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Tolerance of early walking with total contact among below-knee amputees—a randomized test

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Abstract

In order to reduce the need for repeated changes of socket due to postoperative atrophy and resorption of oedema simple temporary limbs are required to delay the casting of individual sockets until the stump is more mature. A randomized study of 95 below-knee amputees was performed with a re-usable temporary one-size prosthesis of endoskeletal type with adjustable tube length. Total contact was obtained by moulding a thin plastic pillow containing small plastic pellets around the stump in parallel connected sections. As air was evacuated the pillow became rigid. The pillow was kept in place about the stump by Velcro bands. Physiotherapists were able to make all adjustments and ambulate the patient 1–2 hours a day. The training started 2–4 weeks after amputation and lasted for 1–4 weeks. Healing problems due to training did not occur in well healed stumps where training started 3 weeks or more after amputation. No negative influence on maturing of stump, hospital stay and walking ability three months after amputation was found.

Introduction

Immediate postsurgical limb fitting for amputees was introduced by Berlemont (1961). Weiss (1966) and others in the middle of the sixties but it was soon found that elderly people with ischaemic limbs tolerated this much less than traumatic cases (Cohen et al, 1974) and that a postoperative plaster shell gave better healing than immediate prosthetic walking (Mooney et al, 1971). Early fitting replaced immediate fitting in most centres. Among predominantly elderly vascular amputees, early fitting has had a tendency to be postponed for 1–2 months to allow safe healing of the wounds and simultaneous reduction of the need for repeated changes of socket due to postoperative muscular atrophy and resorption of oedema.

Therefore, simple temporary limbs for first walking training are wanted. The casting for an individual socket can thus be postponed some weeks until the stump is more mature. Different types of limbs have been designed to meet this need. Some have been made with high ischial support to unload the stump during healing (Devas, 1977; Hierton, 1980). Some have utilized airbags (Little, 1971; Kerstein, 1974; Redhead et al, 1978). Others have used an individually cast temporary prosthesis of differing materials (Ruder et al, 1977); Winkler and Fitzlaff, 1980). The ready-made temporary prostheis tested in this study has a total contact socket, which is moulded on the stump (Henriksen et al, 1978), but in spite of this it is a one-size and ready-made type of aid which does not need any participation from the orthopaedic technical department.

This study was made to examine how it was tolerated by patients and how it influenced healing and rehabilitation.

Material and method

The temporary prosthesis with total contact socket used in this study was an endoskeletal type where the tube length was adjustable by 12 cm.* The foot could be rotated inwards and outwards but not translated antero-posteriorly

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or medio-laterally. The foot had a single axis moving ankle and was of one-size to fit both left and right side. The socket reached 10–20 cm above the knee joint line and was made up of four separate sides like the petals of a tulip. The width in all directions could be adjusted. A patellar tendon support was placed on the anterior petal to relieve pressure from the patella (Fig. 1). Total contact was created by using a thin plastic pillow with small plastic pellets and several parallel connected sections. This pillow was wrapped around the stump and the air evacuated making it rigid (Figs. 2 and 3). The stump with the pillow was then introduced into the Tulip socket and kept in place by Velcro bands. During this application some adjustments for creating a correct alignment were possible.

