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Prefacio

La Sociedad de Ergonomistas de México A.C. (SEMAC), como parte relevante de su actividad e interés en la difusión, promoción y apoyo a la ergonomía, ha organizado desde 1999 y de forma anual, su Congreso Internacional de Ergonomía. En Abril de 2014, la hermosa ciudad de Mérida, y en especial la Universidad Anahuac-Mayab, nos abre sus brazos para recibir el XVI Congreso Internacional de Ergonomía, con la participación de ergonomistas profesionales e interesados en esta área.

Este año está lleno de retos y esperanzas. Tenemos una nueva legislación laboral que aun no comprendemos sus alcances, pero también tenemos un Proyecto de Reglamento Federal de Seguridad y Salud en el Trabajo que esperamos que sea publicado en el primer semestre de este año. Este nuevo Reglamento tiene como novedad, a propuesta de SEMAC, un artículo dedicado a la Ergonomía en los centros de trabajo y aunque parece muy poco, tendrá un gran impacto en la salud de los trabajadores debido a que los centros de trabajo deberán evaluar los puestos de trabajo y realizar las mejoras cuando sea necesario. Aunado a este Reglamento, se está trabajando en una Norma Oficial Mexicana para la aplicación adecuada del mismo.

Se reúnen en este libro una selección de los trabajos, presentados en este congreso, más representativos de las diversas áreas que participan en la ergonomía, aportando diferentes investigaciones y soluciones a problemas específicos, con la finalidad de contribuir a la difusión, apoyo en la educación e investigación, de temas de interés para la ergonomía.

Los editores, árbitros y comité académico, a nombre de la Sociedad de Ergonomistas de México, A.C., agradecemos a los autores de los trabajos aquí presentados su esfuerzo, e interés por participar y compartir su trabajo y conocimientos en el XVI Congreso Internacional de Ergonomía de SEMAC. También agradecemos a los participantes y asistentes, provenientes de muy diversos lugares y formaciones, así como a todo el equipo de organización de este congreso, su valiosa aportación que estamos seguros derivará en el avance de la ergonomía en las Instituciones de Educación Superior y en la planta productiva nacional y mundial.

Enrique de la Vega Bustillos
Presidente SEMAC 2002 – 2004

SOCIEDAD DE ERGONOMISTAS DE MÉXICO A.C.

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CRUTCHES AXILLARY... A REAL PROBLEM

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Resumen: Las muletas son unas de las herramientas más utilizadas para rehabilitación en miembros pélvicos. Generalmente, se ajustan a la altura de la cadera, sirven como soporte del cuerpo y reducen la carga en una sola pierna. Ahora bien, el uso y dependencia de un par de muletas estará en todo momento relacionada con la gravedad en las extremidades pélvicas debido a luxaciones, fracturas, o daños físicos permanentes, resultado de enfermedades congénitas o accidentes. Aunado a ello se tiene que, aún y cuando el uso de muletas axilares puede ser por un corto tiempo, las personas suelen desarrollar problemas como son: dolor en los ligamentos de la muñeca ocasionado por los impactos o malas posturas que fuerzan la posición natural de la articulación; así como la disfunción del nervio axial, daño que lleva a la pérdida del movimiento o de la sensibilidad del hombro. Por tanto, se hace necesario abordar la problemática y con ello, establecer las bases para llevar a cabo el diseño de unas muletas ergonómicas.

Palabras clave: Diseño, Muletas, Lesión.

Summary: Crutches are one of the most used tools for lower limb rehabilitation. Generally conform to hip height, serve as support the body and reduce the load on one leg. However, the use and dependence on a pair of crutches at all times be related to the severity in the pelvic limbs due to dislocations, fractures, or permanent physical damage resulting from congenital diseases or accidents. Added to this must be, even if the use of axillary crutches may be for a short time, people often develop problems such as pain in the ligaments of the wrist caused by impacts or poor posture that force the natural position of the articulation, as well as axial dysfunction nerve damage leading to loss of movement or sensation of the shoulder. Therefore, it is necessary to tackle the problem and thereby lay the foundation for carrying out the design with ergonomic crutches.

