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Initial designs of wheelchair rugby gloves

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Abstract. Wheelchair rugby is a sport played by approximately 200 people in the United Kingdom. Despite being a small part of the population, research suggests that there are some aspects related to the sports-wear that need attention. This is especially relevant for gloves, as they have been identified as one of the main causes of performance losses. Until now, there are no gloves available on the market that were developed to respond to this sport's needs and requirements. The purpose of this paper was to present the concepts of the initial designs and first prototype of a pair of gloves created for wheelchair rugby. The designs were developed based on the feedback from one UK-based wheelchair rugby team. Of the designs produced only one was selected to be developed as a physical prototype. This particular design had in consideration the most important features identified by the athletes, namely the easiness of putting on and taking off the gloves, the padding and grip in specific areas and the elimination of the need for tape to secure.

1. Introduction

Wheelchair Rugby is a sport that was designed for male and female athletes with any type of physical disability. However, it has also gained popularity among abled-bodied athletes. Athletes are always striving for success and improved performance. The evaluation of performance is decisive for athletes, as it allows for a continuous improvement of the athlete and the wheelchair-user interface [1–3].

The very few studies available on wheelchair rugby sports-wear have found that the gloves are a major concern in this particular sport. These studies have found that there are no gloves specific for wheelchair rugby, which causes the athletes to modify existing ones in order to accommodate the performance requirements [4–8]. The International Wheelchair Rugby Federation states that “many different types of gloves are available to choose from”, however, none are sport-specific. Further, they state that “Many athletes prefer using rubber coated cotton gloves because they are inexpensive and provide considerable grip to the player. Using tape to secure gloves to your wrist is a common practice and is highly recommended”. However, this information is only available on their website [9]. The official document containing the International Rules for the Sport of Wheelchair Rugby [10] does not provide any information about gloves.

Mason et al. [4] tried to define the effectiveness of different types of gloves on mobility performance of wheelchair rugby. They concluded that the gloves performed significantly better when they were modified and adapted for the specific athletes' needs. The authors advise that further research is needed to evaluate the athletes' interaction with different types of gloves.



The work of Lutgendorf et al. [5] also evaluated the influence of the use of different types of gloves on standardized wheelchair rugby performance compared with not using gloves at all. This study led to the conclusion that the use of different types of gloves significantly influenced performance. Nonetheless, some gloves helped the athletes to perform better than others (US National Football League gloves were the most favourable ones, whilst multipurpose were even worse than not wearing gloves at all).

In these two studies, it was clear that there is a real need to develop gloves specific to this sport that fulfil the athletes' specific needs and requirements. In other more recent studies, similar conclusions were withdrawn. In the study of Bragança et al. [11] a set of design recommendations for the development of wheelchair rugby sports-wear that responds to the users' particular needs and requirements was evaluated. The results of this study indicate that the athletes would be happy to have improvements introduced to their current sports-wear, particularly on the gloves.

Bragança et al. [12] analysed, by means of videos and photographs, the patterns of activity and movements performed by wheelchair rugby athletes during a set of wheelchair rugby training sessions. Their study served not only to inform on the movements and body postures but also on the problems and difficulties caused by the items of sports-wear worn by the athletes, concluding that gloves are causing the most problems with performance.

The purpose of the current paper is to present an initial prototype of a pair of gloves specifically designed to fit the needs of wheelchair rugby players.

Methodology

1.1. Sample

The sample used for this study was composed by a wheelchair rugby team of 25 athletes based in the United Kingdom (22 males and 3 females).

1.2. Data collection

The design of the glove started with the identification of the end-users' needs. This was done by means of both direct observation (with the capture of several videos and photographs) as well as of interviews to the end users. The videos, photos and interviews were recorded over the course of several training sessions of this particular team. The research team responsible for these observations was composed by a lead researcher and five product design students.

1.3. Data analysis

The information gathered in the unstructured interviews to the athletes was analysed and the users' needs were extracted. The videos and photographs allowed to understand how the athletes move and the main tasks performed during the training sessions. The areas of contact of the hand with the wheelchair and the ball were analysed in detail.

Once identified the needs and all the other necessary requirements, several potential designs were developed. These designs were then evaluated by a team of experts who selected the one that responded to the users' needs and the sports requirements better. The selected design was then transformed into a real physical prototype.

2. Results and Discussion

Due to the lack of availability of a specialised pair of gloves for wheelchair rugby, athletes use a variety of different types of gloves available on the market that have been designed to fulfil other requirements. These other types of gloves include cycling gloves; golf gloves; motorcycling gloves; football goal keeper gloves; and even industrial gloves. Table 1 shows a brief summary of the advantages and disadvantages of each one of these gloves.

Table 1. Characteristic of different types of gloves available on the market.

