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The early rehabilitation of lower limb amputees using a pneumatic walking aid

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Abstract

A pneumatic walking training aid for amputees is described. It was developed by the late Biomechanical Research and Development Unit, Roehampton, from an original design by Professor Little in Australia. The walking aid has been used successfully on the majority of below-knee and through-knee patients rehabilitated in the Roehampton Walking Training School since 1976. There have been no complications that could be attributed to the use of the pneumatic walking aid.

Introduction

Early mobilization following amputation is now generally accepted as being an important factor in the rehabilitation programme of all amputees.

To mobilize the patient by allowing him to hop using a frame or crutches only allows the stump to hang down taking no active part in the exercise. This relative inactivity of the dependent stump is conducive to increased stump oedema even when supported by a stump bandage. Many of the older patients find balancing on one leg exhausting and almost beyond their capability. It is therefore desirable that the patient has support from some form of prosthesis on the side of the amputation from the time of starting standing exercises.

The support may take the form of a simple pylon structure with a pre-made adjustable socket as advocated by Devas (1971) for above-knee amputees. With this approach it is difficult to achieve a socket fit that supports the distal stump tissues.

The immediate post-operative fitting of a plaster socket as described by Burgess et al (1965) can be most effective when applied by staff who are experienced in its use. However this technique is difficult to learn to use safely and therefore its use has in the main been confined to specialist units.

Little (1971) described an early walking device which he designed around a pneumatic air splint as a form of temporary socket using a metal frame and prosthetic foot. This device was used as a walking training aid until the stump was ready for a definitive socket fitting. In this report a modified pneumatic walking aid is described. The new device is now in regular use at many of the major hospitals in the United Kingdom. Other centres abroad have reported on the successful use of pneumatic walking aids (Dickstein et al 1982).

The Roehampton pneumatic walking aid

The apparatus designed by Little (1971) consisted of a single compartment pneumatic sleeve long enough to extend from the groin to below the amputation stump. It was enclosed by a tubular frame, having at its lower end an extension tube to a solid ankle cushion heel (SACH) foot. Following initial use of one such device, kindly loaned by Professor Little to the Biomechanical Research and Development Unit, Roehampton, the structure was modified to provide greater stability of the stump within the pneumatic sleeve and to give improved end support. The stability was improved by dividing the air space in the sleeve into anterior and posterior compartments which communicated with each other via a small transfer port. Improved end support was achieved by using a small subsidiary air bag placed in the lower part of the main pneumatic sleeve and invaginated on itself to support the end of the stump. Simple webbing slings supported the distal end of the pneumatic sleeve in the frame and allowed adjustments in length to be made. A simplified

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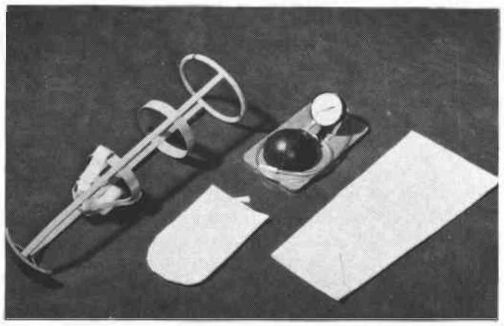

Fig. 1. Roehampton pneumatic walking aid showing support frame, end-support bag, main pneumatic sleeve and foot pump.

support frame was designed with a padded safety ring at the upper end and a simple rocker in place of the SACH foot at the distal end (Fig. 1).

The Roehampton pneumatic walking aid is suitable for patients of widely differing build. It may be used for below-knee and through-knee amputations and with a slightly modified sleeve for above-knee cases.

To apply the walking aid the patient is seated between parallel bars with his stump extended in front of him. The small end-support air bag is positioned over the distal end of the stump and held in position as the long pneumatic sleeve is pulled over this and up to the groin. The frame of the prosthesis is then passed over the pneumatic sleeve and held in place until inflation is complete.

The end-support bag is partially inflated, then the main air bag is inflated to a pressure of 40mmHg using a simple foot pump and pressure gauge. The gauge and pump are removed and the inflating tube is sealed off with a spigot. The patient can then stand so that minor adjustments can be made, and is then able to walk with a stiff knee gait. When the patient bears weight on the socket the air pressure in both bags will rise to 60mmHg or more (Fig. 2).

The apparatus can be worn continuously for a period of 2 hours and can be applied as many times as is necessary in the course of a single day (two periods a day is usual in the course of normal rehabilitation). However, when commencing exercise on the sixth postoperative day or at any time before complete wound healing, the air bag is inflated for periods of 5–10 minutes only during the first day of use and thereafter the time is increased progressively. The appliance is a walking training aid and is intended for use by the patient only under the supervision of trained staff.