Keywords: Design, Crutches, Injured.

Relevance to Ergonomics.- Throughout time, man has managed to give each product created rationality, a value and a certain way... spread the excitement of who conceptualized. In relation to this work, the industrial designer contributes in two ways, one, in the art of the artificial environment on the other, in this environment is fully habitable. And that's where lies with the relevance of ergonomics as a science that studies the relationship between man and his environment, can fully adapt to each other, making it currently one of the fundamental bases without fear of error, the most important in the design stage.

1.- INTRODUCTION

The issue of using crutches is controversial. On the one hand, is identified as necessary for the movement of people who are in rehabilitation element due to injury in their lower limbs and is a basic tool for people with a permanent atrophy. On the other side is an element that can be seen as a hindrance to the time of use because of its rigidity and size. However, in the final analysis, it can be considered as a basic tool for rehabilitation necessary to improve the quality of life of a disabled person.

According to the provisions of the World Health Organization, an injury is "any alteration of the biopsychosocial balance" and to our study, a lesion is an abnormal change in the morphology or structure of a body part (pelvic region), produced by an external or internal injury, where the cells undergo a deterioration that can cause two situations: a) the cell death b) cellular adaptation.

One way to support the rehabilitation treatment when the victim of trauma as it is mentioned above, is through the use of tools or aids, being the most helpful crutches by function, as these represent the best means to prevent atrophy and death of the affected cells, that is, when the skeletal muscle system loses its functionality due to the deterioration in mobility.

Now, say the Royal Spanish Language (2007) is understood as crutches to cane metal, wood or other material with the upper end adapted to place the underarm or forearm and hand, and which is used to support the people go when they have difficulty doing so.

In connection with this tool, its use dates back to prehistoric times, information known through drawings exist from ancient Egypt, where paintings, murals and hieroglyphs show that the ancient Egyptians suffered from the same ailments that we suffer today, also teaching some orthopedic practices of that time. It is important to note for the time that have been found in mummies splints, made of bamboo, cane, wood or bark and padded canvas. There is also evidence of the use of crutches, being the oldest witness an engraving in the year 2,830 BC at the entrance of the tomb of Hirkouf.



Figure 1. Image recorded on grave Hirkouf (2,830 BC)

http://www.ujaen.es/investiga/cts380/historia/civilizaciones_antiguas.htm

Similarly, they have been found evidence in several medical papyri of ancient Egypt, Ramesseum (1900 BC), Kahoum (1850 BC) and in the papyri found by Ebers, Hearts and Edwin Smith dating from 1600 BC, where coexist quotes about related skeletal muscle injury practices. Evidenced in such wise that these documents provide several case reports detailing fractures of limbs and poisonous bites. Being crutches or supports for the operation, the devices used by the pharaohs of ancient Egypt to help relocate. (Crutches, 2013).

It is noteworthy that since ancient times the basic design has not changed much crutches. The truth is that man has always used in one form or another to help move when an injury or illness makes walking difficult. Elaborating, it is possible that the original design departed from the moment that the man required external support after suffering an injury, and in such a situation, should it decide to employ cut tree branches, or use scrap wood whose dimension coincide with the bottom of his shoulder.

In the twentieth century, specifically in 1915 was I. M. & C. Briscoe who obtained *U.S. Patent 1156747 A*, of what might be called the first crutch, which introduced the ability to fit the dimensions of people. Then come various designs as can be seen in the following table.

