

Prototype of a Stair Climbing Walker: An Act of Product Development in Developing Countries like India

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ABSTRACT

Introduction:- With 20% of locomotor disability population and a stiff increase in geriatric population, availability of a stair climbing walker which is technically and economically suitable for a developing country like India is very rare.

Objective:- To design a functional stair climbing walker with hand lever system.

Method:- The anthropomorphic measurements for walker were taken. The walker was fabricated with a pair of anteriorly reversed U- shaped frame with four legs. The anterior legs were adjustable in height by lever system through cable and the spring which is placed at the both the side of the hand grip.

Result:- Patient trial was successful in both ascending and descending of stairs.

Conclusion:- The initial cost of stair climbing walker was moderate and with mass production the price of the walker can be further reduced.

Key words: stair climbing walker, ascending stairs, descending stairs.

INTRODUCTION

The Convention on the Rights of Persons with Disabilities (CRPD) entitles, every disable person has right to avail assistive technology to ensure their full and equal enjoyment of all human rights and fundamental freedoms.¹ CRPD acknowledges that assistive technology can be used both for improving body structures and functions and for improving activities and participation by reducing barriers. When it comes to rural area, only few persons with disability as well as geriatric persons have access to proper assistive devices due to unawareness and non-availability of proper assistive technology. Proper implementation of CRPD requires that assistive technology be equitably

available, accessible and affordable irrespective of gender, age or impairment. To achieve this, governments and other signatories need to carry out measures related to policy, legislation, research, development, production, training, information, use and cooperation. This design of stair climbing walker can aid rural patient to climb stairs with good stability which a standard walker cannot be able to provide. There are many examples of assistive devices for people with manipulative and locomotive disabilities. These device enable disabled people to perform many activities of daily living thus improving the quality of life and play a more productive role in society.² Walkers are commonly used by the persons with

locomotor disabilities due to spinal and lower extremity dysfunctions.³They provide support and balance.⁴These devices can be used temporarily for gait training for persons who are unable to balance and support themselves even for short period of time. Walkers available in the market, all have one function and that is to assist the user in mobility. Walkers with wheels can be pushed forward to provide moderate stability. These walker i.e. standard walker or rollators are limited as they don't make stair climbing accessible to the user. Stair way ascending and descending still remains a challenge by these walkers. For example a physically disabled person can't ascend or descend stairs with a standard walker. A stair climbing walker will actually aid the person with disability in walking up or down staircases. This type of walker has the ability to shorten or lengthen the front legs. The anterior upright of the walkers are adjustable in height. Stair climbing walker, as the name suggest, improves stability for a person while climb up stairs. It should be used by young person with very good upper body strength and balance who are only impaired by lower extremity weakness. A person may be stable and mobile on a flat surface, climbing up and down stairs takes significantly more effort. There is also increased strain on the lower limb, particularly the lower leg and feet and if there is any problems with these parts of the body, climbing stairs may be a very difficult

task. A stair climbing walker should be used by any person who cannot safely ascend or descend stairs without assistance. So it's a necessity to design a simple yet effective stair climbing walker with less cost.

METHODS

The design of a stair climbing walker (Figure-1 (a) (b)) consists of reversed U- shaped handles with four legs. The caster wheels are attached with two front legs. This walker is height adjustable and should be set at a height that is comfortable for the user. This design resists unwanted rolling when the user applies the weight to the walker. These retractable and extendable legs served the function of ascending and descending stairs. The operation of the legs is through cables and springs.

A. Measurement of the walker:

1. With normal walking shoes on feet the subject is made to stand straight with palm facing both sides of thigh
2. With the help of the measuring tape, length from wrist to floor was taken
3. Measurements taken on subjects was used for height adjustment of walker
4. Height of walker is equal to the distance from wrist to floor.
5. Adjustments and readjustments were done with a trial and error basis until the optimum measurements were not achieved.



Figure 1(a): Front view of the walker showing, 1.inverted –U frame, 2. Caster wheels.
Figure 1(b): Side view of the walker showing, 3. Hand lever

B. Component attachment or assembly:

A standard readymade four legged walker was used which is readily available in the market. Height of the walker was adjusted. Telescopic bars on four legs of the walker were readjusted to match the measurement taken on the patient (i.e., greater trochanter to floor). Two springs were incorporated in between the two front telescopic legs, without compromising the height of the walker. So that, in normal condition, four legs parallel to each other. Two springs (figure-2 (a)) which are incorporated in front two legs offers an adjustment of 5 inches, which would be manipulated during the stair climbing. Two front horizontal bars were modified and attached in a reverse manner which would allow two side maneuverability. Two cables with housings were swiftly inserted inside two front vertical legs. Distally, the cable was anchored to distal attachment point i.e., base of the caster wheels. Proximal attachment point is located proximally with a retainer (figure: 2 (b)). The cable is operated manually to make it a versatile one. Two caster wheels (figure-2 (a)) are mounted on the front two vertical legs. This marks the completion of stair- climbing walker.



