THE DESIGN OF THE EPITHESIS WITH THE INTEGRATED ELECTROSTIMULATOR FOR PEOPLE WITH THE ATROPHY MUSCLE OF THE LOWER EXTREMITIES

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Abstract
This thesis introduces the epithesis with the integrated electrostimulator as a rehabilitating and compensating aid which also has the aesthetic function. It presents the epithesis as an aesthetic replacement for people with the atrophy muscle of the lower extremities with missing muscular tissue. This work discusses different production processes, materials, possibilities variations epithesis shape and the realization of a prototype. It proposes the integration of the electro-stimulating unit into the epithesis which extends the possibilities of rehabilitation [1].
Key words: epithesis, atrophia, electrotimulator, polyurethane

1. Introduction

This work deals with a possible aesthetic solution to secondary problems of a paraplegic who suffers from cerebral palsy due to atrophy of muscles of lower limbs. The market offers the orthopaedic trousers for people confined to a wheelchair. These orthopaedic trousers are practical for wearing. For a woman, to feel good in clothes, it is necessary to ensure a good form and an appearance of the garment on the figure. The problem of fitting of a garment is its looseness because of the lack of muscle. The solution may be a profile that simulates the missing muscle. This would achieve a good fit of clothing. This profile can be called epithesis. Epithesis is replacement of lost body parts for cosmetic reasons. Integrated electrostimulator is suggested for extending of the functionality of epithesis, which enables the rehabilitation of sagging muscles [1].

2. The design of the epithesis

The proposed compensation and rehabilitation aid should cover the affected leg from a hip to an ankle. It should be well - shaped, breathable and with a smooth surface . Material used for epitesis should be lightweight, flexible and very strong too, so that is could simulate the missing muscle most suitably. Selected epithesis consists of cloth cover and the core of the material simulating muscle tissue. Epithesis is a cosmetic replacement of body parts without the compensation of the lost function.

2.1. The core of the epithesis

The core of epithesis is based on the anatomy of the lower extremities. The resulting shape should be obtained from the difference between a normal profile and profile legs of atrophied limbs. The core of epithesis can serve as a way for the integration of electrostimulation unit for rehabilitation of muscles.

2.1.1 Design shape of the core

The design of the form was based on the anatomy of the lower extremities in the seated position (the position of sitting in a wheelchair).
To create a shape of epithesis on an individual figure, it is necessary to take the people specific body measurements. You can see in *Fig.1* some of body measurements.

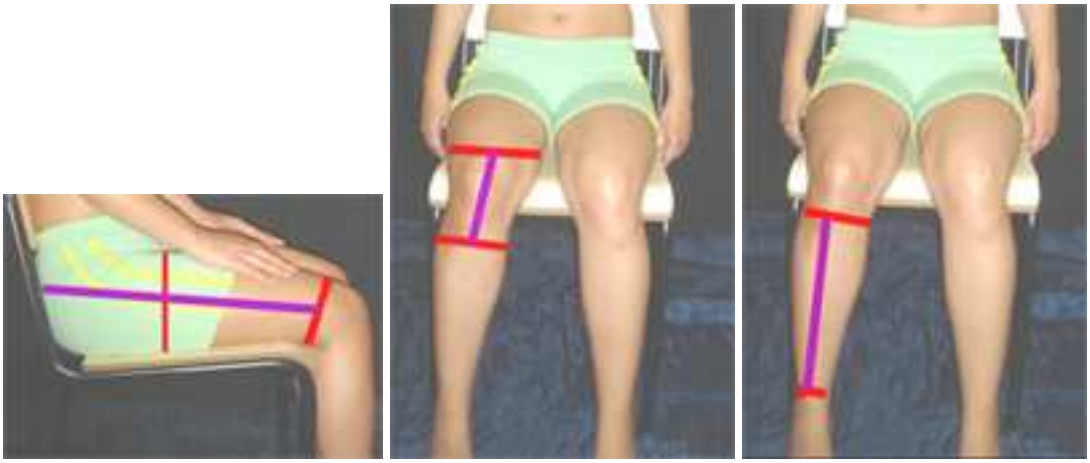

Figure 1. These body measurements [1]

