

Proposal for the design of a rehabilitative device for the prevention of ankyloses in the lower extremities

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ABSTRACT: The ankyloses is the impossibility of motion in a joint that is typically mobile, there are various factors that trigger this disease, early prevention through physical therapy seems to give an alternative solution for the above, the proposed design of a mechatronic device movement arises passive, capable of movement programmed routines, decreasing costs in improving health, making the most efficient and effective process all the above taking into account important factors rehabilitation its correct application and disease prevention..

KEYWORDS: Ankyloses, rehabilitation, conceptual design, disability.

I. INTRODUCTION

Functional capacity is the potential that an individual has to interact freely with their environment, in such a way that allows them to competently perform different daily tasks or activities [1]. It is evident that each individual has a series of common characteristics, although each one differs from others in various aspects, they do not act, feel or think in the same way, individuals are different not only in physical characteristics, but also in psychological ones.

Currently, society is at the height of technological development, which facilitates the human activities of all individuals where solutions are given to different problems in the field of health, however it is still not possible to cover 100% of each of the existing adversities, thus creating different needs in the care of diseases that cause deficiencies or disabilities, all people are different and diverse, everyone needs special

attention that allows them to lead a “normal” life in all areas: family, social and labor.

In order to provide meaning to the lives of people who find themselves in these conditions, improve their quality of life and that of their families, there are various treatments that attempt to reduce the secondary consequences caused by ankyloses, such as physiotherapies, medications. and the support materials used, these types of interventions seek to minimize the effects at the molecular level.

Lower extremity injuries correspond to the most frequent group of traumatic injuries in sports activities and daily life. Therefore, the demand in trauma centers for rehabilitation of these conditions is very large. This activity is commonly performed by a physical therapist together with the patient. The therapist performs a series of exercises on the patient's foot which require arduous and repetitive work activity.

Current forms of treatment involve the adaptation of specialized spaces and supervisory personnel, causing high costs for users, in addition to being a time-consuming and tiring process for the service provider. The present work aims to update the way ankyloses is treated through a device that integrates passive movement routines, thus reducing costs for both the user and the service provider, in addition to making the process more efficient and with less personal, offering the option of receiving treatment at home.

II. DISABILITY

The need for statistical information on the population with disabilities has increased significantly, which is why, starting in 1981, the year designated by the United Nations (UN) as the

“International Year of Persons with Disabilities”, some recommendations on how to capture information from this group of the population are beginning to be widely disseminated.

Disability is the life condition of a person, acquired during pregnancy, birth or childhood or any other stage of life, which is manifested by significant limitations in intellectual, motor, sensory (sight and hearing) and behavioral functioning. adaptive, that is, in the way it relates to the home, school and community, respecting the forms of coexistence in each area [2].

National Demographic Dynamics, there are nearly 120 million disabled people in Mexico. Of them, almost 7.2 million report having great difficulty or not being able to do any of the basic activities for which they are being investigated (people with disabilities), around 15.9 million have mild or moderate difficulties in carrying out the same activities (people with limitations).

According to ENADID 2014 data, the most frequent types of disabilities nationwide are: walking, going up or down using their legs (64.1%). The most frequent types of disabilities mainly affect the elderly and adults, segments of the population where the largest number of people with disabilities are located. Figure 1 shows the percentage of the disabled population that has some type of disability.

In the year 2000, nationwide there were 1,795,300 people with disabilities, which represents 1.8% of the total population. Of the states that make up the central-western region, the state of Colima is the one with the highest percentage of disabled people with respect to its total population (2.40%).

Mobility limitation is the most common disability among the Colima population; Of every 100 people with limitations, 59 have some disability related to walking or moving; The second type of limitation that most prevails in the population with some disability is having problems seeing even when wearing glasses, which represents 25.3 percent [3].

In general, the population perceives disability as a permanent condition. However, there are temporary disabilities and permanent disabilities. For example, breaking your arm or losing vision due to exposure of your eyes to a harmful chemical agent can cause temporary disability. This suggests that any person was in a situation of disability at some point, but it is probably not perceived that way. On the other hand, there are also levels of disability: mild, moderate or severe [2].

The lack of movement of the lower extremities due to any because that causes disability or difficulty in walking or moving brings with it a decrease in muscle tone and can also trigger even greater problems such as ankyloses. The word ankyloses (from the Greek *αγκυλος*, welding or binding) is a medical term for the decrease in movement or lack of mobility of a joint due to total or partial fusion of the components of the joint [4].

The causes of this injury are varied, but those that focus on the joints are mainly due to trauma or infectious diseases. If a fracture extends into a joint, or a fracture with dislocation occurs, blood entry into the injury increases, increasing the risk of ankyloses [5].

On the other hand, approximately 90% of skeletal injuries caused by tuberculosis are related to a joint [6]. In this case, the bacterial infection leads to osteolysis of part of the joint [7]. Subsequently, the deposition of bone tissue is reactivated which, ultimately, can end in ankyloses.

