

REVIEW OF ATTACHMENTS FOR ORTHOPAEDIC CRUTCHES SUPPORTING THE MOBILITY OF PEDESTRIAN ROAD USERS WITH DISABILITIES

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Abstract

In 2022, an interdisciplinary ITS team began work entitled: Development of solutions dedicated to pedestrians using orthopaedic crutches in the context of researching the needs of this group of road users in terms of the availability and functionality of elements supporting their movement and improving their mobility and safety, stage II.

Its objective was to develop an orthopaedic crutch attachment that improved the comfort and safety of pedestrians moving about in various weather conditions.

This article presents the results of the cap review (task 1 of the project), which is the starting point for further project activities.

Keywords:

pedestrian safety, orthopaedic equipment, mobility of people with special needs

Citation:

Wnuk A.K., Malawko P.: Review of attachments for orthopaedic crutches supporting the mobility of pedestrian road users with disabilities, *Motor Transport*, 67(1), s. 10-15

DOI: 10.5604/01.3001.0053.9429

1. Introduction

Demographic forecasts for the coming years clearly indicate that the number of elderly people, people with disabilities and people with mobility problems will increase. In order to support this large and diverse group in its needs related to mobility, systemic and ad hoc activities are carried out using also simple and constantly improved solutions.

The supply of orthopaedic equipment is designed to maintain the human ability to function independently, replace the lost function of the body and strengthen the work of individual organs by performing comprehensive activities related to the selection, construction, adjustment and use of appropriate solutions. Direct support equipment refers to various structural devices designed to stabilize, protect and/or correct orthopaedic disorders.

Assistive devices such as crutches, frames, supports, canes are used by people with mobility disabilities, as well as people with temporary disabilities who need support in maintaining balance while moving. The choice of the means of support depends on the physical condition of the person, the condition of his limbs and the range of movements performed.

There are many technical solutions dedicated to pedestrians with mobility problems, in particular those using orthopaedic equipment, i.e. crutches, canes, frames. The operating elements of these devices, which include caps, often do not fully meet the needs of users. A review of these support measures shows that designers and manufacturers fail to take many important features into account. It is all the more difficult to talk about meeting the needs of their recipients. In addition, these devices, if not treated as medical devices, are not subject to special regulations and evaluation, which may have serious consequences.

Therefore, the design of such solutions is underestimated, and the users themselves – pedestrians, are also not aware of how important this element is.

2. Project assumptions

In 2022, the team of the Motor Transport Institute undertook work to support the mobility and safety of pedestrian road users using orthopaedic equipment by developing a multifunctional attachment as an element that improves the comfort and safety of movement in various weather conditions.

The work is of multidisciplinary character and uses the achievements of many disciplines. It includes the theoretical part (analysis of available solutions), research part (qualitative research – focus, evaluation of a new solution), conceptual part (designing a solution) and implementation part (manufacturing and testing a solution). This approach allows to eliminate errors and develop a product that meets high standards.

The project is planned to be implemented in two annual stages, i.e.:

Stage I – preparatory (2022):

Task 1: Review of generally available devices supporting the mobility of pedestrians with disabilities, moving about with the use of orthopaedic crutches (crutch attachments), in terms of e.g. quality, composition, resistance to temperature, weight, usability, price, aesthetics, performing additional functions, e.g. improving visibility, etc.

Task 2: Conducting focus groups with pedestrians using orthopaedic crutches on the availability and functionality of mobility aids, including the features of an attachment that meets the above criteria and features selected by users.

Task 3: Developing a project for a crutch attachment, taking into account the expected features of the object.

Task 4: Conducting a patent analysis; Preparation of documentation and submission of a patent application on visualization.

Stage II – executive (2023):

Task 1: Development of the composition of the orthopaedic crutch attachment.

Task 2.: Manufacturing a prototype of an orthopaedic crutch attachment in accordance with the developed visualization project and the selected composition.

Task 3: Product testing and evaluation – first laboratory, and then with the participation of potential users; preparing a research report.

In this article, we present the previously unpublished results of task 1 of stage I.

3. Overview of orthopaedic crutch attachments

The starting point for the review of orthopaedic crutch attachments was the offer of such solutions commonly available in medical stores in the country and abroad. Another criterion accompanying this review was the presentation of conceptually different solutions. Selected products were purchased in order to analyse the details of their manufacture and material.

