2nd INTERNATIONAL CONFERENCE ON
RESEARCH IN SCIENCE AND TECHNOLOGY
Istanbul-Turkey 14 March 2016
RSTCONF
دومین کنفرانس بین المللی
پژوهش در علوم و تکنولوژی
ترکیه - استانبول ۲۴ اسفند ۱۳۹۴

Designing and Constructing of Axillary Springy Crutch for Easier Walking of Disable and Elder People

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Abstract
The crutch is an ambulatory device which is uses to improve mobility, maintain balance, increase self-confidence and prevent to falls in disable and elder people. Although the crutch offers physiological and psychological advantages for users but it can led to many difficulties and complications even in axillary types which are more comfort and safe. Large force which induced from long-term application of axillary crutches may be transmitted to the elbow and shoulder joints and led to pain, irritation and injury. So, this study aimed to designing and constructing of axillary springy crutch for easier walking of disable and elder people. The using of spring for its unique feature and capability to energy conservation is common in human and devices mobility. It seems that using spring in crutch structure especially in axillary crutch can led to its less energy exhausting; more comfortably and safety; and fewer complications for its users during its application. Thus, due to the considerable trait, user-friendly and high cost-effectiveness of such crutch, the researchers of this study are strongly suggesting its use in disabled and elder people for better daily quality of life and more pleasure.

Keywords: Springy Crutch, Walking, Disability, Elderly

Introduction

The appropriate health care delivery in all care levels including prevention, treatment and rehabilitation is a social right for all citizens of societies and considered as a governmental duty. A glimpse to the sanitary and epidemiological statistics points out which in today's world the significant proportion of the population faced disabilities and elderly. The variety of mobility difficulties especially in walking increase continually in the form of temporarily or permanently because of increases in road and occupational injuries; population aging; and chronic debilitating diseases such as heart attacks, strokes and MS (Tomita et al., 2004; Faruqui and Jaeblon, 2010).

"Advancing age is often accompanied by the functional decline of many body systems, particularly in those aged 75 years and over" (Orimo, 2006; Branch et al., 2004). "These changes increase the risk of chronic diseases and disability, which subsequently decrease the ability to perform daily activities independently and increase the requirement of external assistance from other persons or devices" (Horowitz et al., 2006; Van Hook et al., 2003).

The fall and its related injuries which happen in elderly can led to serious negative consequences such as fractures and head injuries and are an important source of morbidity and mortality (Peel et al., 2002; Campbell et al., 2005). As well as the performance of patients in diseases such as cerebral palsy, spinal cord injury, strokes, osteoarthritis and Parkinson in daily activities decrease and most of these patients need to use assistance devices for standing, balancing and walking (Karimi and Kamali Ardakani, 2012; Li et al., 2001). The orthopedic problems and injuries especially resulted of road and occupational accident can decrease the ability of the lower extremities to hold the body weight, therefore requiring to using of the walking assistance devices (Van der Esch et al., 2003).

"Ambulatory devices including canes, standard walkers, front wheeled walkers, 4-wheeled walkers, and walking stabilizers are prescribed for improve disable people's mobility, maintain balance, and possibly prevent or reduce falls. These devices can increase confidence and sense of safety, which can raise a person's level of mobility and independence" (Constantinescu et al., 2007; Aminzadeh and Edwards, 1998; Zhang et al., 2011; Smania et al., 2012). Also, these ambulatory devices are able to assist decrease lower-limb loading and alleviate joint pain or compensate for weakness or injury (Bateni and Maki, 2005).

"More than 4 million people use canes and more than 1.5 million use walkers in the United States. Such mobility aids are often required by older adults or by people with various clinical conditions so that they can move about independently and maintain their balance" (Bateni and Maki, 2005). "Traditional crutches and other walking aids have been used for over 5,000 years and in that time, they have not changed much" (LeBlanc et al., 1993). "Standing and walking allow for improved growth of bone, improved circulation of blood, reduced bladder infections and reduced pressure lesions" (Shortell et al., 2001).

At present, the axillary and elbow crutches are two basic forms of crutches (LeBlanc et al., 1993). "Many long-term crutch users prefer axillary crutches to elbow crutches because it can offer increased control during gait as well as the ability to stand stably while performing tasks with the arms" (Subramony, 1989; Raikin and Froimson, 1997). In addition, the researchers previously found that energy consumption was less for ambulation by axillary crutches than elbow crutches and be causes less fatigue (Dounis et al., 1980). Although Crutch walking offers physiological and psychological advantages but it can led to many difficulties to the user (Shortell et al., 2001).