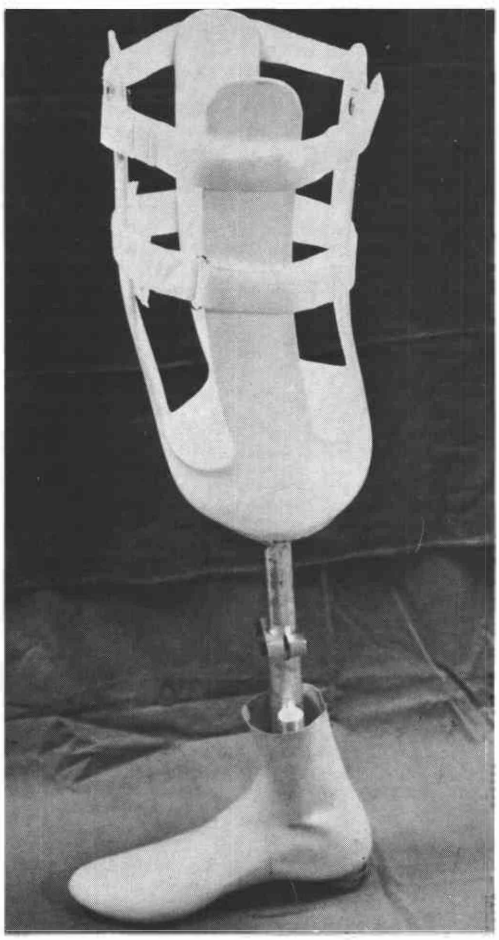

Fig. 1. The ready-made temporary prothesis (Tulip limb), with adjustable length, universal foot, Velcro bands to control width and patellar tendon support.

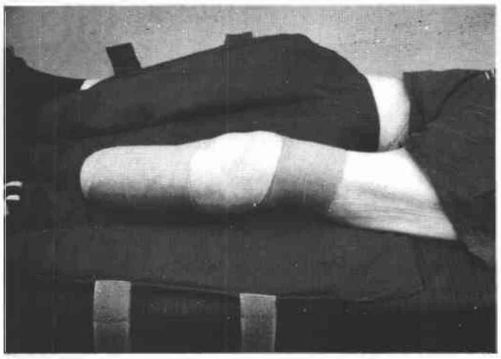

Fig. 2. The vacuum pillow about to be wrapped around the stump, fixed with Velcro bands and made rigid by evacuation of air.

The Tulip limb can also be applied to through-knee (TK) as well as below-knee (BK) stumps. About 15 degrees of movement in the knee of a BK amputee was possible within the upper part of the socket. Normally the patients used this limb for 30–60 minutes in the morning and in the afternoon. Application, instruction, training and observation of the effects were performed by the physiotherapists.

This randomized series included 169 patients amputated for ischaemic disease at below-knee level from 1978 through the first half of 1980. All amputations except one were performed with the sagittal skin incision described by Persson (1974). Of the 169 patients, 79 were allocated the use of the Tulip limb, being chosen randomly by picking all patients whose age was an even number. An ischial weight bearing temporary prosthesis was used only if secondary healing of long duration occurred. All patients were treated similarly with physical exercises

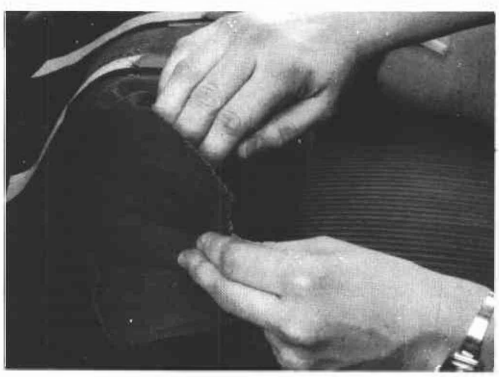

Fig. 3. Total contact at the end of the stump is achieved by folding the flaps before evacuation of air.

Table 1. Exclusion of patients from study.

Cause	Tulip	Non-Tulip
Dead within 3 months	16	17
Re-amputated within 3 months	8	9
Inaccessible	8	9
Not following randomization	0	7

Table 2. Distribution of patients in test

Sex and side	Tulip	Non-Tulip
Male/female	30/17	21/27
Left/right	28/19	25/23
Uni-/bilat-	38/ 9	38/10
Total	47	48

postoperatively. As soon as possible they were jumping in a walking-frame, with the aid of quadrapeds or elbow crutches. The only difference between the groups in relation to rehabilitation was the use of the Tulip limb.

