**Prescription practices for rigid Ankle Foot Orthoses (AFO): a survey amongst UK orthotists**

**Objective**: The purpose of this study was to investigate rigid ankle foot orthosis (AFO) prescription practices for adult males, amongst UK orthotists.

**Design**: A cross-sectional study using a survey, distributed online to UK orthotists via the British Association of Prosthetists and Orthotists (BAPO) to its members and via social media and orthotic networks. The survey was completed between 1st November 2020 and 29th November 2020.

**Main outcome measures**: Descriptive statistics of survey results, including information related to the material used, the thickness of the material, positive cast rectification, AFO reinforcement, footplate design, padding, strapping system and height of AFO.

**Results:** 100 participants completed the survey which equates to a response rate of 30.5% of BAPO members targeted. A clear consensus emerged on the design of a bespoke rigid AFO for the hypothetical patient in this study, which is detailed as follows: a) 4.5mm co-polymer polypropylene, b) no additional reinforcement, c) full-length footplate with medio-lateral trimlines terminating behind the metatarsal heads, d) 3-point-correction with parallel sides, e) padded VELCRO® straps with D-rings at the calf and heel, e) no forefoot or other additional strapping, e) 3mm Poron® (international Ltd.) padding at the malleoli, f) AFO height that finishes 2cm below the fibular head.

**Conclusions:** This study has highlighted a consensus on AFO prescription/design amongst UK orthotists surveyed, based on the hypothetical patient described in this study.

Keywords: Orthotics; ankle-foot orthosis, splint, prescription.

Introduction

Ankle-foot-orthoses (AFOs) are often prescribed to manage functional gait deficits in adults and children with neuromuscular conditions such as stroke [1]. There are numerous types and designs of AFO, offering varying degrees of control of stance and swing phase during gait. The use of bespoke rigid AFOs are commonly indicated to influence the ankle joint for a number of reasons including stability, range management, and influencing gait, or where there is a need to influence hip and knee kinematics [2].

The biomechanical effects of rigid AFOs are well described [3,4]. However, AFO design is often poorly described in the literature despite its importance for the biomechanical optimisation of gait, and to aid study reproducibility [5]. There is a lack of defined terminology for describing the design of rigid AFOs [6], and few guidelines [7] exist to inform the design of bespoke rigid AFOs, which are often designed and prescribed based on historical practice and the experience, and preference, of individual clinicians.

Rigid AFO designs can vary in the type and stiffness of the material used, as well as design characteristics such as the trimlines, and reinforcements that added to the AFO superstructure at fabrication stage. These parameters affect the rigidity of the device, which influences gait kinematics. In this study, the authors define a rigid AFO as having ankle trimlines that are anterior to the malleoli, which blocks tri-planar movement of the foot and ankle complex during gait.

The authors recognise that the design of bespoke rigid AFOs should be tailored to the individual needs of each patient. However, there is a need to understand common clinical practice among orthotists as to the design of bespoke rigid AFOs for the adult, male population. This may help inform the production of guidelines for AFO prescription. The aim of this study was to investigate whether this is a consensus on baseline AFO design amongst UK orthotists when presented with a hypothetical patient.

Methods

A cross-sectional online survey was distributed to UK orthotists, which opened on 1st November 2020 and closed on 29th November 2020. The survey was approved by the Staffordshire University Research Ethics Committee (Ref. CBRT-LSE-1-10-2020) and administered via Microsoft Forms. Informed consent was sought and recorded via the online survey.

The survey was circulated via BAPO to all its member orthotists (n=334). The total number of prosthetists and orthotists registered with the Health and Care Professions Council (HCPC) is 1,105 [8] with approximately two thirds practising as orthotists [9]. The survey consisted of 25 questions, largely closed-ended (n=24) (see online supplementary file 1). The questions were based on a typical bespoke AFO specification form used by orthotic manufacturers, in addition to the knowledge of experienced clinicians and researchers, relating to a baseline prescription that is used for most patients prior to adding individually specified design characteristic required for the presenting pathology.

In order to remove the variables of patient presentations, in this study the subject was described as an adult male aged between 18 and 45 years old, weighing between 64kg and 88kg, and between 173cm and 188cm in height. The aim of this study was not to investigate AFO prescriptions and designs for specific patient pathologies but to explore whether there are common AFO prescription practices based on height, weight, age, and gender of the presenting patient before any pathologies are considered. The results of which will form part of a wider study exploring the integrity of the AFO structure.

Data processing

Descriptive analysis of the data collected via Microsoft Forms was utilised.

Results

100 survey responses were received.

71% (n=71) of respondents said they had a standard baseline prescription for adult bespoke rigid AFOs. Those who answered “no” (n=29) were presented with a further open-ended question, which asked how they decide on the specifications for their AFOs. Respondent 70 stated:

*“I base my prescription on the weight; activity levels and if any increased tone is present. The strapping configuration is dependent on any instabilities [sic] at the foot and ankle as well as the trim lines. I would say I either use 3mm or 4.5mm polypropylene. The ankle angle is also dependant on ROM [range of motion] at the ankle and any fixed contracture”.*

Several respondents highlighted the need for the design of bespoke rigid AFOs to be tailored to the individual needs of each patient, with respondent 34 commenting that:

*“Each patient is individual so [it] depends [on] what their needs and goals [are] as well as the orthotist’s goals*”.

