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DEVELOPMENT OF ORTHOPEDIC FOOTWEAR FOR ORTHOSES ON THE LOWER LIMBS

Purpose. Analyze the available range of orthopedic footwear for orthoses worldwide and to design a model for implementation in Ukraine.

Keywords: orthopedic footwear, footwear for orthosis, 3D-modeling.

Introduction. Orthoses for the lower limbs can be mass-produced (e.g., knee braces) or custom-made. They are used to support, correct, or improve the function of the musculoskeletal system. Orthoses are employed to treat a wide range of conditions affecting the lower limbs, including foot and ankle injuries, knee pain, and hip joint diseases [1].

Orthoses may also be indicated for the correction of pathologies in children with cerebral palsy, SMA, or other CNS disorders that impair the function of the lower limbs.

According to international classification, orthoses are referred to by an abbreviation that describes the anatomical joints they stabilize: Foot orthosis (FO), Supra malleolar orthosis (SMO), Ankle Foot Orthosis (AFO), Dynamic AFO (DAFO), Knee AFO (KAFO), Hip Knee AFO (HKAFO) [2].

When wearing the aforementioned types of orthoses, the ankle joint and foot are stabilized, this prevents flexion in these joints. Therefore, wearing regular footwear becomes a significant challenge.

Additionally, the orthosis adds significant bulk to the foot, which substantially increases the required width of the footwear.

Abroad have been developed several types of designs that meet the necessary requirements. (Fig.1).

For example, models with a counter that unzips and secures using a textile Velcro fastening or a special patented elastic closure with a locking mechanism that transitions into lacing at the front. (models HeelEntry High-Tops by Surestep [3] (Fig.1a) and TwisterStar SB07 by Tomcat [4]. Also, FlipTop technology was patented (for example by Billy company) [5]

(The vamp and overlays with lacing can be completely detached from the boots and the upper part using a zipper).

In addition to the aforementioned models, special designs have been developed specifically for easier donning and doffing: Nike Pegasus EasyOn [6] and GoFlyEase [7] (Fig.1b, c). The first model features an external polymer heel counter that restores its shape, while the second model has a detachable folding sole.



Fig. 1. Easy to put on footwear: Surestep, Heel Entry High-Tops (a), Nike Pegasus EasyOn (b) and Go Fly Ease (c)

Methods of research. Analysis of the existing range of footwear for orthoses, automated 3D design.

Results. Despite the significant increase in the number of people in Ukraine who use orthoses for the lower limbs, footwear is currently only available in one design (FlipTop technology). Moreover, similar footwear is not included in the product range of companies that manufacture orthopedic footwear under government contracts.

Most people who wear orthoses are forced to wear usual sneakers with a deep opening of the upper and several sizes larger to accommodate the foot with the orthosis. But in the fact shoes for the foot with an orthosis have other parameters of the internal shape, which are based on the parameters of the orthosis (Fig 2).



Fig. 2 Plaster copy of foot with orthoses as the base for shoe last design.

For implementation in production, a model of children's footwear with a detachable counter (Fig. 3a) was proposed. The shoe last for the model was developed based on a 3D scan of the foot with an orthosis. The 3D model of the footwear was created using the CAD system MindCAD and the 3D-modeling software Rhinoceros.

The counter is stitched to the boots only at the lower part, allowing the shoe to open widely for easy donning over the foot with an orthosis. The counter is fastened and secured on the foot with a heel strap using a textile Velcro fastener. The strap is attached to the counter with a central loop (Fig. 3 (b, c)).

There is no need for a rigid heel counter, as the foot is already secured in the correct position by the orthosis.

The footwear can also be easily adjusted for width, because of the low lacing at the front.

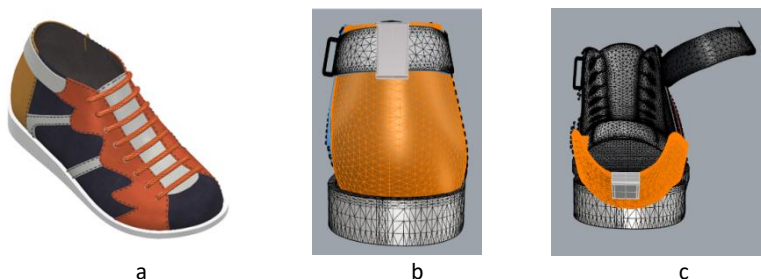


Fig. 3. Children's orthopedic footwear for orthoses with an easy put on system: sketch of the proposed model (a), rear view (b), rear view in an unfastened state (c).

Conclusions. Unfortunately, today a large number of both children and adults are forced to wear orthoses for the lower limbs to correct congenital and acquired conditions. An analysis of the existing designs of footwear for

orthoses on the global orthopedic footwear market was conducted. The analysis of orthopedic footwear produced in Ukraine revealed that similar designs have not been implemented in production in Ukraine.

As a result, using the CAD system MindCAD and the 3D-modeling software Rhinoceros, designing of orthopedic footwear for orthoses has been created. Moreover, this model is proposed for implementation in production at Ukrainian companies that manufacture orthopedic footwear.

By changing the color combinations and the configuration of the components, the designed model of footwear can also be used to produce footwear for adults.

References

1. Надточій Я., Ортезування стоп при патології нижніх кінцівок у дорослих: Кваліфікаційна робота (227 «Фізична терапія та ерготерапія»)/ Я. Надточій/Тернопільський Національний Медичний Університет імені І.Я.Горбачевського Міністерства охорони здоров'я України; наук. кер: к. н. біологічних наук Н. Давибіда – Тернопіль, 2023. –61 с.
2. Бердніков Н. Роль ортезування нижніх кінцівок у базовому догляді дітей з церебральним паралічем: Магістерська робота: (227 «Фізична терапія та ерготерапія») / Н. Бердніков / Український католицький університет. Кафедра фізичної терапії та ерготерапії; наук. кер: к. н. з фіз. вих. і спорту В. Рокошевська – Львів: УКУ, 2021. – 76 с.
3. Surestep.net. *Heel Entry High-Tops*. Дата звернення 20 вересня 2024 з <https://surestep.net/products/heel-entry-shoes/>
4. Tomcatuk.org. *Twister Star SB07*. Дата звернення 20 вересня 2024 з <https://tomcatuk.org/product/occupational-and-lifestyle-aids/twister-shoes/childrens-footwear/twister-star-sb07/>
5. Innovocare.com.ua. *Взуття дитяче Kid'sNavy / WhiteCanvas BILLY ClassicLaceLow*. Дата звернення 20 вересня 2024 з <https://innovocare.com.ua/product/vzuttia-dytiache-kid-s-navy-white-canvas-billy-classic-lace-low/>
6. Nike.com. *Nike Pegasus EasyOn Electric*. Дата звернення 20 вересня 2024 з <https://www.nike.com/ca/fr/t/chaussure-de-running-sur-route-pegasus-easyon-electric-pour-skWjTM/HF5457-900>
7. Nike.com. *Nike Go FlyEase*. Дата звернення 20 вересня 2024 з <https://www.nike.com/ca/fr/t/chaussure-facile-a-enfiler-et-a-retirer-go-flyease-4bM44t/DR5540-300>