

Evaluation of Moto-Stand A New Vehicle for Upright Ambulation in Paraplegics

M. A. Medhat, M.D.;¹ V. Nanda Kumar, M.D.;² and J. B. Redford, M.D.³

¹ Ass't. Professor in Rehabilitation Medicine, ² Chief, Rehabilitation Medicine Service and ³ Professor and Chairman, Rehabilitation Medicine Department, The University of Kansas College of Health Sciences and Hospital, Kansas City, KS 66103, U.S.A.

Summary

The Moto-Stand is a motorised vehicle to propel paraplegics in the upright position. It safely allows handicapped persons a wide range of working capabilities and extends mobility far beyond the limits of a wheelchair. Twenty adults with spinal lesions were evaluated for using the Moto-Stand. The levels of lesion ranged from C₆ to L₁. The tetraplegics studied had incomplete lesions and they could get on the Moto-Stand but needed some assistance. All the paraplegics studied were able to use the Moto-Stand independently. The Moto-Stand was found to be superior for kitchen activities, especially when handling hot objects and reaching objects at different levels. As it turns in its own space it offers superior manoeuvrability in the limited space of a kitchen, workshop or even a trailer home. Subjects with moderate to severe spasticity appear to have difficulty in using the Moto-Stand. It was found to be safe and comfortable by the majority of subjects studied.

Introduction

A portable, collapsible, indoor vehicle became available in 1961 called Stand Alone. The user stands on a platform on four small wheels. Two large propulsion wheels similar to the handrims of a wheelchair (38 cms in diameter) are connected by a chain with the rear wheel on the same side. A paraplegic with a spinal cord lesion at the eighth thoracic level will require moderate assistance to transfer between the rolling Stand Alone and a wheelchair and for higher lesions more mechanical assistance is required. By the use of toe loops and three pads (one each against the knees, the abdomen and the buttocks), the patient stands in this device without braces and without holding on to the device. In this position the upper limbs are free for desired activity and able to reach objects at the level of a standing person.

A motorised version became available in the mid 1970s, but both of these vehicles are usually too large to use in an office or home.

The Moto-Stand was designed and built by an engineer who is a paraplegic. This device allows the paraplegic a wide range of capabilities and mobility far beyond the limits of a wheelchair, yet turns within its own space, making it easily manoeuvrable in the limited space of a home, office or workshop.

Moto-Stand

The basic construction of the Moto-Stand consists of a platform supported by two larger wheels in front and one smaller wheel in the rear with a ground clearance of 4 cms ($1\frac{1}{2}$ ""). The rear wheel is driven by a motor powered by a 12 volt battery. There is a well padded ('T' foam) vertical mount directly placed over the front wheels whose height can be adjusted for the paraplegic's height. On the top of the vertical mount are placed the controls which include a toggle switch (on-off), battery power indicator, and a horizontal steering rod in the middle. On the side of the vertical mount there are two adjustable belts used to strap the paraplegic in position (Figs 2 and 3). The motor has two forward speeds and reverse. Brakes are placed on both front wheels and are controlled manually by turning a knob on the vertical mount. The Moto-Stand has a width of 55 cms ($21\frac{1}{2}$ ""), and weighs 60 kgs (130 pounds). It has a turning radius of 90 cms (36").

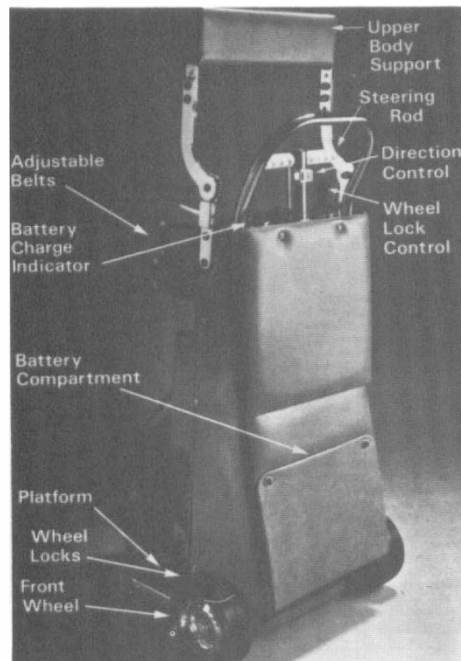


Figure 1. Moto-Stand showing the various parts.