However the axillary crutches is better and more comfort than other type of crutch but using of it can be problematic because of complications known to be associated with their long-term use (Subramony, 1989; Raikin and Froimson, 1997). "Large forces may be applied to the tips of axillary crutches at initial contact, and these forces may be transmitted to the elbow and shoulder joints, causing irritation and injury" (Orimo, 2006; Branch et al., 2004). Such forces may lead to crutch palsy, aneurysms, and thromboses, causing pain, discomfort, and other serious conditions in some axillary crutch users (Poddar et al., 1993; Feldman et al., 1995). Repetitive impulsive loading of joints leads to joints stiffness, injury, osteoarthritis (Radin et al., 1982), Crutch palsy (Raikin and Froimson, 1997), acne

mechanica, nerve dysfunction with denervation (Kang et al., 1999).So, the comfortably and safety of crutches is very important for people with disabilities (Shortell et al., 2001).
Traditionally, the use of spring for its ability in energy conservation in human, animal, vehicles or devices mobility was common (Geyer et al., 2006). It seems that using spring in crutch structure especially in axillary crutch can led to its more comfortably, safety and effectiveness. So, this study aimed to designing and constructing of axillary springy crutch for easier walking of disable and elder people.

Methods and Materials:

Crutch design:
In this study the researchers used from spring features to make appropriate, safe and comfort axillary crutch. The spring has some unique features such as the ability to storage of energy is pressure status and releases the stored energy at the time of leaving the pressure which researchers used from these characteristics to achieve the study objectives. The designed crutch during this study consists of two separate upper and lower parts with proper springs with a suitable K factor between them (Figure 1). The amount of energy storing and its releasing is directly depends on K factor of spring.

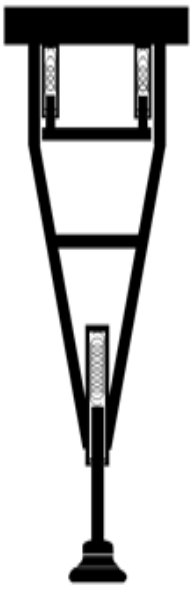

Figure 1: The technical structure of designed crutch

Performance and technical capability:
The used springs have the ability to store the energy from the person weight and took it out in press release. This structure and design lead to bearing much of the body weight in walking by the previously stored energy which induced from person weight and consequently ease walking. This can facilitate a person's gait so that walking speed and distance will improve; the exhaustion of the individual in mobility and activity is reduced; and the skeletal health problems caused by the continued use of custom axillary crutch are reducing too.
In this study the research team was tried to design a unique and ergonomic crutch to easier walking of disabled and elder people using spring features. The designed springy crutch in this study has excellence features which prevent from muscle soreness in axillary area and reduce of required energy for walking in compared with other types of crutches. This structure will led to more long walking of disabled and elder people with fewer fatigues and their more satisfaction.

As mentioned, the springy crutch has the ability to store the energy from the person weight and took it out in press release situation which this feature led to easier mobility and comfort walking. Based on Physics rules, the stored energy in a spring which helps to walking (F) is dependent on the quality degree of spring (spring K) and the change in springy size due to the pressure of body weight (ΔX) according to following formula;

$$F=K\Delta X$$

According to the above formula when an object such as persons' body is placed on the spring, the force of body weight stored in the spring in the form of potential energy which is released when object picking up.

In addition, there is an issue in physics science which if the effect time (t) of a force (F) on the ground or an object increases the momentum or severity of tolerated forces (P) will be reduced drastically, based on following formula;

$$P= F/t$$

Accordingly when the person apply his weight on the springy crutches the transmission time of person weight force of the ground will increases and the severity of a collision force of person weight on the ground reduced, consequently the person comfort will increased in waking time. Such as the function which the car shock absorbers make when the car falling in a puddle and prevent from entering severe blows to the vehicle and passengers' body.

Findings and Discussion:

The researchers believe that the application of this springy crutch has concrete and meaningful benefits for disabled and elder people to increase of users' comfort and prevent from damages; the health system and the government in aspects of reduction of therapeutic costs and prevention from sores, falling and trauma; ability of mass production of springy crutch; increase of peoples productivity; and currency attraction.

This crutch has the momentous benefits associated with patients and disables people including slight pressure on the patients' armpits and shoulders and relieves pain caused by this pressure; increase the patient comfort during the walking; reduce the risk of falling and their related injuries; ability to more distance walking because of energy saving and reduces the fatigue; early walking resume during and after the acute phase of disease; more disabled people tend for walking and back to routine life; and improve the patient's mood for faster betterment and back to routine life.

Undeniably, one of the most appropriate criterions of one invention is their acceptable cost which has been mentioned in the current device because this crutch is produced by low costs so that the applied technology in it couldn't lead to notable increase in the total price. This crutch has capability of mass production in the nationally and internationally level and by consideration of the lack of similar samples abroad and 20-years exclusivity production rights for the inventors, this product could export to other countries for many years as well as bringing remarkable income.

Conclusion:

The study results showed that the new made crutch has been able properly to achieve pre determined objectives, so the researchers have strongly suggested to mass production of this crutch for people with low walking ability especially the elder one. The various hospitals and care delivery centers, especially those who care from elder people, disabled and orthopedic patients can using such technology in order to provide safe and comfortable walking of patients too.

Acknowledgement:

The authors would like to express their gratitude to the Deputy of Researches and Technology of Tabriz University of Medical Sciences for their intellectual and financial supports.

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