

Evaluation Of Efficacy & Efficiency In Implementing Knee Ankle Foot Orthosis (KAFO) As A Functionally Assistive Indoor Ambulatory Device For Motor Complete Thoracic Level (T₁₀ –T₁₂) Spinal Cord Injury In Males

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Abstract:- The objective was to evaluate walking velocity, walking endurance & energy expenditure in use of KAFOs over the alternative Aluminum Back Slab & Toe Raising Straps (ABS & TRS) on paraplegic (T₁₀ –T₁₂) ambulation which has not been performed among Sri Lankan patients. This was a case cross over study where fifteen, T₁₀ – T₁₂ motor complete paraplegic males who were practicing indoor ambulation with ABS & TRS & recommended to use KAFOs were recruited. A two weeks standardized ambulatory training was provided with either device prior to test. The 10 meter walk test, 6-minute walk test & physiological cost index (PCI) were used to assess walking velocity, walking endurance & energy expenditure respectively. Testing was done 6 weeks apart. A statistically significant difference was seen in walking velocity ($z = -3.30$, $p = 0.001$), with ABS & TRS having faster velocity. The walking endurance was significantly less ($z = -3.41$, $p = 0.001$,) & the energy expenditure was significantly high ($z = -3.41$, $p = 0.001$) with KAFOs relative to ABS & TRS. The results are closely compatible with previous studies, but remarkably differed with values of healthy individuals in normal ambulation. The walking velocity & the walking endurance of participants were relatively greater with less energy expenditure during ambulation with ABS & TRS. Therefore, it is concluded that KAFOs have less efficacy & efficiency as a functional

indoor ambulatory device over ABS & TRS in rehabilitation of T₁₀ –T₁₂ paraplegic males.

Keywords: KAFOs, ABS & TRS, T₁₀ – T₁₂ paraplegics, walking velocity, walking endurance, energy expenditure, 10 meter walk test, 6-minute walk test, physiological cost index (PCI).

Introduction

A pair of Knee Ankle Foot Orthosis (KAFOs) is recommended as an assistive functional indoor ambulatory device for subjects with paraplegia resulting from T₁₀ –T₁₂ traumatic spinal cord lesions in local settings where an analysis of the efficacy and efficiency of the device yet to be performed among Sri Lankan patients undergoing rehabilitation following spinal cord injuries. Hence the objective of this study was to evaluate walking velocity, walking endurance & energy expenditure in use of KAFOs over the alternative Aluminium Back Slab & Toe Raising Straps (ABS & TRS) on paraplegic (T₁₀ –T₁₂) ambulation which has not been performed among Sri Lankan patients.

Methodology

This was a case cross over study conducted at the Department of Spinal injury rehabilitation, Rheumatology & Rehabilitation Hospital, Ragama during the period of 4 months from April 2019 to evaluate the gait related parameters in indoor ambulation using a pair of KAFOs & that of using ABS with TRS. Fifteen,

T₁₀ – T₁₂ motor complete paraplegic males who were eligible for indoor ambulation with ABS & TRS as well recommended to use a pair of KAFOs were recruited for the study. They were providing with 2 weeks standardized ambulatory training with either device prior to test. The walking velocity, walking endurance & energy expenditure were assessed first with ABS & TRS & then with KAFOs. The 10 meter walk test (see Figure 3), 6-minute walk test (see Figure 4) & physiological cost index (PCI) were used respectively. Testing was done 6 weeks apart. Three data collecting trials were performed for 10MWT & PCI where it was two for 6-minute walk test. The ethical approval was gained from the Ethical Review Committee of Faculty of Medicine, University of Kelaniya, Sri Lanka.