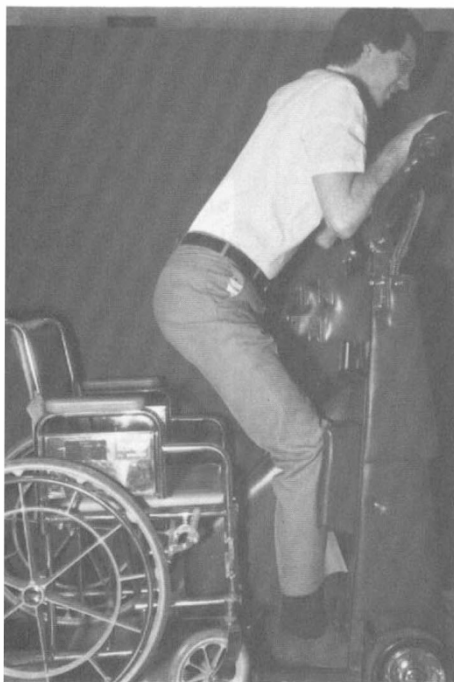


Figure 2. Subject in the process of getting on to the Moto-Stand.

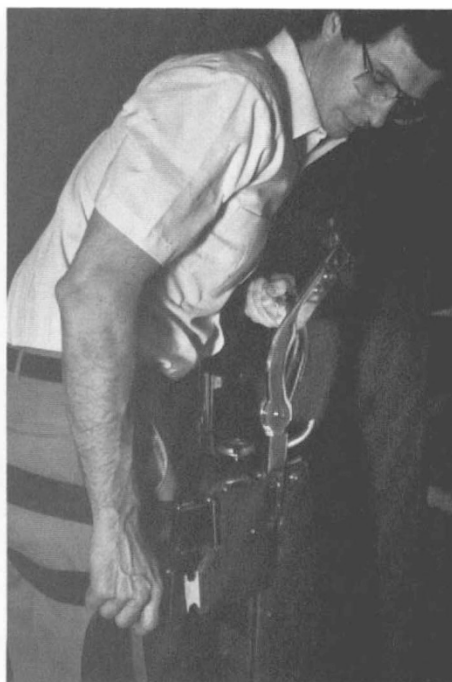


Figure 3. Subject using the two belts to stabilise himself.

Methodology

We studied 20 subjects with spinal cord disorders with lesions at various levels. The criteria for selection of subjects for trial use of the Moto-Stand were:

1. Patients with a spinal cord lesion below C₆ level.
2. Heights not less than 150 cms (5'), and not more than 185 cms (6'2").
3. Patients weighing less than 115 kg (250 pounds).
4. Patient presently wheelchair-bound.

Before a trial of a Moto-Stand a thorough clinical examination was undertaken for exact motor and sensory level, respiratory function, presence of spasticity, presence of contractures in the lower extremities and upper extremity coordination. The subject was then allowed to get on to the Moto-Stand and to move around. He was asked to go up and down ramps and manoeuvre in a kitchen setting which included working near a hotplate and also working near a dining table to serve food. Other activities included working in a laboratory setting. After various activities, while standing in the Moto-Stand for 60 minutes, the subject returned to the wheelchair. Clinical examination was repeated to see if any pressure areas over the bony prominences had developed, especially the front of the knees. The subjects were also asked to comment on comfort, safety and overall impression.

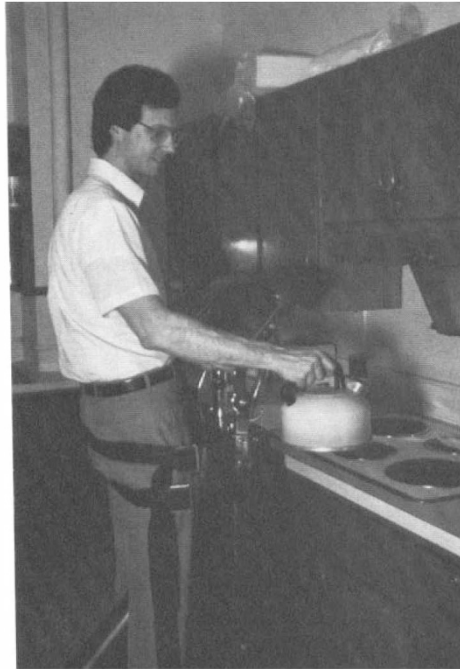


Figure 4. Subject in a kitchen setting.