From the 169 patients 74 were excluded for the reasons shown in Table 1. During the last months of the study seven patients in the non-Tulip group erroneously walked with the Tulip limb. These seven patients showed no differences compared to the rest of the non-Tulip group but were excluded. A number of patients were lost from re-examination because they lived at homes or nursing homes far away from the hospital (Table 1). No difference between the groups was found according to distribution of sex, side and number of bilateral cases (Table 2).

Among ischaemic amputees there is a great proportion of elderly patients with other symptoms of cardiovascular disease. A screening of somatic and mental conditions on clinical grounds was therefore done during the first week after amputation and before the plaster of Paris was removed. In one patient the somatic condition was not available. In this way a classification of the rehabilitation potential in the two groups was done (Table 3). The use of Tulip limb is shown in Table 4.

Stump healing was classified as primary or with a minor necrosis (less than 0·5 cm) or a larger necrosis (above 0·5 cm) leading to a secondary healing process. Secondary breakdown of a wound was also noted when occurring.

Using proximal and distal circumferential tape measurements and the length from knee joint to

Table 3. Somatic and mental conditions for prosthetic rehabilitation.

Condition	Tulip	Non-Tulip
Good somatic	25	21
Questionable somatic	16	15
Bad somatic	6	11
Good mental	37	35
Questionable mental	9	7
Bad mental	1	6

Table 4. Primary randomization and final use of Tulip limb.

Use of limb	Tulip	Non-Tulip
Used Tulip limb	35	0
Used other limb	3	9
Used no temp. limb	9	39
Total	47	48

end of stump an arbitrary volume was calculated as a cut cone at 2, 4, 6 and 12 weeks. (Persson and Liedberg, 1983).

Results

Use of the Tulip prosthesis began on average three weeks after surgery (Fig. 4) and the duration of training averaged 2–3 weeks (Fig. 5).

Secondary ulceration on the healed stump occurred in both groups (Table 5). Only one had used the Tulip limb before the secondary ulceration occurred, and the patient began his training only 15 days after the amputation.

Seven patients started Tulip training despite not being healed. In one case the wound diastases increased before the secondary ulceration was healed and in four cases the secondary ulceration healed with careful continuous training with the prosthesis.

Two re-amputations were needed after the use of the Tulip limb. One was a 77 year old diabetic woman wih an infected gangrene midway up the calf. She started her training 19 days after a sagittal amputation despite a minor necrosis ventrally. Training continued for 23 days but after a secondary suture re-amputation was needed. The other was a 49 year old woman with arteriosclerosis obliterans amputated by the Burgess technique after an aortofemoral graft, a femoro-popliteal bypass and repeated tombectomies. There was a necrosis ventrally in the suture line but the patient started her training

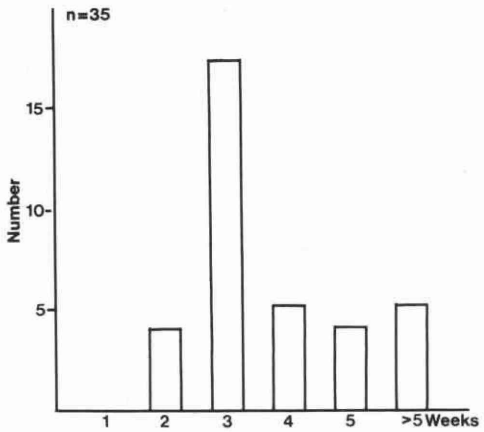

Fig. 4. Time in weeks from amputation to start of training with Tulip limb.

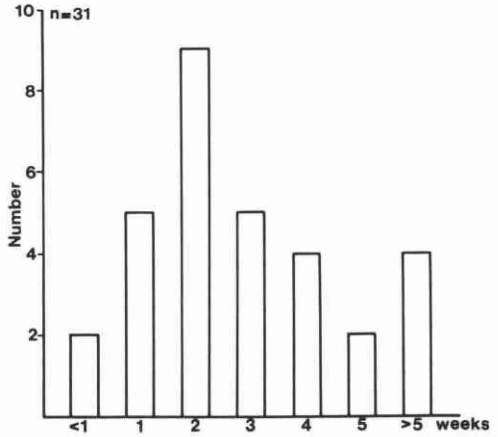

Fig. 5. Duration in weeks of training with Tulip limb.