The prototype design of the epithesis shape was created in AutoCAD based on individual dimensions of the people. It consists of three parts, the thigh, knee and calf parts *Fig.2.*

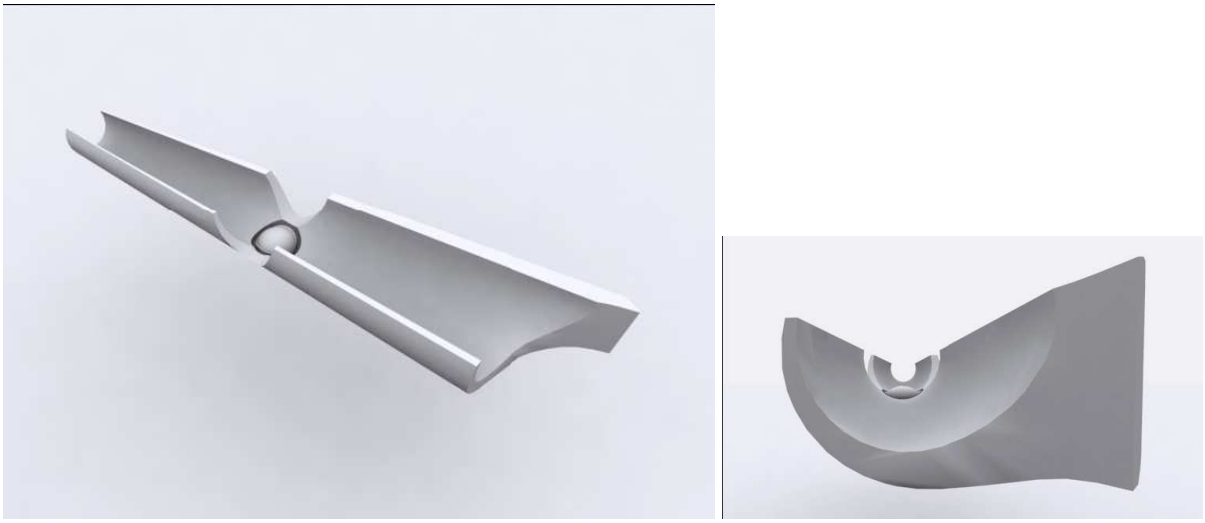

Figure 2. The design in AutoCad [1]

2.1.2. Typing material of the core of the epithesis

Different types of foams appear as the most suitable materials. For example: polyurethane, silicone, natural latex or synthetic latex foam.
Factors affecting the selection are as follows:

- good formability,
- both relative softness and strength,
- permeability (comfort),
- bacteriostatic and bactericidal properties,
- the price availability of the material.

2.2. The cover of the epithesis

2.2.1. The pattern of the epithesis cover

The form of the epithesis cover is based on the design of the profile of the epithesis core. Patterns can be obtained either by direct construction based on the input body measurements or developing the surface of the core obtained in the 3D software.

2.2.2. Typing material of the epitheses cover

CoolMax® material was chosen for its excellent properties. It preserves a human body permanently dry and warm. It has an excellent ability to drain humidity away. It keeps continuous layer of air on a body which is heat-stable in both cold and warm environments. It is not prone to take bad odours. There is easy maintenance of material.

3. Prototyping

Some projects of foreign students University of Minho preceded the development of prototype. The prototype was designed on the basis of their experience - both good and bad [2]. Four stages of development were before the final prototype.

3.1. Profile Cutting

The polyurethane foam was chosen for the prototype. It can be easily cut by resistance wire and other tools (such as scissors, knives, boxes cutters, etc.). Polyurethane foams are offered in different kinds of strength and water vapor. Resistance cutter was used for cutting epithesis core - *option 1 Fig.3*.