Patent Crutches

No. Patent	Date Presentation	of	Date publication	of	Requestor	Title
US2453632	October 15, 1945		November 9, 1948		Lofstrand Jr Anders R	Crutch
US2516852	September 8, 1947		1950		Burry William C	Crutch
US2575681	March 23, 1948		November 20, 1951		Peters Jerry M	Crutch
US2788793	Apr 1 1955		April 16, 1957		Abbott Charles E	Crutch
US3272210	September 24, 1964		September 13, 1966		Otto Boruvka	Folding Telescopic Crutch
US3635233	March 19, 1970		January 18, 1972		Robertson Charles H	Cane and Crutch Foldable Construction
US3710807	November 18, 1971		January 16, 1973		Ferry C	Crutches
US4869280	July 1, 1988		September 26, 1989		Joseph Ewing	Folding Crutch

No. Patent	Date Presentation of	Date publication of	Requestor	Title
US6085766	September 25, 1998	July 11, 2000	Geary, John A.	Geary Convertible System Crutch
US7104271	October 10, 2003	September 12, 2006	Millennial Medical Equipment, LLC	Ergonomic Folding Crutch
US7222633	June 23, 2005	May 29, 2007	Werner Iii Philip Henry	Apparatus Ergonomic Support Staff
US7347215	September 14, 2006	March 25, 2008	Bernardo Birnbaum	Ergonomic Crutches
US7383848	May 15, 2006	June 10, 2008	Erwin Kowsky GmbH & Co. Kg	Forearm Crutches to Walk
US7434592	October 7, 2004	October 14, 2008	Millennial Medical Equipment, LLC	Ergonomic Folding Crutch
US7712478	7 Apr 2008	May 11, 2010	Cowboylogic, Llc	Ergonomic Crutch
US7712479	October 15, 2007	May 11, 2010	University of South Florida	Folding Crutch
USH2138	September 7, 2001	January 3, 2006	The United States of America as represented by the Secretary of the Air Force	Forearm Crutch Custom Fit Composite Carbon Fiber
WO2011048028A1	October 15, 2010	April 28, 2011	Conall Stokes	Ergonomic Crutch "A Walking Aid"

Font: IFI Claims Services Patentes, U.S. (2013)

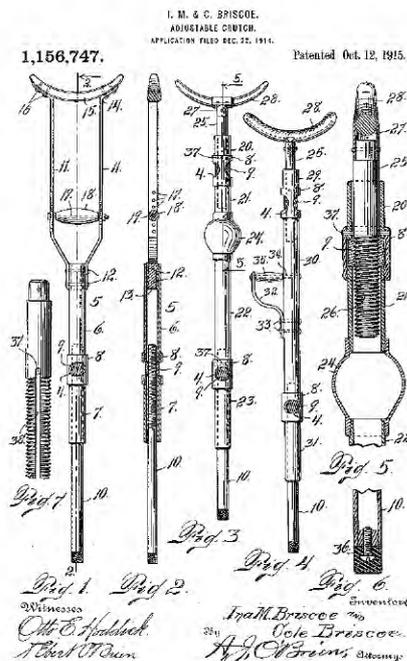


Figure 2. First recorded mapping crutch, Patent U.S. 1156747 A

Despite the existence of a large number of axillary crutches, the commercial or recommended in the area of orthopedics appeared on the market around 1988 model, and it is the work of Thomas Fetterman, who contracted polio in the 1950's when he was only 8 years old. It Fetterman noting the dangers associated with continued use of

crutches under his arm, as slips, falls and possible damage to the nerves in the armpit area, dedicated his efforts to design crutches that could be used safely, using criteria that crutches require greater support area on the ground. (Ujuaen, 2013)

However, even if the models are varied, and that the design has endured for being "functional" is not quite ergonomic, since the use of axillary crutches despite being for some cases for a short time, has identified that the vast majority of people problems often develop as are pain in the ligaments of the wrist caused by impacts or poor posture that force the natural position of the joint, as well as dysfunction of the axial nerve damage leading a loss of movement or sensation of the shoulder. Which is why it is important to address this issue, looking slow postural complications and increase efficiency, especially considering that every person with a disability wants to be autonomous, and to that end, you must have the necessary tools to improve their lives without limiting or that they are uncomfortable.

2.- OBJECTIVE

Contents in a first step a documentary research on the problems caused by the use of axillary crutches, which will establish at a later stage, alternative solutions with a view to designing a ergonomic crutches to facilitate the progress of people with disabilities in lower limbs whose ages range between 10 and 50.

