

DESIGN OF THERMOPLASTIC IMMOBILIZATION FOREARM SPLINTSMaria Danko; Monika Michalikova; Lucia Bednarcikova;
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Keywords: thermoplastic, splints, design, forearm, orthoses**Abstract:** A retrospective view of orthopaedic devices gives the impression of a missing element. Fully functional custom-made orthoses appear to be prototypes in progress. They lack colour, variety, original motif, uniqueness, additional functionality i.e. design. Nowadays it is possible to choose a colour combination of the whole orthosis and the aim of the submitted study is to find out the interest in incorporating an additional function or original design.**1 Introduction, study background**

If we focus on small children, teenagers or adolescents who need to be motivated to wear orthoses, the solution offers custom made design [1,2]. Little girls would welcome iridescent orthoses with glittering sequins and a large unicorn, the "boys" would not disdain the comic motif of their sci-fi action hero, which would also attract the looking of people around [3,4]. From a practical point of view, especially with long-term wear during the day [5], a splint with an USB key, a smart watch or a small transcript text field on the forearm would be helpful.

In order to create a statistical survey of the present study, the area of investigation is focus on the specific type of forearm brace that is one of most often orthopaedic aid used after trauma, surgeries, illnesses etc [5]. Therefore, this article is focused on a custom-made thermoplastic immobilization splint for the dorsal side of the hand, which is applied to about 75% of the forearm and 50% of the hand causes. This fixation positioning device prevents wrist flexion and is made of a low-temperature thermoplastic, that can be arbitrarily shaped, modelled and applied to any part of the body after heating [5-7]. So, this is a fast and net production with minimal patient discomfort with the benefits of being lightweight and well ventilated [5,8,9]. It allows easy deployment and composition, e.g. personal hygiene [10]. Indications for prescription are mostly

injuries and hand surgery. It is prescribed when the joints are dislocated, sprain and stretched ligaments. According to the ŠÚKL Code, it is classified like a therapeutic instrument that is prescribed or dispensed according to the patient's health condition, otherwise once a year or compensatory paid by the health insurance company once a year. Individually made passive brace of the hand is fully paid by the health insurance company. If the client does not have health insurance or a doctor's prescription, as it also has a prescription restriction (OPR, ORT, CHI, TRA, RHB), it can be made for a direct payment, depending on the price list of a particular orthopaedic manufactory. Most also offer special and extra adjustments for an additional fee [11-14].

2 Methods

The aim of the presented study is to evaluate the merits of incorporating a functional or original element on a thermoplastic splint of forearm. At the Department of Biomedical Engineering and Measurement it was made several designs with some improvements that were tested by general population of physiologically and mentally healthy people, that were divided into four categories according to ontogenetic development [3].

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The study sample consists of 60 respondents divided into four age groups [3]:

1. small children and schoolchildren aged 3-12 years, 9 respondents, nurseries and pupils
2. adolescents aged 13-20 years, 32 respondents, pupils and students
3. adults aged 21-64, 17 respondents, doctoral students and teachers
4. seniors aged 65 and over, 2 respondents, pensioners

The survey is based on a questionnaire and was focused on a purely lay, theoretical assessment of the added value of individual handmade original pieces. None of the respondents surveyed has experience with the long-term use of an immobilization thermoplastic splint. Therefore, for the purpose of this study and better imagination the splint would be for a non-dominant limb and the period of use of the fixation brace for 16 hours per day for 6 months [5]. The most important question was if the design and the additional functions of the orthosis are important to respondents. They were able to choose from following design and it was allowed to point more than one option.

2.1 Variants of design for thermoplastic splints from the questionnaire

A) Hand painted splints

The design of the brace is truly custom made, with the only limitations being the artist's fantasy and creative abilities. Pictures of splints from our department with own motives e.g. street art for "little" superheroes, car track, design inspired by Japanese geisha or for girl with ladybugs and many more (Figure 1).



Figure 1 Hand painted splints

B) Choose from samples of colour and pattern

There is also a wide range of colours, patterns and finishes available on the manufacturer's websites (Figure 2).

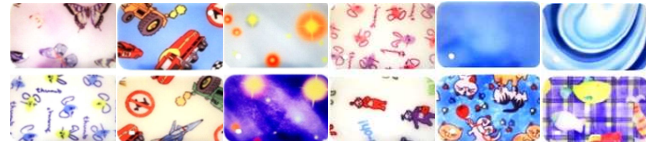


Figure 2 Samples of colour and pattern

C) Splint „Whiteboard surface with white board pen“

The surface of the splints is especially adapted for repeated writing and erasing with the added marker pen (Figure 3).



Figure 3 Splint „Whiteboard surface with white board pen“

D) Brace with alarm, GPS or with smart watch

The device can make an alarming sound or send a mobile phone signal to an ICE person or measure vital signs or for sport training and other (Figure 4).



Figure 4 Brace with alarm

E) Brace "pills always with you"

Splints with practical box for storing valuable treasures for children but also adults e.g. to pills, flash cards and so on (Figure 5).



Figure 5 Brace "pills always with you"

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F) Thermoplastic splint with built-in USB key (Figure 6)

Excellent aid not only for pupils and students.