In total, several dozen solutions were analysed. Some of them are presented in Table 1.

Based on this review and expert evaluation, it was indicated that the important parameters of the attachments are: material, weight, size, resistance,

functionality, safety of use and the user, price, quality of workmanship, aesthetics, and additional functions.

The analysis of source materials also revealed deficiencies related to functional and technical tests of attachments for orthopaedic equipment.

There are many solutions of this type available on the market, often imported from Asian countries, without any documentation guaranteeing quality and safety.

4. Conclusions from the review of the element improving the functionality of orthopaedic crutches (attachments) dedicated to pedestrian road users

During the review of attachments for orthopaedic crutches that can contribute to improving the functioning of pedestrian road users, the following features were taken into account: type of attachment, purpose of use, technical parameters (weight, material, size), price.

Based on the catalogue data of the cap manufacturers, the caps can be classified as follows:

- standard (universal) attachments
- winter versions (e.g. spikes, increased area at the base),
- specially dedicated (addition to the cap equipped with spikes, self-standing cap),
- off-road versions (e.g. shock-absorbing attachment that leans out in several planes during use).

Attention was drawn to the use of the same type of attachments not only in orthopaedic crutches, but also in frames, walking sticks, trekking poles, walkers. Their use is mainly limited by the diameter of the mounting hole; in some versions, shape and purpose.

Most of the attachments available on the market used in orthopaedic crutches are available in a universal version. This version allows to move in different weather conditions and on different surfaces (wet, dry, icy, snowy, loose – sand, gravel, snow, etc.).

Features that affect functionality and purpose are size and weight. The attachments are produced with different opening diameters. Their setting is between 18-22 mm.

Versions from the standard group in most models, due to the smaller amount of material used for production, are lighter. The weight reduction is due to the slimmer construction, the lack of additional mechanisms (metal bushings, metal joints, springs) that may increase the weight.

An important feature of the cap is its adhesion to the ground, which guarantees the stability of the user in contact with the surface, e.g. the attachment cannot collect water from the ground, dirt and dust should not accumulate in the tread of the cap, etc. No information has been found whether the functionality of those available for sale has been checked. Also, no information was found on their ease of use, i.e. fitting it on/taking off, washing, etc.

Another parameter is the material of the attachment. Manufacturers use various materials and their composites, i.e. plastic, rubber, natural rubber (caoutchouc), metal (structural reinforcement sleeves, reducing sleeves, springs enabling shock absorption), foam (shock damping), metal joints (allowing tilting in every possible direction).

The above review shows that, on the one hand, manufacturers try to meet the needs of different users of attachments, on the other hand, there is too much fragmentation of available variants.

Depending on the needs and function of the attachments, their price also varies, ranging from a few to several hundred zlotys per pair. It would be appropriate to work out a compromise between the cost of producing the cap and the final price of the product, enabling the purchase of the cap not necessarily dictated by the price.

The unregulated manufacturing process of products for people with mobility difficulties, including orthopaedic crutch attachment users, is worth rethinking. In this review, no information or labelling was found to indicate that the products are certified.

There is no uniform path (all processes are connected, design process, production process, testing process, certification process, finished product) taking into account all activities from design to testing, the final result of which would be a certified product that meets specific standards. It should be reconsidered whether this topic should not be subject to consultations.

5. Summary

The attachments are a replaceable part of the crutches. Their suitability should be determined by the manufacturers. Due to the fact that they wear out, they need to be replaced from time to time in order for them to perform their function properly. Non-slip, easy-to-install attachments are an important element of safe and functional moving about using orthopaedic crutches on various surfaces and in various weather conditions.

Contrary to popular belief, preparing a good quality product that meets the recipient's expectations is not an easy task.

As mentioned, the first task of the work was to review and evaluate dozens of generally available devices of this type on the world market, according to the developed criteria. Based on the results of this stage, the author's team designed a prototype of a multifunctional attachment for orthopaedic equipment dedicated to pedestrians.

The proposed solution was the subject of focus groups with the participation of pedestrian road users moving about with the use of such equipment (crutches with caps). Their feedback allowed to improve the prototype of the product.

Work is underway to develop the material from which the product will be made. The next step will be the production of attachments and laboratory and target group evaluation – pedestrian road users using orthopaedic devices. A positive opinion of this evaluation will be an incentive to introduce the product to the mass market.