3.- METHODOLOGY

For this research project has been based on the design method of Bernd Löbach, which comprises the following six steps:

- Target.
- Phase 1 training: where most problematic analysis, human needs / products, history, market (function, structure, aesthetics and distribution) is developed.
- Phase 2 preparation: problem definition, requirements.
- Phase 3 Incubation sketches, drawings, models and tests.
- Phase 4 Lighting: functional model.
- Phase 5 verification: building plans, costs, lay out.

Moving on, usually using crutches is necessary after having suffered an injury or surgery at all or partiality of one or both lower extremities, specifically when it is necessary to have some help with balance and stability to walk.

Elaborating, various are the situations that make essential use of these devices, as in the case of a ligament injury in the knee or the presence of an amputation, which speaks of the separation of an individual or part thereof, a body extremity by trauma, also called avulsion or surgery. It is worth mentioning that amputation is a type of procedure performed for centuries with the goal of reducing disability, remove useless limbs and save lives, and that lower limb amputations are 7 or 8 times more frequent than those of a member superior, likewise due to immobility syndrome, which is the decreased ability to perform activities of daily living impairment of motor functions, or

getting osteoarthritis, degenerative disease that causes erosion of cartilage in the joints. (The University of Chicago Medicine, 2013)

However, once it has been diagnosed using crutches, has been identified that being such a stranger to the body object it generates a reaction, both positive and negative, with the possibility to appear after a short interaction time permanent damage. At first you have an injury or dorsal spine, shoulder problems due to excessive use or wear of the muscles and joints and torn muscles surrounding the head of the shoulder joint (ROTATOR CUFFS), not to mention problems in the wrists and elbows by repetitive stress and muscle during the seizure of those items.

An injury is more pain that is located on the wrist, which usually tends to be associated with a hamstring injury, whose origin is in shock from impact or awkward postures which force the natural position of the joint, eventually causing a sprain.

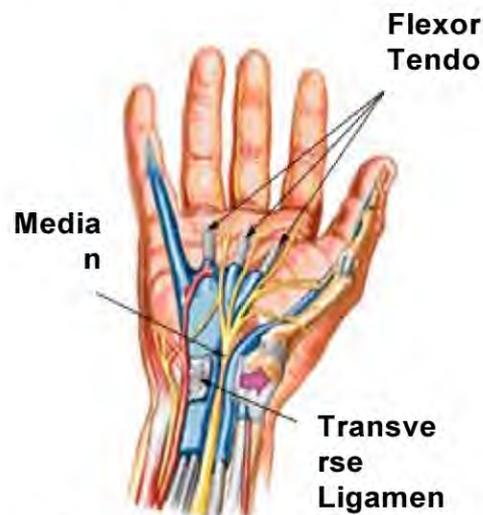


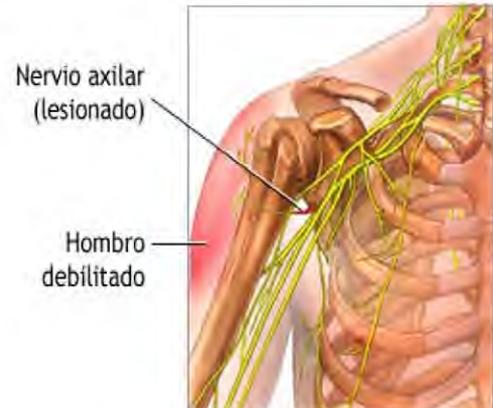
Figure 3. Ligaments of the wrist

<http://ortopediaplus.blogspot.mx/2013/05/ortopedia-la-importancia-de-adquirir.html>

Furthermore, a recurrent injury is dysfunction axial nerve injury leading to loss of movement or sensation of the shoulder, where the axillary nerve dysfunction is a form of peripheral neuropathy that occurs when there is damage to axillary nerve which supplies the deltoid shoulder muscle and the skin around it, a problem which is called as mono neuropathy. It is noteworthy that the damage may destroy the myelin sheath that covers the nerve or part of the neuron. (LARSSON, 2012)