Figure 3. The core of the epithesis - *option 1* [1]

3.2. Making cloth cover

The cover must meet several functions simultaneously. This is primarily a function of so-called "smart" materials. This material drains away excess fluid from the skin surface thanks to better-shaped fibers. Practical function includes: the appropriate forms of festening, the possibility of easy maintenance of package, removing the cover because of washing. Aesthetic function helps to complete an epithesis appearance. Correct construction style is important for perfect fit of the cloth cover and the epithesis core. These patterns needed to manufacture cloth cover were created in AutoCAD *Fig.4.*

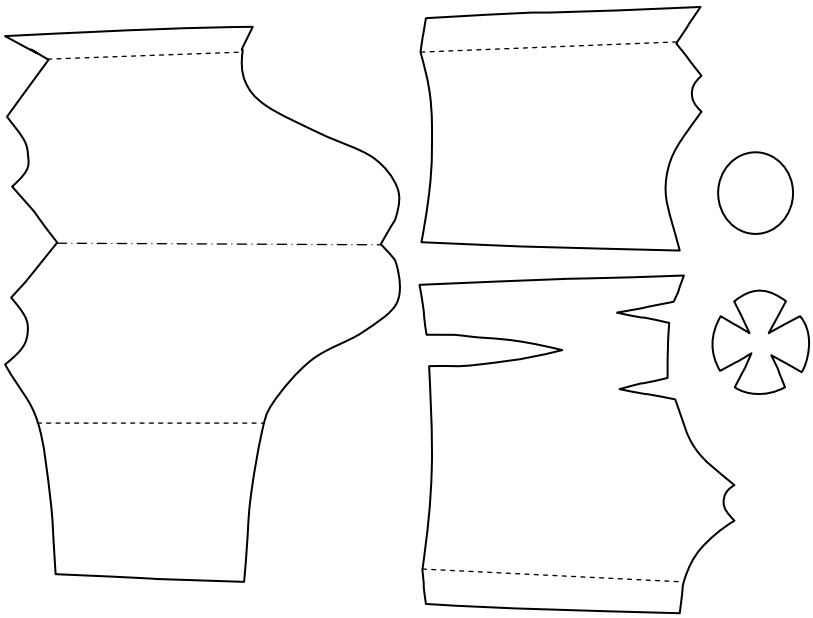

Figure 4. Patterns of cloth cover [1]

We will fix complete epithesis with the help of harness on lower extremities see *Fig.5.*

Figure 5. Complete epithesis – *option 1* [1]

3.3. Modification of functional properties of epithesis core

The goal is to increase the physiological comfort of epithesis (Design *option 2*). Creation of longitudinal grooves in the "V" shape increased airflow and thus increased the physiological comfort. You can see in *Fig.6.* These grooves allowed to shape epithesis into an appropriately shaped curve. After the application it copies the profile shape of the limb. Difficult epithesis shaping profile was resolved by this adjustment. The second modification increased the permeability of polyurethane. These openings were created on the whole surface epithesis. You can see in *Fig.6.*

Figure 6. Profile with grooves and openings - *option 2* and profile with gel electrodes [1]

3.4. Integration electrostimulator

Device XFT-320 with two outputs was selected for incorporation electrostimulation unit into the profile. Each for one extremities. The outputs are terminated with two interchangeable gel electrodes. These gel "pads" have an adhesive surface and therefore it is easy to put them there instead of stimulation. These holes in the epithesis core were used to integrate the outputs from electrostimulator see *Fig.6.*

4. Conclusion

The main subject of this work was to propose epithesis for people with lower limb muscle atrophy. You can see complete epithesis - *option 2* in *Fig.7.* The profile which is responsible for simulating a missing muscle was designed in AutoCAD.

Figure 7. Complete epithesis – *option 2* [1]

Several possible materials were collected to create the epithesis, both for the manufacturing cores, and for creating packages. Several modifications have been created to improve the physiological epithesis comfort and fit on the atrophied limb. Perforation of the core offers several ways of the integration of the electrostimulation profile. Epithesis can also be used as a rehabilitative aid.

References

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