Orthotics and Prosthetics, Vol. 32, No. 3, pp. 32-36, September 1978

The Salop Skate—An Orthosis For Improving 'Drag-To' Gait

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Many patients with paralysis of the legs, particularly those with some degree of deformity or limitation of movement in joints, perform 'drag-to' gait. Because of their inability either to walk reciprocally or to raise their body from the ground to perform 'swing-through' or 'swing-to' gait, they use a rollator or, less commonly, crutches to pull themselves forward and drag their feet behind them. It is most prevalent amongst obese patients since they are less likely to be able to raise their body from the ground to perform 'swing-to' or 'swing-through' gait. Few such patients are very effective ambulators because the technique requires a high level of energy consumption, and most eventually subside into a purely wheelchair existence. The degree of locomotion difficulty varies considerably with the type of floor. High friction surfaces such as rough concrete or cord carpet are particularly troublesome, and completely defeat some patients.

Observation of 'drag-to' gait pattern (Fig. 1) showed that the cycle commenced with the toes of the footwear in contact with the ground and the heels raised. As the patient progressed forward, the heels came down onto the ground and the rollator (or pair of crutches) was then moved forward. This completed the cycle since the heels were then raised automatically.

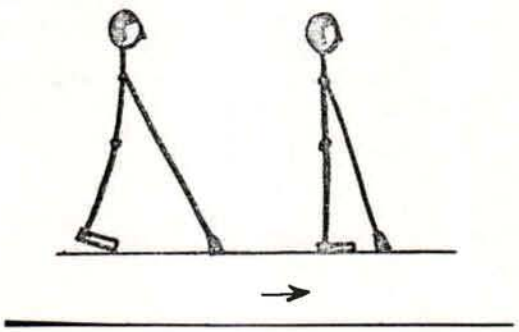


Fig. 1. The "Drag-to" gait.

A device, designated as the 'Salop Skate' (Fig. 2), has been designed to be worn on the patient's feet to reduce the friction between the feet and the ground. The principle is to use wheels beneath a platform (a in Fig. 3) onto which the feet are strapped. In order to prevent the patient rolling backwards when the heels are raised at the start of the cycle, the wheels used are rubber covered roller clutches (b in Fig. 3) that permit forward rotation only. Also on the bottom of the platform at the rear are mounted rubber covered 'brake stops' (c in Fig. 3) of the same height as the roller assembly, so that as the 'drag-to' cycle is completed and the heels grounded, the stops come into contact with the floor and prevent the patient overshooting forwards.

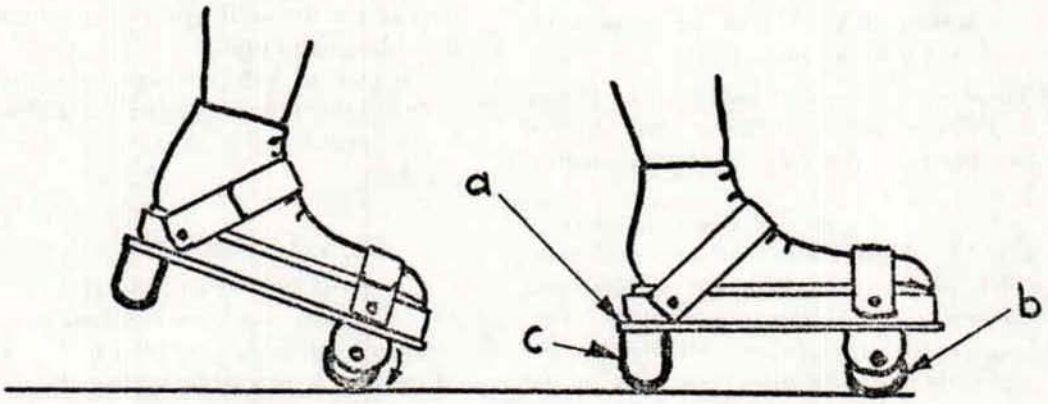


Fig. 3. Side view of the Salop Skate.

Fig. 2. The Salop Skate in use.

Fabrication

The Salop Skate consists of a 1/8-in.-thick aluminum plate of sufficient size to contain the patient's feet when standing comfortably (typically 11-in. wide x 7-in. deep). Two roller assemblies are attached to the underside of the plate in a position which aligns with the metatarsal heads of the patient. These assemblies each consist of the following components:

1 M.S. Bushing 1-in. O.D. x 7/8-in. I.D. (toleranced bore) x 1-in.-long, zinc plated, with a 1/8-in.-thick bonded covering of Dainite (rubber compound).

1 Torrington RCB-081214 combined clutch-and-roller bearing.

1 bearing pin 1/2-in. diameter x 2-3/8-in. long silver steel.

2 Torrington NTA-815 thrust bearings and 4 TRA 815 washers.

2 nylon brackets 7/16-in. wide (machined from 1-3/4-in. dia. nylon rod).

2 Roll Pins, 1/8-in. dia.

4 Screws 2BA x 1/2-in. long c'sk head, M.S. cadmium plated.

These are assembled as shown in Figure 4, and then attached to the outer sides of the plate in the line of the metatarsal heads.

