research on the effectiveness of orthoses involves children. We know that children often outgrow their podiatric issues even without treatment. This means long term studies should contend with age and development as a confounding variable [25].

Also of note, much of the available research is designed to assess orthoses as a time-limited treatment option [14]. One study focussing on the long term effects of foot orthoses on walking kinematics limit the time-frame of the study to just 4 months [26]. I have not been able to find much research relevant to ongoing management of functional deficits (an exception is Hawke et al. [20]).

4.3 Foot orthoses for people with ASD

I have not found any literature specifically focussing on prescription of foot orthoses for people with ASD. Valagussa et al [2018] mention only 2 studies that look at treatment of toe-walking in people with ASD. I have only found 3 papers that mention foot orthoses as a treatment option for people with ASD and none of them look at this option in depth [3,10,19].

A summary of evidence-based treatments for ASD endorsed by the European Society of Child and Adolescent Psychiatry only briefly mentions motor deficits and notes only occupational therapy as a possible treatment [27]. Martikyan, Kaur, and Patel point out that consideration of the particularities of ASD which might complicate treatment of toe-walking are absent from the current literature [19]. For example, Leyden, Frung and Frick conclude:

> current [idiopathic toe-walking] treatment guidelines do not include specific recommendations for patients with comorbid conditions like ASD, and nonoperative treatments may be more challenging in patients with ASD if the patient has difficulty complying with instructions, sensitivity to tactile foot sensations/manipulation or is disturbed by the noise of cast saws. Medical treatment decisions should consider family preference, severity of the patient's condition, as well as any comorbid conditions [8].

As shown in 3. Motor difficulties for people with Autism Spectrum Disorder, people with ASD are at a much higher risk of DCD [5]. Podiatrists in Australia tend to think foot orthoses will be a viable treatment option for people with DCD. However, according to one analysis, podiatrists more familiar with DCD are less likely to prescribe orthoses [28]. There is very little evidence to suggest foot orthoses will have positive outcomes for people with DCD.

5. Reasonable and necessary

There is evidence that prescription of foot orthoses assists patients to reduce pain and disability and increase function for some conditions. There are several gaps in evidence and difficulties in generalising based on the current body of available evidence.

Considering the available evidence outlined in 4. Effectiveness of foot orthoses, it is unlikely that the treating clinician will be able to say with certainty that the prescription of custom moulded foot orthoses will improve the participant's functional outcomes. However, the clinician may have very good reason to suppose that the orthoses are likely to improve a participant's functional mobility.

When assessing requests for custom moulded foot orthoses for participants with ASD, assessors should:

- compare the reason for the request with the evidence of functional impairment and likely functional outcomes. Is it expected that the orthoses will increase comfort, reduce pain, improve walking tolerance, endurance, posture or gait, reduce falls risk, improve functional performance of daily activities such as increased independence and participation etc.?
- check if the participant has trialled or used custom orthoses in the past and what evidence has been collected demonstrating their efficacy and benefits
- confirm whether the orthoses are required:
  - to achieve short term treatment goals

  - as an early intervention support
  - to substantially improve the life stage outcomes of the participant
  - to manage ongoing functional performance of daily activities
- determine any characteristics of the individual that might complicate a prescription of foot orthoses. For example, does the participant have particular sensory needs? What is the likelihood that they will refuse or abandon the orthosis? Will insistence on this treatment lead to behaviours of concern?
- consider the research evidence which suggests that while children often improve gait and posture with age, people with ASD are also under-diagnosed with motor and gait issues including DCD
- request information regarding other options that have been completed, trialled or considered. For example:
  - prefabricated foot orthoses or supportive footwear
  - physical therapy
  - serial casting
  - surgery.

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7. Version control

Version	Amended by	Brief Description of Change	Status	Date
1.0	AHR908	Research request relating to prescription of orthoses for treating people with Autism Spectrum Disorder.	Approved	24/11/2021