Throughout history, the main purpose of the study of disabling diseases is the development of protocols, devices and manuals that allow people who suffer from this type of disease to maintain an optimal level of functional independence, taking into account the evolution of the same disease and providing alternatives to prevent alterations that affect the functionality of the individuals who suffer from it.

Correct treatment of these diversities, from a social and psychological point of view, promotes respect, reintegration and care for people who have some type of illness like this, contributing to driving the different variables that cause the differences to be positive or negative.

III. METHODOLOGY

The need for statistical information on the population with disabilities has increased significantly, which is why, starting in 1981, the year designated by the United Nations (UN) as the “International Year of Persons with Disabilities”, some recommendations on how to capture information from this group of the population are beginning to be widely disseminated.

For the development of this work, the total design methodology proposed and developed by [8] was used, focusing only on the Systematization of Ideas stage, where the client's needs, product specifications, as well as the generation were taken into account. of ideas and concepts that allowed establishing a design proposal. This stage is called “conceptual design” and is where the morphology of a product is defined, how it is composed and

how it could be designed. It is this phase where you can use some techniques such as brainstorming, morphological analysis and trees. of function, according to what was proposed by [8], it is about generating a preliminary concept aimed at the global solution of the problem without going into specific points.

The methodology is illustrated schematically in [8], with which its scope can be determined. As can be seen, the information on the requirements flows from the market as the main source of data about the requirement to satisfy a need, subsequently the specifications are defined under which it must fulfill certain functionality according to the need to be covered, therefore which starts to make a conceptual design that delimits and formalizes the idea of what is intended to be done, this work focuses on this stage.

In the methodology, once this point is defined, the detailed design is determined, a phase in which the data from the previous phases are formally characterized, to subsequently advance to the manufacturing of the components with the vision of taking into account that the development up to this point is according to the original need, and finally it returns to the market part, since the design and implementation process of the product starts from a need to be covered. This study takes into account the specification and conceptual design phases, which are described below.

Specifications: In this stage, the data that defines the functionality required by the product is involved, as well as its performance expectations are known, under the conditions of use desired by the user. This phase is of utmost importance since it is the starting point for the formal data, and assumptions formulated from the necessary conditions according to the need, that is, this part functions as a controller of the design activity, since it delimits the process, which is why it is important to include the necessary factors that characterize the formal part of the need [8].

Conceptual Design: The early stages of design where important decisions must be made is sometimes called "conceptual design", the conceptual design part can be defined as the morphology of a product, how it is composed and how it could be designed, this is phase you can use some techniques such as brainstorming, morphological analysis and function trees, it is about generating a preliminary concept aimed at the global solution of the problem without going into specific points [9].

It is very important to highlight that this methodology works in an iterative sequence between phases, since if there is the possibility of

making an adjustment derived from a previous phase, it is possible to return to it, and provide feedback on what has been done in order to detail and facilitate the result of later phases [9].

Regulations: Compliance with the regulations established for working conditions provides the possibility of carrying out successful and safe operation of the different machines and equipment. To conceive the design, safety aspects and ergonomic principles applied, the process for designing the parts and the final design proposal of the prototype were taken into account [9].

IV. RESULTS

Derived from the analysis of the specifications and taking into account the needs required for the design, a proposal was made. The purpose of the research is to design a rehabilitation device for lower extremities for patients with musculoskeletal diseases, capable of improving the physical conditions in the muscles and joints, creating an automated procedure for the treatment of this condition. Below are the parameters to take into account for its implementation:

- Identify the anthropometric measurements of the Mexican population.
- Identification of the existing characteristics for the rehabilitation of the muscle in the lower extremities.
- Specification of the exercises necessary for the rehabilitation treatment of muscles in the lower extremities.
- Carry out a design methodology and device functionality.
- Establish the important parameters in muscle rehabilitation.
- Design through mechanisms an automatic structure that carries out the programmed instructions for muscle rehabilitation.
- Obtaining precise calculations and regulations that justify the mechanical development of the device.



Figure 1. 3D view of the device.

The prototype of this device was modeled with advanced Computer Aided Drawing (CAD) software, in this case SolidWorks. The figures shown below show the design and dimensions (in centimeters) of the prototype. Figure 1 shows the 3D design.

In the case of materials, various metals are proposed for the mechanical structure, the characteristics for their evaluation are the following:

Aluminum 6061: It is proposed in the general structure.

Grade A steel type 8: It is proposed for all screws.

Bronze SAE 62: It is proposed as the material for all bushings.

V. CONCLUSION

The conceptual design of a lower extremity rehabilitation device for patients with musculoskeletal diseases was carried out, capable of improving the physical conditions in the muscles and joints.

From the analysis of the information collected, it was detected that the state of Colima is not prepared to address this type of problem in people with disabilities, likewise the centers where this condition is currently treated are insufficient, in addition to the current therapy system. does not provide the required efficiency due to the high demand for this service.

VI. FUTURE WORKS

It is intended in later stages to incorporate techniques for the treatment of muscle atrophy, in addition to controlling the device remotely, that is, using a graphical interface (application) that includes patient data storage.

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