Figure 2: (a) Caster wheel, (b) Cable operated hand lever.

C. Patient trial

Clinical trial was done for the stair climbing walker. A patient was provided with the stair climbing walker. The patient used the walker while ascending (figure-3 (a)) and descending (figure-3 (b)) through the stair way. The caster wheels were easily transferable at the steps during ascending. Similarly, in descending the ferrules stop the forward movement.

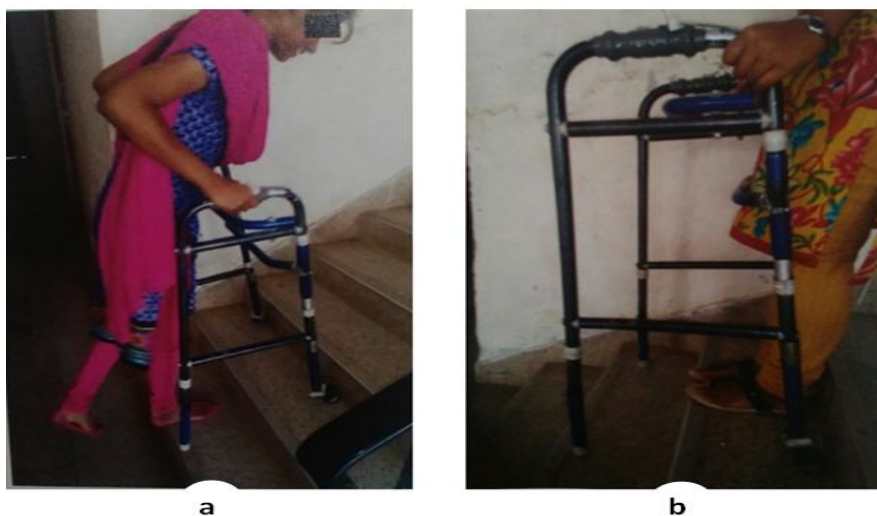


Figure 3: (a) Patient trial during ascending upstairs, (b) Patient trial during descending downstairs.

RESULT

The result of the trial seemed positive. Only qualitatively the patient's feedback was considered as the outcome for this study. A positive feedback was taken from the user. Balance and stability was good during ascending as well as descending. Patient's feedback also stated about the easy maneuverability of the walker.

DISCUSSION

This device requires good balance and great strength of the upper extremities. An adjustable component of spring and cable provides extra support in order to enhance stability for stair climbing. Advantage and disadvantage are associated with the use of a walker and should be considered when prescribing a walker as an assistive device for any patient. It gives maximum base of support to the patient with which the user's center of mass can move without losing stability. The possibilities of walking with ascending and descending stairs are also easy to access for turning the walker. Disadvantages of this walker are slow and awkward gait, creates bad posture and limited to indoor use in most cases.

CONCLUSION

A plausible design was achieved that fulfilled the objectives in the problem statement. The final concept was selected, by means of an appropriate selection process, from series of three concepts: 1. A track to climb stairs. 2. A rotating wheel assembly. 3. Adjustable front legs. Kinematic and static analysis was done on the final concept in order to attain a safe and optimal design. Further adjustments must be made to ensure that the walker design is optimal. An attempt has been made to fabricate a stair climbing mechanism with the available indigenous material and is proved that the fabrication of stair climbing mechanism can be achieved.

Clinical significance

The stair climbing walker prototype was designed according to the stair heights of small Indian homes. It is expected that the price of the stair climbing walker can further be reduced on mass production.

Future research scope

Technical and material up gradation is required for the prototyped stair climbing walker to make it lighter in weight and to improve functional efficiency. A quantitative and qualitative data analysis can be carried out to investigate its functional efficiency and its acceptability among the persons with disability and geriatric population.

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Authors' Contribution

Both the authors have contributed equally to the successful completion of the study. Tapaswini Mohanty was in charge of the Design and fabrication of the novel stair climbing walker and Bapina Kumar Rout looked after the patient trial and manuscript preparation.

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