Results

Twenty subjects were studied; 19 with spinal cord injury and one with multiple sclerosis and a T₁₀ lesion. Nineteen were male and one was female. Ages ranged between 23 and 69 years with a median of 43 years. Twelve were single and eight were married. The heights ranged between 162 cms to 182 cms (65"–73"), and median was 175 cms (70"). Weights varied from 53 kgs to 92 kgs (114–200 pounds) with a median of 76 kgs (165 pounds). Four were employed, three were students, and 13 were unemployed at the time of evaluation. The years of disability ranged from 2 to 26 years with a median of 8 years. The level of injury ranged between C₆ and L₁ levels. Three subjects had incomplete cord lesions, two of them were at the level of C₆ and one at C₇ level. Sixteen had thoracic cord lesions, T₄ being the highest, and one had a lumbar lesion.

Clinical assessment for associated musculoskeletal conditions revealed that three subjects had flexion contractures of the hips and knees. Seven had mild spasticity below the lesion and eight had moderate spasticity. Four had Harrington rod fixations and six had spinal fusions. One subject had scoliosis of the spine (15°).

Sixteen subjects were able to transfer from wheelchair to Moto-Stand independently; two needed minimal assistance and two needed moderate assistance. Those who needed assistance had cervical and high thoracic lesions. For transfer from the Moto-Stand to the wheelchair 16 subjects managed this independently, three required minimal assistance and two moderate assistance. For kitchen

activities 15 subjects (75%) felt that the Moto-Stand was better than a wheelchair, two (10%) felt that the Moto-Stand was worse than a wheelchair, and three (15%) felt that there was no difference between the two. The height accessibility (using the Moto-Stand), ranged between 60 to 270 cms (2' to 9') from the ground with a range of 62 cms 210 cms (2' to 7').

When asked to comment on the overall function, 19 said the Moto-Stand was comfortable with one reporting it was uncomfortable. Seventeen subjects felt that it was safe, two felt that it was unsafe and the others had no comment.

Discussion

Paraplegics from T₄ to L₁ level were able to use the Moto-Stand without any assistance. It was quite obvious that the lower the level of the lesion, the better the ability of the subject to transfer to the Moto-Stand and back to the wheelchair. The subjects with high thoracic and cervical lesions felt nauseated initially due to postural hypotension, which cleared up after a short period. Moto-Stand could be used by three incomplete tetraplegics below C₆ level but they needed minimum to moderate assistance. Those who were tetraplegic also needed to have reasonably good dexterity of their hands; without dexterity it would be impossible to use or manoeuvre the Moto-Stand, even if the subject could get on to the Moto-Stand with assistance. The number of years of disability did not appear to have any bearing on the ability to use the Moto-Stand. The older age group, however, was not as enthusiastic as the younger group and preferred the wheelchair for mobility. The subjects with moderate to severe spasticity appeared to perform worse on the Moto-Stand but flexion deformities of 20° or less of hip and/or knee joints did not affect performance on Moto-Stand. Subjects who had the ability to do pushups in the wheelchair were consistently able to get on and off the Moto-Stand with ease. The Moto-Stand appeared to be superior in kitchen activities, especially when handling hot objects and the reaching for objects at different heights. This also holds good for activities to be done in limited spaces, such as a workshop. The space taken by the Moto-Stand to turn around was no greater than that of a wheelchair. The majority (80%) of the subjects felt that the Moto-Stand is comfortable, safe, and could be used at work, if employment was considered. Those people who were walking with two crutches (or with braces and crutches), felt that the Moto-Stand would leave their hands free to pursue other activities.