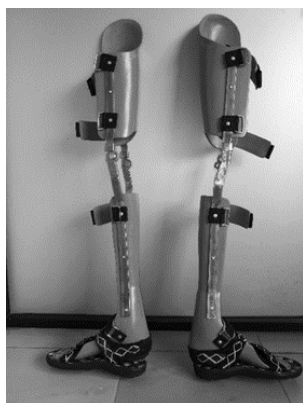


Figure 1 - Pair of KAFOs

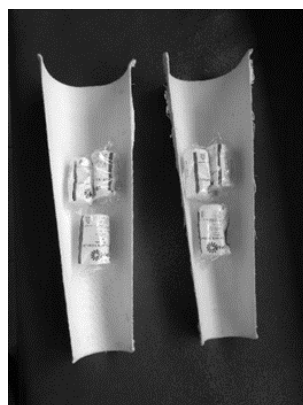


Figure 2 - Pair of ABS & TRS

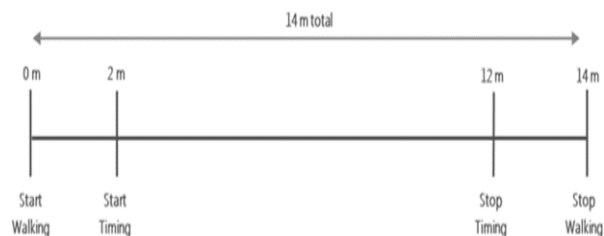


Figure 3 - Illustration of 10 MWT – Walking Path

Source: <http://blog.parker.com>

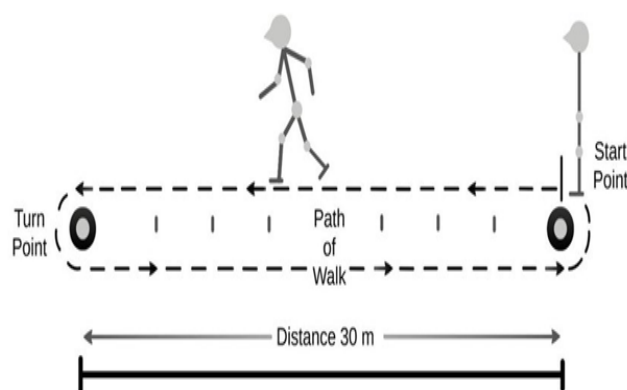


Figure 16 - Illustration of 6 MWT – Walking Path

Source: <https://www.researchgate.net>

Result

10-meter walking velocity with ABS & TRS was significantly ($z = -3.30, p = 0.001$) faster than that of KAFOs with a median (IQR) value of 5.36 m/min (4.50– 5.86) & 4.12 m/min (3.48 - 4.82) respectively. The walking endurance of lower thoracic level motor complete paraplegics with 6-minute walk test was significantly less with KAFOs ($z = -3.41, p = 0.001$) than ABS & TRS, with median (IQR) values being 27.48 m (19.60 m – 33.20 m) and 30.40 m (27.20 m – 38.40 m) respectively. A statistical significant difference was seen in energy expenditure values ($z = -3.41, p = 0.001$) where it is higher with KAFOs than that with ABS & TRS which showed median (IQR) values as 7.14 beats/m (5.95– 9.08) & 4.68 beats/m (2.91– 5.30) respectively.

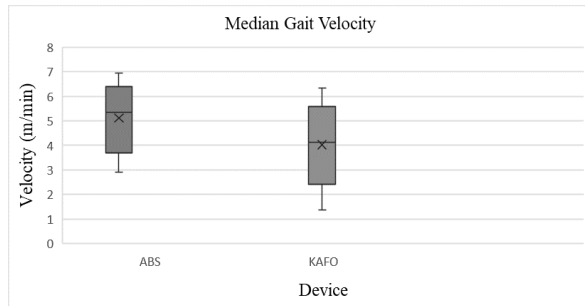


Figure 17 - Illustration of median gait velocities

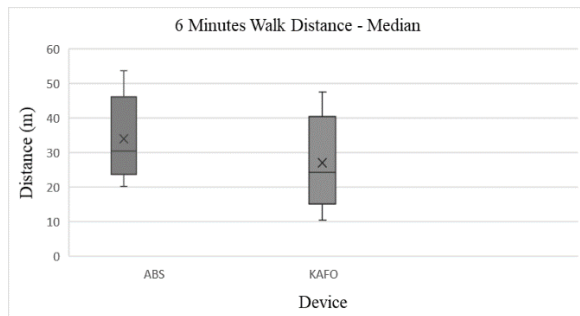


Figure 18 - Illustrate the median distance

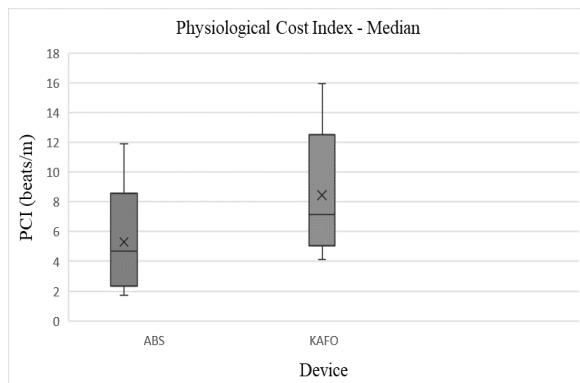


Figure 19 - Illustrate the median PCIs

Discussion

The extent to which an individual with paraplegia is capable of ambulate with an orthotic device is not merely determined by the lesion level itself. The degree of energy consumption, speed of ambulation, physical endurance, user friendliness, independency & several demographic factors as age & gender are crucial.

Since KAFO lost its popularity among the international setting with high abandon rate, use of KAFO as a functional assistive indoor ambulatory device in local setting is questionable. This study was conducted to

evaluate the functional efficacy & efficiency of KAFO use of paraplegics with complete lesion at the level of T₁₀ -T₁₂.

Results of the present study revealed that the walking velocity with ABS & TRS was significantly greater than that of KAFOs. It specifies that the subjects are proficient of walking faster with the alternative device than with more sophisticated KAFOs. As the same user tested with each device, the reason could be the considerably high amount of (almost triple) weight of the entire KAFO unit with the foot wear.

One parameter that has high demand in evaluating efficacy & efficiency of functional ambulation of paraplegics is the walking endurance. There was no literature related to endurance of orthotic ambulation.

The distance covered over 6 minutes was used as the predictor of endurance & it was significantly higher with the ABS & TRS than with KAFOs. This reveals that KAFOs has placed a greater exhaustion on paraplegics even in short distance ambulation. The less endurance in ambulation with KAFOs again could be due to the heaviness of the unit that subject has to propel with at a low velocity.

The endurance of healthy subjects ranged from 400m -700m. Therefore, compared to the healthy subjects, paraplegics have remarkably less endurance in ambulation with either device (ABS & TRS > KAFO).

Finally, the results of all the timed measures of this study support to prove the hypothesis of the functional performance of paraplegics in indoor ambulation with ABS & TRS is greater than that of KAFO.

Conclusion

According to the findings, the efficacy & the efficiency of the paraplegic ambulation with ABS & TRS is greater than that with KAFOs. The results showed a relatively greater gait velocity & comparatively higher endurance under less energy consumption with ABS &

TRS. Therefore, it is concluded that ABS & TRS would be a functionally effective indoor ambulatory alternative in rehabilitation of T₁₀-T₁₂ thoracic level paraplegics in local settings rather using highly expensive less beneficial KAFOs.

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