Type of glove	Pros and cons
Cycling gloves	<u>Pros:</u> Sweat absorbent; easy to get on and take off; breathable; enables grip. <u>Cons:</u> Not very durable.
Golf gloves	<u>Pros:</u> Easy to get on and take off; breathable; durable; has some padding. <u>Cons:</u> Does not provide enough grip.
Motorcycling gloves	<u>Pros:</u> Breathable; made for rough conditions; texturized grip areas; has protective patches; durable. <u>Cons:</u> Restricts movement on the areas with protective patches.
Football goal keeper gloves	<u>Pros:</u> Very protective; very padded; enables some grip; durable. <u>Cons:</u> Too padded; not breathable.
Industrial gloves	<u>Pros:</u> Easy to get on and take off; enables grip; durable; padded. <u>Cons:</u> Does not stay in place; not breathable.

However, gloves for wheelchair rugby need to have special features that none of these gloves have. Some of the gloves analysed present a few relevant features but there is not one pair that has all the necessary characteristics at the same time. Generally, according to the feedback from the athletes interviewed and to previous studies [8], gloves for wheelchair rugby need to be:

- durable;
- resistant to wear and tear;
- lightweight;
- sweat absorbent;
- allow movements of the fingers and wrists;
- enable grip on the areas of contact with the wheelchair and the ball;
- have padding on the areas of contact with the wheelchair for protection;
- able to be kept in place while manoeuvring the wheelchair;
- easy to put on and take off.

It is important to mention that each athlete has a very personal way of interacting with the wheelchair and the ball. As such, it is very difficult to develop a product that suits everyone’s needs in the same way. The several designs created tried to respond to all of these needs and requirements in a general way. Nonetheless, the design selected to be developed into a prototype responded better to the needs and requirements of the majority of the athletes (Figure 1). Still, it is important to note that even though this has been designed for the majority of the athletes, it would be possible to modify this design to accommodate users with different needs by implementing the same changes and applying them to different areas of the hand.

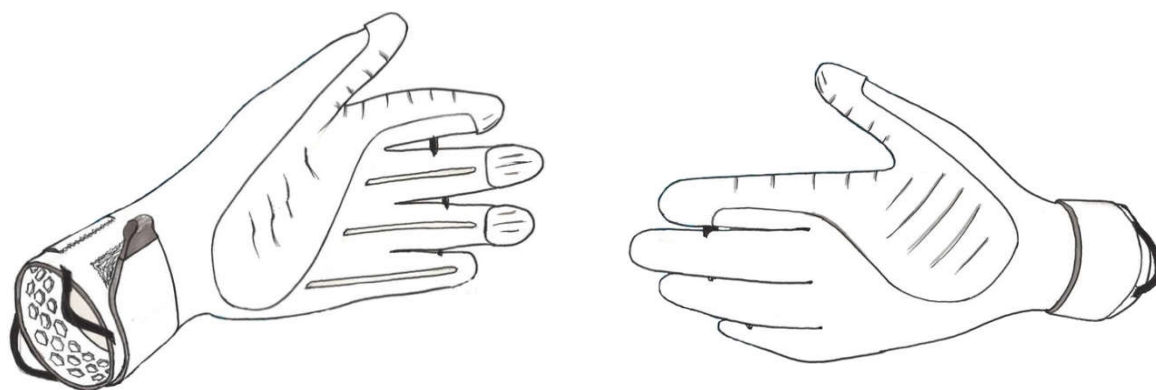


Figure 1. Draft of the prototype.

The design that was selected focused on the most important issues identified by the athletes: (i) the ability to secure the gloves in place; (ii) the ability to easily put the gloves on and take them off; and (iii) the provision of padding and grip in the areas that are in contact with the wheelchair.

The first issue (ability to secure the gloves in place) was addressed by exploring different ways of securing the gloves in the wrist area. It was decided that the best way of doing this would be by having a Velcro strap placed just above the wrist. This positioning of the strap would allow not only to ensure that the gloves do not come off while manoeuvring the wheelchair but it would also allow for an increase range of movement of the wrists (Figure 2).

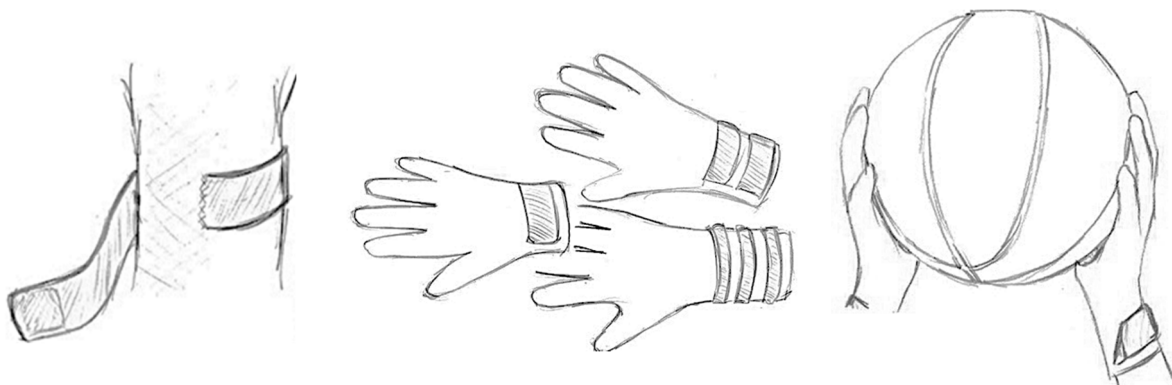


Figure 2. Testing on the wrist strap.