**AFO material and reinforcements**

51% (n=51) of respondents chose 4.5mm co-polymer polypropylene as the material from which to fabricate the AFO. Other responses included 3mm (n=4) and 6mm (n=5) co-polymer polypropylene, and 4mm (n=1), 4.5mm (n=20), 5mm (n=1) and 6mm (n=4) homopolymer polypropylene. 1 participant chose carbon fibre.

50% (n=50) of respondents stated that they do not reinforce their AFOs as standard. Those who stated they would select either ribbed (n=30) or carbon fibre ankle reinforcement (n=20).

**AFO trimlines**

The majority of respondents (n=93) stated they would request a full-length footplate. Additional options for this question allowed respondents to stipulate where the trimlines would terminate along the medial and lateral aspect of the AFO. The most common response (n=15) was that the trimlines should terminate behind the metatarsal heads.

**Cast rectification**

The most commonly selected cast rectification was 3-point-correction (n=45). 36% (n=36) respondents reported they request their casts are modified with parallel sides built up forward of the malleoli to prevent anterior cupping and to ease donning of the AFO. 67% (n=67) respondents reported that they request a finished AFO height of 2cm below the fibular head.

**Strapping and padding requirements**

All respondents (n=100) answered the question on the type of strapping typically requested for the calf, heel, forefoot, and any additional strapping. A large majority of respondents (n=98) said they would request a padded Velcro strap with D-ring for the calf. For the heel, respondents (n=91) reported that they would request a padded velcro strap with D-ring. 62 respondents reported using no forefoot strap. Similarly, 63 respondents said they would not use any additional strapping. In terms of padding requirements most respondents (n=70), said they would request 3mm poron at the malleoli.

From the survey responses, a clear consensus emerged on the design of a bespoke rigid AFO for the hypothetical patient in this study, which is detailed as follows:

* 4.5mm co-polymer polypropylene.
* No additional reinforcement.
* Full-length footplate with medio-lateral trimlines terminating behind the metatarsal heads.
* 3-point-correction with parallel sides.
* Padded VELCRO® straps with D-rings at the calf and heel.
* No forefoot or other additional strapping.
* 3mm Poron® (international Ltd.) padding at the malleoli.
* AFO height that finishes 2cm below the fibular head.

Discussion

This survey was undertaken to gain an understanding of AFO prescription practices amongst UK orthotists, the results of which will be relevant to international orthotic practice. The respondents had varying levels of orthotic experience, ranging from less than 1 year (n=6), 2-5 years (n=25), 6-10 years (n=25), 11-15 years (n=15) and more than 15 years (n=31 years). The results indicate a clear consensus of a baseline prescription for AFO design for an adult male, as described in this study. The authors are aware that the prescription would be different had a presenting pathology been described. However, the aim of this study was to determine whether there was a consensus regarding baseline prescriptions, from which the orthotist would then adapt for presenting pathologies. Providing a hypothetical patient with a hypothetical pathology presents a challenge due to the significant number of variables involved and the influence these have on gait kinematics and AFO design. These variables, such as muscle tone and joint range of movement, were highlighted by some respondents (n=37) in this study.

Currently there is a lack of robust guidelines informing the design of bespoke rigid AFOs, in either the adult or paediatric population [5]. Failing to provide this information affects the validity and reproducibility of research studies and may result in poor clinical outcomes if AFOs are not appropriately designed. There is, therefore, a need to develop AFO prescription guidelines that can be used to inform evidence-based clinical practice and promote standardisation of treatment for service users across the UK. Owen [7] described the influence of AFO design on gait kinematics in children with cerebral palsy (CP) and produced algorithms that can be used to inform AFO angle design with this patient group. There are currently no available algorithms which dictate AFO design, material choice and thickness, footplate length, strapping and reinforcements, for presenting pathologies, which represents a significant research need.

In this study, a consensus in AFO design clearly emerged. Overall, the consensus was simple to identify and extract from the results, although there are no definitive guidelines for AFO design and prescription, there appears a consensus amongst orthotists.

Another point to note within the current study relates to the question on metatarsophalangeal joint (MTPJ) trimlines. The question was presented in a way that combined both the MTPJ trimline design (e.g., behind, on, or in front of the met heads) and the footplate design (e.g. length of footplate, toe spring etc.) and allowed for multiple answers to be selected. 62 respondents (62%) chose only one option, which was “full length footplate”. Of the remaining 38 respondents (38%), the most selected MTPJ trimline was “behind met heads” (n=15, 15%). The design of the MTPJ trimlines must be stipulated independent of the footplate design, when formulating a bespoke rigid AFO prescription, and must terminate on some aspect of the medial and lateral sides of the AFO. Therefore, in this study, the consensus AFO design includes MTPJ trimlines that terminate behind the metatarsal heads. The authors recognise that this question should have been presented as two separate questions to avoid conflating the two separate design specifications.

Overall, the AFO design described in this study, which represents the consensus baseline design among UK orthotists, should be utilised in further research to investigate the integrity of the structure and its efficacy in controlling and influencing adult gait parameters. There is a clear need for further studies in the area of bespoke rigid AFO design characteristics and their influence on gait kinematics. This could be expanded to include research into the effect of individual design characteristics, such as ankle reinforcements, material thickness and strapping systems, each of which can influence the control over the hip, knee, ankle and foot during gait. The lack of AFO prescription/design algorithms is an issue for orthotic practice in general therefore, the results of this study have relevance to our international orthotic practice. In summary, this study provides a clear consensus amongst the orthotists surveyed regarding the baseline prescription/design criteria used for an adult male aged between 18 and 45 years old, weighing between 64kg and 88kg, and between 173cm and 188cm in height.

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