Results

The pneumatic walking aid has been used on the majority of patients having below-knee or through-knee amputations who have attended the Roehampton walking school since 1976. Redhead et al (1978) reported on the use of the walking aid in the management of 87 lower limb amputations in 85 patients of mean age 67 years (range 21–94 years). In 6 patients the amputation was of the second leg and 2 patients required bilateral amputations.

Use of the pneumatic aid was commenced from the sixth post-operative day, but owing to delayed wound healing in some patients the mean time to its first use was 17 days (range 6–55 days). A permanent prosthesis was supplied to 80 of the patients as soon as their stumps were healed and showed no volume changes; this was at an average of 40 days post-operatively (range 15–112 days).

Five patients had to be withdrawn from the trial for various reasons not connected with the

Fig. 2. Pneumatic walking aid applied to patient.

use of the walking aid. No complications were recorded from pressure damage to the stump; several patients fell but the pneumatic aid acted as a protection to the stump.

Discussion

Although a long pneumatic splint can be used as a walking aid and is commercially available *(Jobst), stability with such devices has been a problem, (Kerstein 1974), and the addition of the outer frame represented a significant improvement (Little 1972).

Little reported on the use of his pneumatic walking aid in a group of 50 patients, 85 per cent of whom became permanent limb users.

The advantage of a pneumatic walking training aid is that it is an inexpensive piece of equipment that can be kept available for immediate use. While it is being worn it provides protection for the healing stump. The overall contact and the variations of pressure, (40/60 mmHg) during the walking cycle reduces oedema and hastens the shaping and maturation of the stump as venous and lymphatic return is facilitated. General and specific muscle work is being used and, most importantly, the early resumption of a standing posture and the commencement of walking prevent deterioration of postural reflexes, which can happen in spite of intensive physiotherapy if the patient remains bedfast or chairbound. Devas (1971), in a study of 162 patients having surgical amputations, mainly for vascular disease, identified the need for an early walking aid which could be used within a week or two of surgery. While he was able to provide this by using a home-made socket and secondhand parts from discarded prosthetic limbs, it is clearly preferable to have a simple device available in all hospital physiotherapy departments which can be used over and over again for many patients during their rehabilitation. The pneumatic walking aid has obvious advantages over the plaster sockets used in the immediate postoperative fitting techniques when attempting to introduce the concept of early mobilization of the amputee across a wide range of hospitals.

Minimal staff training is required which makes the use of the pneumatic walking aid attractive to rehabilitation departments. The device has met with the approval of many surgeons because the stump and the possible development of complications are not hidden from view as is the case when a plaster socket has been applied. Experience has shown that the walking aid is safe to use during the early postoperative phase of the rehabilitation of the new amputee. The reaction of the patients to this apparatus is favourable and there is little doubt that a number of patients have been able walk independently through its use who would otherwise have had to accept a wheelchair existence. Most find the gentle pressure comfortable and discomfort in the stump is often eased. Objectively, it appears that oedema is reduced, wound healing is not impaired and volume change in the stump limited, permitting a definitive socket to be made at an early stage.

The Roehampton Pneumatic Walking Aid is now commercially available from:

Vessa Ltd
Paper Mill Lane
Alton
Hants GU34 2PY

Price: £45 each ex. works.

*Jobst, Box 653, Toledo, Ohio 43694, USA or Jobst Ireland Ltd, Thurles, Co. Tipperary, Ireland.

REFERENCES

Burgess, E. M., Romano, R. L., Traub, J. E. (1965). Immediate post surgical prosthetic fitting. *Bull. Prosthet. Res.* **10–4,** 42–51.

Devas, M. (1971). Early walking of geriatric amputees, *Br. Med. J.* **1,** 394–396.

Dickstein, Pillar, T., Mannheim, M. (1982). The pneumatic post-amputation mobility aid in geriatric rehabilitation. *Scand. J. Rehabil. Med.* **14,** 149–150.

Kerstein, M. D. (1974). Utilization of a an air splint after below-knee amputation. *Am. J. Phys. Med.* **53,** 119–126.

Little, J. M. (1971). A pneumatic weight bearing temporary prosthesis for below-knee amputees. *Lancet,* **1,** 272–273.

Little, J. M., Gosling, L., Weeks, A. (1972). Experience with a pneumatic lower limb prosthesis. *Med. J. Aus.* **1,** 1300–1301.

Redhead, R. G., Davis, B. C., Robinson, K. P., Vitali, M. (1978). Post-amputation pneumatic walking aid. *Br. J. Surg.* **65,** 611–612.