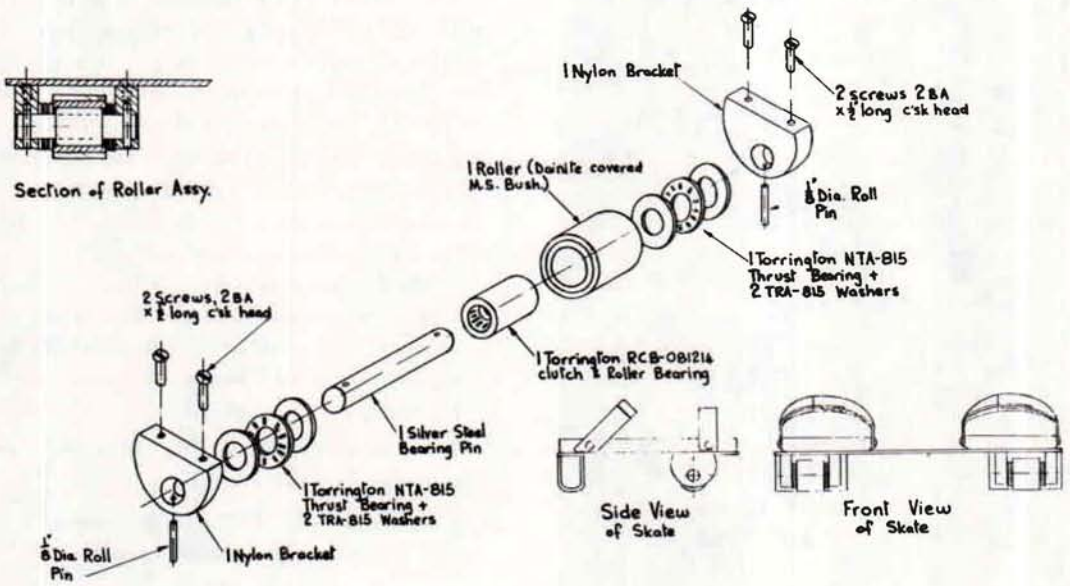
The brake stops are constructed from 1-1/4-in. high x 2-1/2-in. wide x 3/4-in. thick plyboard to which is stapled and bonded 1/8-in. Estasol rubber compound, the stops being attached to the outer sides of the underside rear of the plate with No. 8 x 3/4-in. c'sk. head wood screws.

The patient's feet are located to the plate in shallow plastic mouldings (approx. 1/2-in. deep) of the bottom of their shoes. These are vacuum formed in polypropylene over the shoes which are protected by aluminum foil, and each is attached to the plate with four 1/8-in. dia. pop rivets through appropriate holes in mouldings and plate.

Two sets of Velcro straps are riveted to each of the polypropylene mouldings to locate around the ankle and over the forefoot.

Clinical Trials

Five patients ranging in age from 6 to 14 years who were established users of 'drag-to' gait were provided with a Salop Skate. Each was able to use the device after a few minutes practice and was allowed to use it under the supervision of a physiotherapist for a period of one month. At the end of that period each subject was tested for speed and heart rate over five runs of 20 ft. with a one-minute rest period between each with both 'drag-to' gait and with the Salop



THE SALOP SKATE

Fig. 4. Exploded view of the Salop Skate.

Patient	DRAG-TO GAIT Average Speed ft/sec.	DRAG-TO GAIT Heart Rate b.p.m.	USING SALOP SKATE Average Speed ft/sec.	USING SALOP SKATE Heart Rate b.p.m.	Change in performance using Salop Skate Percentage increase in speed
			PLASTIC FLOOR PERFORMANCE		
a	1.39	130	1.58	122	13.7
b	0.76	194	1.01	187	32.8
c	0.82	190	1.54	185	87.8
d	1.36	171	1.60	154	17.6
e	1.26	173	1.61	162	27.8
			CORD CARPETED FLOOR PERFORMANCE		
a	—	—	—	—	—
b	—	—	—	—	—
c	0.41	210	1.11	188	170.0
d	0.74	161	1.15	150	55.4
e	1.08	151	1.46	151	34.9

Results of Patient Trials using 'drag-to' gait and the Salop Skate on two floor surfaces.

TABLE I

Skate on a plastic floor. Three of the patients were also tested on cord carpet.

Table 1 shows the average speed and heart rate for each of the trials and the percentage increase in speed when patients used the Salop Skate. It can be seen that on the plastic floor the average speed with the Salop Skate increased in every case over that for 'drag-to' gait with a concurrent lower heart rate. On cord carpet the average speed increased in every case with a lower heart rate in all but one case, where the higher speed was achieved at the same heart rate. The average percentage increase in speed on the plastic floor was 35.9 percent and on carpet 86.8 percent.

The patient's subjective impression was in every case that it was much easier to ambulate with the Salop Skate. Both these impressions and the objective results were confirmed by the longer term (12 months minimum) experience of the patients. All had improved independence in that they could ambulate further with less assistance and over surfaces which have previously defeated them. One girl, who has been on the verge of subsiding into a wheelchair existence, is once again an assured ambulator within her school environment.

Discussion

The clinical trials indicated the advantages of the Salop Skate to paralyzed patients who perform 'drag-to' gait by giving them quicker ambulation at a lower energy cost. It offers tremendous

potential for improvement in locomotion for 'drag-to' ambulators, particularly since the training period is so short. Results from the speed/heart rate trial, the subjective impressions of the patients and the long term experience were all positive and none of the patients involved in the trials wishes to discard the device.

The method of manufacture adopted was purely for prototype construction and a production device would need some small modifications. These would primarily involve a bonded metal-to-rubber stop bar and an adjustable footclamp arrangement with quick-release buckle and strong fabric straps.

The device has commercial potential and negotiations are in hand with a British orthotics manufacturer who hopes to have the Salop Skate available in 1978.

Summary

'Drag-to' gait, in which the patient uses a rollator or crutches to drag their feet along the ground rather than swinging through, is used by many patients suffering from considerable degrees of paralysis of the lower limbs. This method of ambulation is adopted because the subjects have insufficient strength to raise their body from the ground and on high friction surfaces it is extremely energy consuming. A simple, effective device known as the Salop Skate which sharply reduces energy consumption by providing low friction 'drag-to' ambulation has been developed and described here.

Footnotes

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