Conclusions

The Moto-Stand can be used by most paraplegics between T₄ and L₁ levels without assistance. Incomplete tetraplegics up to C₆ level may be able to use (but need moderate assistance), to get on to a Moto-Stand. They also need reasonable hand function to manipulate the controls. Although the number of years of disability has no bearing on the usefulness of this vehicle moderate to severe spasticity can definitely interfere with the use of a Moto-Stand. Moto-Stand is superior in the kitchen to a wheelchair, especially when handling hot objects and reaching for objects at different levels. Moto-Stand has superior manoeuvrability and is safe on ramps. No tipping was seen when used on a

10° gradient surface. The majority of the subjects tested felt that it is comfortable and safe.

Résumé

Couramment, tous les efforts à aider le déplacement des paraplégiques ont concentré à améliorer l'aspect, la durabilité, le poids et la vitesse du fauteuil roulant. Récemment, un véhicule électrique a été introduit pour servir à transporter les malades paraplégiques debouts. Le Moto-Stand donne aux personnes handicapées une grande capacité à travailler et beaucoup plus de mobilité que le fauteuil roulant. Vingt malades portant des blessures à la moelle épinière de C₆ à L₁ ont utilisé le Moto-Stand pour l'évaluer. Trois malades avec des blessures cervicales avaient une tétraplégie qui n'était pas complète. Dix sept malades avaient des blessures entre T₄ et L₁. Tous ont été invalides pour deux à vingt deux années. On a trouvé que le malade peut utiliser le Moto-Stand mieux quand sa blessure est basse. On a conclu que les paraplégiques peuvent utiliser le Moto-Stand sans aide, mais les tétraplégiques doivent être aidés à s'élever. Le Moto-Stand est meilleur pour le travail dans la cuisine, surtout pour utiliser les objets chauds et pour atteindre les différents niveaux. Le Moto-Stand tourne en place et permet une meilleure manœuvrabilité dans une cuisine, dans la place d'emploi ou même dans une maison roulante (Trailer). À l'exception de deux, tous les malades l'ont trouvé confortable et facile à utiliser avec sécurité. Le Moto-Stand permet les malades d'arriver, avec les deux mains, à un niveau par-dessus la tête. Aussi, ils peuvent ramasser des objets de parterre parce que le Moto-Stand peut s'abaisser avec un "power forward" spécial. Les malades avec spasticité sévère ou modérée ont plus de difficulté avec le Moto-Stand. La sécurité, le maintien et la durabilité du Moto-Stand étaient satisfaisants.

Zusammenfassung

Heutzutage werden alle Bemühungen der Fortbewegung der Paraplegischen zu helfen auf die Verbesserung des Baues, Staerke, Gewicht, u. Geschwindigkeit der Fahrstuele gerichtet. Unlaengst wurde ein Drinnenfahrzeug zur Fortbewegung der Paraplegischen vorgefuert. Der Moto-Stand gibt den Behinderten eine Reihe von Arbeitsmoeglichkeiten und erweitert die Grenzen der Fortbewegung weit ueher die der Fahrstuele. Zwanzig Erwachsene, spinal Verletzte mit C-6 und L-1 Verletzungen wurden fuer den Benutz des Moto-Stand bewaertet. 3 Patienten mit cerviculen verletzungen hatten unvollendete Quadrupereuse und die anderen 17 hatten Verletzungen zwischen T-4 und L-1. Das Alter dieser Gruppe war 2 bis 24 Jahre. Wir fanden das je niedriger die Verletzung, desto besser der Nutz des Moto-Stand. Dieses Fahrzeug Kaunn von allen Paraplegieschen ohne Hilfe benutzt werden. Die Qudriplegishen brauchen Hilfe beim Aufstehen. Der Moto-Stand dreht auf eigener Achse und ist deshalb mehr nuetzlich fuer beschraenkte Raume wie z.B. die Kueche. Der patient hat die Haende frei und Kann nach Sachen ueber dem Kopf reichen oder aber auch Sachen vom Fusboden mit Hilfe eines spezialen "Staerke Vozwaerz" Biegung, aufheben. Patienten mit mittel, oder schwerer Verkrampfung haben mehr Schwierigkeiten mit dem Moto-Stand. Die Sieherheit, Pflege und Stabilitaetstests waren alle sehr befriedigend.

Acknowledgements

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