As for the shape, while there have been changes in the configuration of the crutches, most have been based on a structure that has certain basic elements. In this regard, the Biomechanics Institute of Valencia (2009) has established that the essential elements that must be at least a crutch are:

Figure 4. Axial nerve injury
<http://www.clinicadam.com/imagenes-de-salud/8729.html>



1. The crutch, which seeks to stabilize the trunk of the user. Ideally should be held between the inner arm and the anterior lateral aspect of the thorax. Typically, it is formed by the same material as the structure and is lined with a soft material such as foam, to avoid damage to the bearing region.
2. The arm element is usually composed of two bars passing through both ends of the handle. In some models is adjustable in length.
3. The handle, which should allow a comfortable and secure grip of the hand. The shape of the handle may be straight or anatomic. On some models the clamp arm and handle are a single integral piece.
4. The cane, whose aim is to transmit the load to the floor. Normally it is metal and adjustable length, allowing the adaptation of the crutch to the user's height.
5. The ferrule, responsible for cushioning the impact of the crutch with the ground and also serves as anti-skid system. Usually made of rubber.

So far the problem seems to be tiny, however, according to statistics from 2010, it was estimated that over one billion people living with disabilities, nearly 15% of the world population, a figure that far exceeded to estimates by the World Health Organization made in the early seventies of the last century. Providing a vision of the spirit, the National Institute of Statistics and Geography reported through the census in the year 2010 that exist in Mexico 5 million 739 thousand 270 people with disabilities, which speaks of a 5.1 % of the total population. Of these, 58.8 % have a physical disability, a situation that one way or another refers to the loss or limitation of a person to move, walk, keep a few positions around the body or a part thereof. And where is the total population, 49 % are male and 51% female. (INEGI, 2013), so a large number of people at national or international level in a given time need the support of crutches to resume its movement autonomously.

Finally, it should mention that, although generated design proposals relating to crutches, which at first seem to be the best solution to the problems that develops in an individual after use, has neglected the economic factor, given that the majority of the population does not have the ability to access models created in Madrid as Spain in 2011, a proposal was developed using carbon fiber and plastic, which to be the lightest with only 430 grams per unit and whose cost reached € 500. Or the Millennial

Junior crutches, which have a shock absorption system and assistant walking, or crutches Mobilegls calls, which give the option to be personalized and presented two variants, the universal ergonomic design and extra ultra estate, both with a comfortable arm support and pivot that rotates according to the movements of the body.

4.- RESULTS

After a review of both domestic and foreign existing products, we have identified that axillary crutches are used or recommended that forearm crutches and platform, so that the same type of crutches have in common the advantage of being adjusted according to the height of the user, be lightweight and provide a certain comfort in those parts that have direct contact with the human body. However, the disadvantages are found to be higher, as in the case of its low efficiency in traveling on public transport, direct or indirect discomfort generated by reducing the living space, instability or stairs to access to a wet surface, the cost, appearance and most importantly, damage to the bone structure.

Therefore, it was determined that for the second stage of this research, the new design of axillary crutches should at all times seek to avoid injury develop in parts of the human body that have direct contact or serve to provide support in pursuit of greater stability, use materials that make use of experience comfort, they can be customized easily by the user in turn, the possibility of being acquired by people of limited economic resources and enable the transfer comfortably in any type of transportation.

5.- CONCLUSIONS

Within the work of the industrial design is extremely important to conduct research through which they are identified social problems, problems that even when there are objects or systems of objects destined to play a role, they turn out to be not entirely efficient or that instead of benefit, are generating more problems. As you see the left anterior axillary crutches information regarding products conceptualized as support for the march.

In relation to this problem, its importance lies in the centrality rating on par physical and cognitive aspects of the person using crutches, since at the time to use them in one way or another requires attention span, memory and adaptation. And where on many occasions who design a product, forget or lose sight of the march after an accident or being unable carries an increased risk or even a risk to others.

It is a fact that the crutches are used to facilitate the ongoing increasing stability by broadening the base of support and reduce the load on one or both lower limbs, but it is also a fact that needs to be done in order to give the society a crutches that only provide support and where possible, reduce time of incapacity.

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