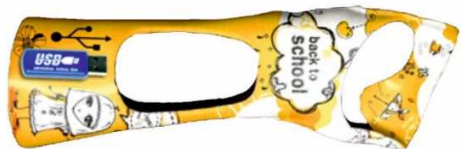


Figure 6 Thermoplastic splint with built-in USB key

G) Standard forearm immobilization splint without custom design (Figure 7)



Figure 7 Standard forearm immobilization splint

3 Evaluation of statistical survey

Respondents were asking about their age and then were categorized accordingly this [5]. They have written all of their experience with orthopaedic devices (to any part of the body) in terms of evaluating their application for a 24 hour mode of action and commenting to the total period of orthotics brace using for months [4]. None of the survey participants had experience with thermoplastic forearm splint at the time of filling in the form.

Each additional element on the brace was evaluated in the questionnaire separately. There were interesting views on the essence of design and interest in associated value depending on the respondent's age. Quantitative representation of design in each category is given by numerical value and evaluation by percentage.

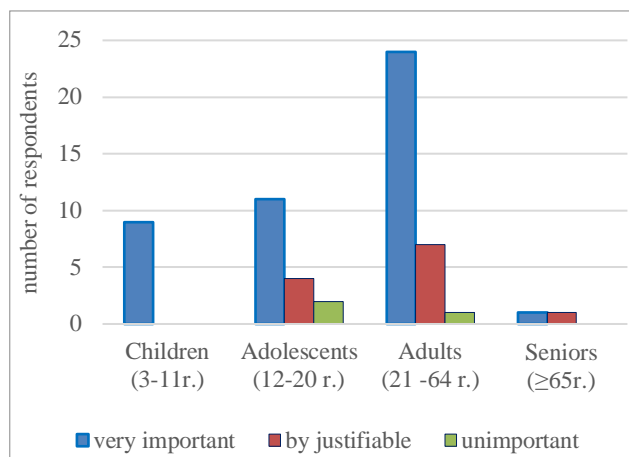


Figure 8 Opinion on the design depending on the age of the respondents

Based on our study sample, design is important, as up to 95% of them responded (see Figure 1), and its need grows exponentially depending on the long-time of use of the orthopaedic device. Because most of the respondents started to think more about the design, when taking into account the temporal aspect of using the orthosis [13,14]. Of course, children definitely want to a colour thermoplastic splint, as up to 100% of them show the necessity of this (see Figure 8) and preferably with their own motif, with magic white board surface, smart watch or USB key (see Figure 9).

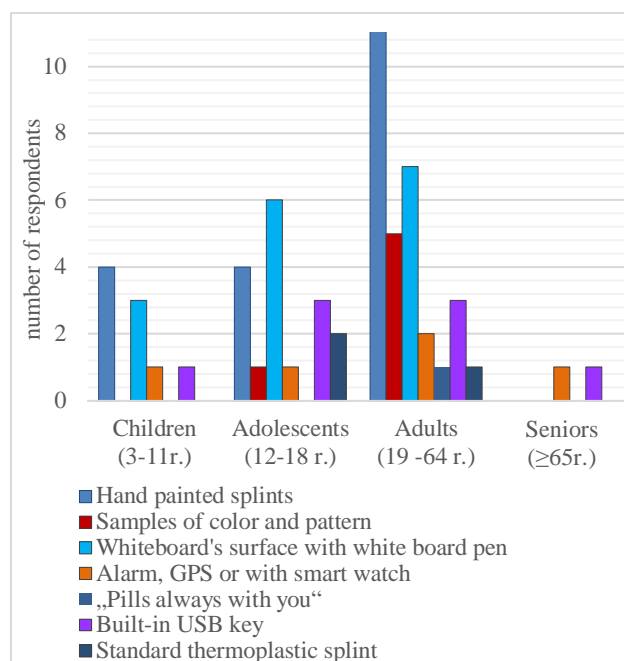


Figure 9 Evaluation of variants of design of thermoplastic splint from the questionnaire

Adolescents would appreciate a splint with a surface of marker board and white board pen (35.3% of them). 23.5% of them would like an original hand painted design or having an USB key always at hand (17.6% of them). Two of the interviewed teenagers and one adult would not be interested in any improvements, they are also not interested in to choose from the sampler of colour or pattern. Up to 40.6% of adults would prefer to self-realize by choosing an original painting or improving the brace for a fashion accessory. Also, up to 21.8% of them would appreciate the surface of whiteboard with white board pen. Seniors would be interested in an orthosis with an alarm or a built-in USB key.

4 Conclusions

The present study examines the merits of design implementation according to the ontogenetic categorization of respondents, using the method of qualitative evaluation based on the subjective opinion of the individual. According to the concept of the survey, the

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upward trend of a hand-made original with incorporated functional accessories can be clearly stated. The question of comfort was answered by 68% of respondents that they would not mind any restrictions on use resulting from the design in terms of increased caution e.g. sequins, buttons, USB key, button, watch or attached pen etc. Overall, 55% of surveyed the adolescents and adults would not hesitate to pay extra for a possible custom-made redesign. Based on the data obtained from the survey participants, it can be concluded that custom made design has a future and great potential [3-5,13].

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Review process

Single-blind peer review process.