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Table 1. Review of attachments for orthopaedic crutches supporting the mobility of pedestrian road users with disabilities

Attachment illustration	Version (Winter, Summer, Universal)	Size (Ø or size designation)	Material, material composition	Weight	Additional functions, features provided by the manufacturer	Users' opinions	Price	Manufacturer	Other
 www.orteo.pl	Universal	Inter. diam. 19mm Outer diam. 40mm	Rubber	No information	Non-slip, easy to fit, shock absorbing, does not scratch the surface, articulated structure facilitates contact with the ground	Very good, comfortable	4,90zł	Pivoflex	Can be used in canes and crutches
 www.orteo.pl	Universal	Inter. diam. 19mm Outer diam. 40mm	Rubber	No information	Non-slip easy To fit, absorbs shocks, does not scratch the surface	Good, standard	5zł	High Q	Can be used in canes and crutches
 www.orteo.pl	Universal	Inter. diam. 26mm Outer diam. 39mm	Rubber	No information	Non-slip easy To fit, absorbs shocks, does not scratch the surface	Good, standard, good quality	6zł	ARmedical-reha	Can be used in frames and walkers
 www.orteo.pl	Specially dedicated / Winter	Adjustment of the attachments diam. (1.6-2.5 cm), Height 12cm	Steel, plastic	No information	Universal size, adjustable, easy to fit and disassembly, solid workmanship	Meets expectations, good workmanship, quick and easy to fit	17zł	JCM2900	Can be used in frames, walkers, crutches, canes
 sklep.imed.warszawa.pl	Universal	Inter. diam. 15 mm Outer diam. 22 mm	Caoutchouc	No information	Absorbs shocks, reinforced construction	Standard, good quality	7zł	REHA FUND	Can be used on crutches, canes
 www.agamedic.pl	Winter	Inter. diam. 18 mm Outer diam. 50 mm	Rubber / metal	0,11 kg	Non-slip, large contact surface, steel spikes	Sturdy	9,50zł	UNI-AKC-NASA-DK-00454	Can be used in crutches, sticks

Attachment illustration	Version (Winter, Summer, Universal)	Size (Ø or size designation)	Material, material composition	Weight	Additional functions, features provided by the manufacturer	Users' opinions	Price	Manufacturer	Other
 mikirad.com.pl	Universal	Inter. diam. 18.5 mm Outer diam. 40 mm	Rubber	0,039 kg	Non-slip, large contact surface, thick protector on the bottom, slightly deflecting upper part of the cap	Meets expectations	3,90zł	MIKIRAD	Can be used in crutches for adults and children canes
 www.ninelife.pl	Off-road	Inter. diam. 19.5 mm Outer diam. 80 mm	Rubber	0,198 kg	Non-slip, bends in different directions, different variants (Ergocap High Performance, ERGO CAP X-Treme, ERGO CAP Ultralite), cushioned	Does not meet off-road expectations, does not fit some crutches, good quality	269-470zł	Ergoactives	Can be used in crutches, sticks
 www.walmart.com	Off-road, sports	Inter. diam. 16-19 mm Outer diam. No.inf.	Reinforced rubber	No information	Increased grip in the field (sand, gravel)	Stable, good quality, durable	34,29 \$	Wisremt (Cane and Crutch Pad.)	Can be used in crutches, sticks
 www.walmart.com	Off-road, sports	Inter. diam. 16-19 mm Outer diam. No.inf.	Reinforced rubber	No information	Increased grip off-road (sand, gravel), non-slip	Too big, nice look, good quality.	14,99 \$	Wisremt (Cane and Crutch Pad.)	Can be used in crutches, sticks
 www.walmart.com	Universal 360°	Inter. diam. 19-22 mm Outer diam. 65 mm	Stainless steel, rubber	0,222 kg	Flexible, 360 degree tilting in every direction for maximum stability, non-slip	Sturdy, comfortable, durable	21,45 \$	Swietlik (Cane and Crutch Pad.)	Can be used in crutches, sticks
 www.walmart.com	Universal	Inter. diam. 35 mm Outer diam. 48 mm	Rubber, latex, metal	0,158 kg	Anti-shock, non-slip	Standard, good	1,90 \$	Duro Med. (Cane and Crutch Pad.)	Can be used in crutches, canes, frames.
 www.walmart.com	Off-road/ Winter	Inter. diam. 19,05-25,4 mm Outer diam. 152,4 mm	Rubber	0,312 kg	For use on grass, sand, snow, mud, rocky terrain and general paved surfaces	Good quality, works well on sand, snow	30,99 \$	American Ventures Ltd. (Cane and Crutch Pad.)	Can be used in crutches, canes, frames, etc.

