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3D PRINTED HAND ORTHOSIS DESIGN

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Abstract - *3D printing, or additive manufacturing, is a technology that uses a digital model to print a three-dimensional object, layer by layer. Today, it is widely used in many different fields and provides a manufacturing method with advantages such as precision and the ability to print complex shapes from many different materials. 3D printed prostheses have recently gained a lot of interest thanks to the possibility to reduce material costs and production time. The aim of this thesis has been to create a body powered 3D printed prosthetic arm and evaluate the 3D printing technology for this purpose.*

The final prototype is lightweight, easily maneuvered for the user and with a simplistic design. However, many aspects still require future work to develop a fully functional orthosis device, which is discussed in the end of the thesis. The project has shown that 3D printing is an incredible method with potential to orthosis make more customized, cheaper and produced faster. Hopefully this area will continue to grow to help more patients.

Key Words: *3D Printing, Additive Manufacturing, Orthosis, Prosthetic Arm, Rapid Prototyping.*

1. INTRODUCTION

An orthosis is "an externally applied device used to modify the structural and functional characteristics of the neuromuscular and skeletal system". An orthotist is the primary medical clinician responsible for the prescription, manufacture and management of orthosis.

This project is titled "3D printed orthosis design". The purpose of the present study is to define and describe the new product that has been developed. This product aims to present a new concept of 3D printed wrist orthosis. The aim of this Proyecto is to create a product which is able to solve medical problems such us tendinitis, carpal tunnel syndrome, wrist sprains and so on. Nowadays, these problems are affecting a large number of the population.

One of the most important aspects to consider is the aesthetics. As it is known, an orthosis is something that cannot be hidden. This is why it was wanted to look for an innovative product as the same as simple in order to anybody who will wear without any qualms.

As said before, the production method will be the additive manufacturing which not only means an aesthetic improvement but it will be much easier to use and to place, besides allowing the doctor a better help for the recovery of the patient. It also will avoid problems that the traditional plaster had, as for example sweat, itching or the inability to take a shower.

Furthermore, 3D printing improves the quality of the pieces, speed up the production process and advances in the reduction of costs which is a very important factor of the society nowadays. So one of the requirements to achieve is to design an affordable orthosis for everyone.

1.1 RELEVANCE

As we saw before, the concept of orthosis has been studied, as well as her functions, or the different types that exist in the market. This project aims to develop a study of design of a personalized wrist orthosis, so the different medicals problems which the orthosis has to face and is able to solve, must be examined.

The wrist is a joint in itself, so it is very much susceptible to injury. This susceptibility is further increased by the fact that the wrist is commonly used and easy to overuse. We need our hands to function in our day-to-day, so even a minimum pain, it should not be ignored, since if left untreated, this could lead to arthritis and other medical conditions to the wrist that could be more problematic.

1.2 PROBLEM DEFINATION

The main aim of using Additive Manufacturing (AM) to produce orthosis is to get higher levels of compliance amongst patients who are required to wear a wrist orthosis. For it, it is necessary to study the disadvantages presented by the traditional orthosis, such as:

- Difficulties keeping orthosis clean and dry.
- Induced perspiration, subsequently leading to odor issues.
- Poor aesthetics.
- Weight implications.
- Discomfort, poorly fitted orthosis can cause pressure points and friction.
- Limited function and compromised performance during everyday tasks.
- Fasteners which may be difficult to fix, adjust, remove and replace.

- Difficulty putting on and taking off the orthosis.

1.3 PROBLEM STATEMENT

One of the purposes of the new orthosis in 3d printing is to be able to solve or improve the problems mentioned above. Orthosis can be made that are easier to clean. Splints can be made that have a pattern cut out leading to a greater aesthetic value and a lighter and more breathable orthosis. Using a scan of the patient's hand, a orthosis can be fabricated that fits perfectly.