20 days after amputation for 8 days but the enlarging necrosis led to re-amputation a month later.

The maturity of the stumps was observed by clinical judgement of resorption of oedema and muscular atrophy. The number of days between amputation and plaster casting for making a definitive socket was recorded (Table 6). About three or four patients in both groups were cast for making a socket for definitive limb 1–6 months after amputation and without statistical difference between the groups. Normally the definitive prosthesis was made two months after amputation.

Table 5. Wound healing and secondary ulceration.

Healing	Tulip	Non-Tulip
Primary healed (6 w)	25	21
Secondarily healed	10	12
Healed with secondary ulceration	12	15
Total	47	48

Table 6. Time in days from amputation to casting for making socket for definitive prosthesis.

Number and time	Tulip	Non-Tulip
Number of patients	47	48
Number cast	36	35
Mean time	64	63
Median time	45	54
Range	31–181	25–206
SD	41	35

Walking ability three months after amputation was studied by the number of supports (Table 7). Only 10 patients had no or one support and there was no difference between the groups.

To what extent the maturing of stumps was stimulated or disturbed by the use of the Tulip limb was studied by measuring the shrinking rate by proximal and distal circumference of stump and length between joint line and end. Using these measurements a cut cone was calculated as an arbitary volume of stump. There was a decrease in volume of about 7% from first measurement at two weeks to third measurement at twelve weeks, but there was no difference between the groups.

The mean stay in hospital after amputation was 46 days in both the Tulip and non-Tulip groups with median values of 39 and 36 days respectively, and standard deviation of 28 and 41 days.

Discussion

The technique of moulding a vacuum pillow socket directly on the stump as in this study is

Table 7. Walking status 12 weeks after amputation. Number of patients using canes, tripods and wheelchair.

Walking aid	Tulip	Non-Tulip
No support	2	1
One support	4	3
Two supports	23	22
Wheelchair	18	22
Total	47	48

unique. It is less bulky than the air-bags (Little, 1971; Kerstein, 1974; Redhead et al, 1978) and easier to adjust to the patient than those with ischial support (Devas, 1977; Hierton, 1980).

This clinical test has been going on since 1977 to evaluate the effects on rehabilitation of this temporary limb. Normally it is said that a stump that has healed will remain healed but in this series 27 patients of 95 were found to get secondary breakdown of the wound after being healed (Table 5). Of these 27 only one had started to use the Tulip limb prior to the secondary breakdown and this patient started to use it 15 days after amputation. The secondary breakdown did not occur until the fifth week after amputation and the small breakdown healed despite continuous use of the Tulip limb. Two of the re-amputated patients had used the Tulip limb despite not being healed, starting 19 and 20 days after amputation and they developed accelerating stump problems necessitating re-amputation.

We have observed a small number of patients with reddening and stretching of the suture line when starting training in the second and third week, as also with the two re-amputated cases, and because of this the training was postponed till 21 days after amputation and after the stitches had been removed. Healing problems due to training did not occur in well healed stumps where training started 3 weeks or more after amputation.

The number of walking supports at three months after amputation was the same in the Tulip as in the control group.

The Tulip limb was considered to be an advantage in cases with debatable walking possibilities due to their debilitated general condition. In such cases the physiotherapist could use the Tulip limb for testing walking ability and training the patient for a few days before a decision was made whether to prescribe a permanent limb or not. A more thorough analysis of the problem was unfortunately not included in this study. Especially now, when many patients are over 80 (Liedberg and Persson, 1983), about a third will never be active walkers. Almost half of all the patients in this study had a wheelchair for help at three months.

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