Attachment illustration	Version (Winter, Summer, Universal)	Size (Ø or size designation)	Material, material composition	Weight	Additional functions, features provided by the manufacturer	Users' opinions	Price	Manufacturer	Other
 www.walmart.com	Universal	Inter. diam. 10-19,05 mm Outer diam. 58 mm	Rubber with polyurethane sleeves	0,115 kg	Non-slip, increases the ability to move on unpaved terrain	Durable, good	12,91 S	Colaxi	Can be used in crutches, canes, frames, trekking poles
 www.walmart.com	Specially dedicated	Inter. diam. no inf. Outer diam. 80 mm	Rubber, plastic, metal	0,114 kg	Non-slip, increases the ability to move on unpaved terrain, increases stability, anti-shock	Stable	12,69 S	Pakewalm	Can be used in crutches, canes, trekking poles
 www.amazon.com	Universal	Inter. diam. No inf. Outer diam. No inf.	Rubber	0,054 kg	Non-slip, anti-shock	Good quality, nice colours	17,99	SureTip by Kit King	Can be used in crutches, sticks ,
 www.amazon.com	Off-road	Inter. diam. 19 mm Outer diam. 58 mm	Rubber , plastic	0,135 kg	Twists in axis, non-slip, anti-shock	Good off road, good quality, nice look	15,99 S	Rehand	Can be used in crutches, sticks
 www.amazon.com	Universal	Inter. diam. 19 mm Outer diam. 49 mm	Fluorescent rubber	0,100 kg	Non-slip, luminous	Good, solid, bright	9,99 S	MESINURS	Can be used in crutches, sticks
 www.amazon.com	Universal	Inter. diam. 19,05-25,4 mm Outer diam. 60,3 mm	Rubber, natural caoutchouc	0,05 – 0,201 kg	Anti-shock, non-slip	Very good, super quality	62,99 S	Thomas Fetterman Inc.	Can be used in frames, walkers, crutches, canes
 www.amazon.com	Winter	Inter. diam. 19,05 mm Outer diam. No inf.	Rubber, metal (spike)	0,045 kg	Non-slip, for ice and snow	Good quality	24,04 S	POPab.	Can be used in crutches, sticks

Attachment illustration	Version (Winter, Summer, Universal)	Size (Ø or size designation)	Material, material composition	Weight	Additional functions, features provided by the manufacturer	Users' opinions	Price	Manufacturer	Other
 www.flexsticks.com	Universal	Inter. diam. 19,05-22 mm Outer diam. 44,45 mm	Rubber, steel	0,085 kg	Flexible, 360 degree tilting in every direction for maximum stability, non-slip	Good workmanship	17,49 \$	FlexSTICK	Can be used in crutches, sticks
 www.flexsticks.com	Off-road	Inter. diam. 19,05 mm Outer diam. 76,2 mm	Rubber, steel	0,130 kg	Flexible, 360 degree tilting in every direction for maximum stability, non-slip	Sturdy	19,99 \$	FlexSTICK	Can be used in crutches, sticks
 www.rubberferrules.co.uk	Off-road	Inter. diam. 19,05 mm Outer diam. No inf.	Rubber	No information	Flexible, 360°, tilting in every direction non-slip, multi-surface capability	Good quality, sturdy	19,99€	SLIPNOTT	Can be used in crutches and sticks
 www.rehshop.pl	Universal	Inter. diam. No inf. Outer diam. No inf.	Rubber	No information	Non-slip, the ability to move on various surfaces	Super quality	16,90zł	FDI France/Antar	Can be used in crutches
 www.ortomoda.pl/laski-ortopedyczne/akcesoria-do-lasek	Specially dedicated Stabilizing	Inter. diam. No inf. Outer diam. 145 mm	Plastic	0,11 kg	A device allowing the crutch or cane to remain upright when not held by the user. The tripod is easy to fit. Spacing – 15,8 cm.	Very light, good quality	57zł	Antar	Can be used in balls and sticks