2. LITERATURE SURVEY

The paper provides the information about the ankle foot orthosis is a device that supports the ankle and foot area of the body and extends from below the knee and including foot area. This device is used to control instabilities in the lower limb by maintaining proper alignment and controlling motion of the foot. Finite element analysis of models was developed to predict the mechanical behavior of AFO. The Carbon Fiber is best suitable material for manufacturing of AFO also CF-AFO is capable of taking maximum stress than thermoplastic material also CF-AFO is light weight and durable than other materials. This is validated by conducting experimental testing and analysis by Ansys. [1]

The paper presents the detailed information about rapid prototyping (RP) is a novel technology and emerging rapidly in medical & engineering applications. RP technology works on the principle of layer by layer manufacturing. Recent studies prove that Bio-RP plays a key role in tissue engineering, preplanning of complex medical surgeries, manufacturing of prosthesis, forensic pathology, surgical simulation, diagnosis, design & manufacturing of implants and as well as medical tools. This Bio-RP gives a new dimension to the medical field. Now a day's medical models are also fabricated with biocompatible materials which can be implant directly in to the patient. Bio-RP models are fabricated as per patient specific requirement. These models are not only having biocompatibility but also having high accuracy, low cost, time saving and biodegradable in specific scenarios. This article provides overall understanding of Bio-RP models, Bio-printing process, fabrication of RP methods and its applications. [2]

2.1 3D PRINTING METHODOLOGY

As has already been explained, 3D printing has become a reality in the world of health. This advance in technology allows to create solutions adapted and customized for patients. In order for this to be possible, we must look at the fabrication of orthoses produced both using traditional methods and 3D printed.

The process of creating an orthosis by additive manufacturing, begins with an evaluation of X-rays on the fractured person, and later a three-dimensional scan of the area is made using a 3D scanner. Once this has been done, the model of the orthosis is processed using CAD software, considering the proportions of the patient's limb. Finally, through the 3D printing technology, the custom structure is printed. After the creation process is complete, all that remains is for the specialist to place and adjust the orthosis on the patient, leaving an orthosis fully adapted for each patient.

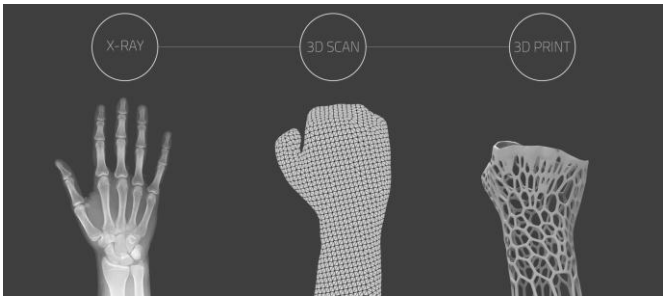

Fig No. 1 Printing Procedure

For the realization of a traditional orthosis, the first step must be done is taking a measurement of the body segment, once this, a negative impression is taken with a plaster of bandage. Upon hardening of the plaster, it is carefully cut or sectioned and removed, preserving the shape. Finally, the surface of the positive plaster model is smoothed by sanding.

Fig. No. 2 3D printed

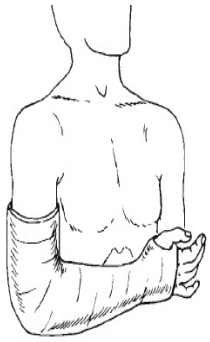

Fig. No. 3 Traditional plaster

3. CONCLUSIONS

Finally, it can be said that a final product has been designed in accordance with the objectives to be achieved, raised at the beginning of the Project. The requirements and specifications required by the designer were also achieved in order to ensure that the product meets the user needs.

Regarding to its functionality, the Velcro closure system, not only works as a way to close the orthosis, but also, gives the possibility of making the orthosis personalized an adjustable, what is something essential for the first days of recovery, in which tend to appear swellings. Movement is key; An orthosis that can be assembled and disassembled easily requires little effort and can be adapted to all types of spaces and maneuvers.

It also has been reached the production requirement through 3D printing which means reducing costs and being able to create more organic shapes. The material in which the orthosis is made, makes this a lightweight orthosis at the same time resistant. Specifically, it is ten times more than the traditional ones. On the other hand, it is a responsible product with the environment, since the main material is recyclable and reusable.

This orthosis design also has ventilation and it can be wet. It is as well more hygienic than a traditional plaster and allows the doctor to perform a better inspection of the limb.

As a conclusion it can be said that an innovative product has been reached and it also is going to help people's life helping them with their daily tasks, without having to forego of such simple things as a simple dip in the pool could be.

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BIOGRAPHIES

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