The second issue (ability to easily put the gloves on and take them off) was addressed by including webbed tabs in between the fingers to help take the gloves off with the opposite hand. To help in putting the gloves on, either with the opposite hand or with the teeth, the same type of tabs was added to the ends of the glove in the wrist area. These attachments can be seen in Figure 3.



Figure 3. Webbed tabs to help put on and take off the gloves.

The third issue (provision of padding and grip) was addressed by choosing thick neoprene as the main element of the gloves and by coating the areas of contact with the wheelchair and the ball with a rubber solution. Padding is a very important part of the gloves as it can prevent injuries, by protecting the hands from heavy contact with hard surfaces or objects. On the glove itself, the two most common areas for padding are located on the palm of the hand. It is important to select the right padding material for the gloves as, after a short amount of time, padding and other materials on the glove wear and tear. By looking at other contact sports where padding is usually used (e.g. American football, hockey, rugby and ice hockey), some different materials were classified as good options for wheelchair rugby: foam padding; gel padding; or wadding material. Neoprene can also be used as an option as it is a durable, breathable and comfortable material. Moreover, its thick and elastic structure can act as a good protection material to use between the hand and the objects. However, the construction of the glove using this neoprene as a base can become quite complex as it is somewhat

difficult to work with when used in such an intricate manner. Figure 4 shows how the stitching of the neoprene was made (with the addition of a thinner neoprene layer to avoid the rubbing of the seams with the skin).

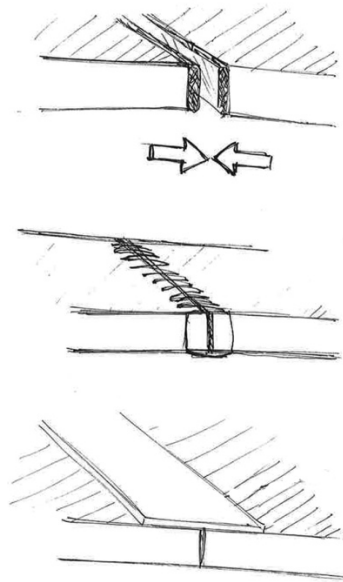


Figure 4. Stitching on neoprene breakdown.

As for the grip, there are some materials that are usually used for this purpose, such as rubber; silicone; or polyurethane. These materials are flexible and somewhat resistant so they represent good options for wheelchair rugby. In the prototype created, a rubber solution was used as it was the most inexpensive and easy way of obtaining the desired result. Nonetheless, a very good alternative would have been the application of a vulcanised rubber patch as this material is very durable and has a high resistance to wear and tear. However, this would require the manufacture of a mould specific for this glove, which is a much more expensive solution. Figure 5 shows how the vulcanised rubber should be moulded to fit the parts of the hand that need more grip.

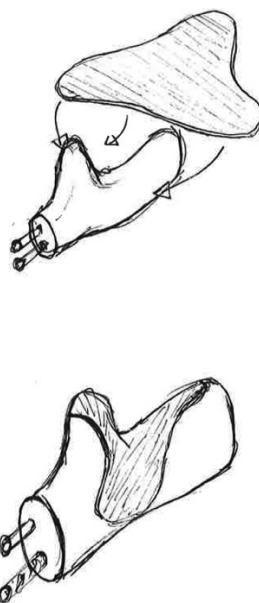


Figure 5. Vulcanised rubber moulding.

3. Conclusions

Several initial designs were created for a pair of gloves specific for wheelchair rugby. These designs were created based on the results of previous studies as well as on unstructured interviews conducted over the course of several training sessions of one UK based team. One of the designs was selected to be turned into a physical prototype as it focused on the most important features for the athletes, namely the ability to secure the gloves in place; the ability to easily put the gloves on and take them off; and the provision of padding and grip in the areas that are in contact with the wheelchair.

This first prototype of a pair of gloves specifically designed to accommodate the needs of wheelchair rugby players fills a gap in this area of research.

The major limitations of this study are the fact that this design has not yet been tested by the end users and that it might not satisfy the needs of every single user. As such, as future work, the authors intend to test and evaluate this first prototype with the same sample that provided the initial feedback.

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