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A standardised trans-tibial amputation method following chronic occlusive arterial disease

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Abstract

The histo- and biochemical parameters of leg muscles from patients with chronic occlusive arterial disease were examined. The outcome of these tests indicated that it is not possible visually to determine the amputation level accurately at the time of surgery. These test results therefore encouraged the authors to develop a standardised surgical procedure for trans-tibial amputations. With this standardised technique specific musculature is resected to assure that no pathological tissues remain. This surgical prophylaxis is meant to prevent the development of gas gangrene and thus to obtain primary healing. Eighty-six trans-tibial amputations were performed and in 93% of these the knee joint was preserved.

Problems and goals

Visual muscle assessment at the time of amputation surgery and the actual histopathological and biochemical test results of the same tissues are seldom identical (Brückner, 1983; Geissler and Brückner, 1985; Brückner *et al.*, 1986). A high failure rate occurs when the decision to resect impaired muscle tissues is based only on the surgeons' visual judgement during surgery. The author therefore considered removing all musculature not required to cover the stump end. This practice, combined with clinical observations and surgical experience over a 16 year period, encouraged them to standardise the trans-tibial amputation technique as practised by Burgess *et al.* (1971) thus avoiding subjective errors which could result from merely visual muscle assessment during surgery. This surgical standardisation provides to surgeons a more effective and reliable trans-tibial amputation method which is indicated for patients who have chronic occlusive arterial disease.

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Surgical technique

The procedure to create anterior and posterior flaps is identical to the Burgess *et al.* (1971) original technique. The level of the anterior skin incision is 1–2 cm below the tibial tuberosity.

After the division of tibia and fibula the major vessels are closed with double ligatures. One should note that the major vessels seldom show heavy bleeding. The n. tibialis and the n. peroneus are traced proximally and cleanly resected. The end of the tibial remnant is bevelled. Then the m. tibialis anterior as well as the remaining fibula are totally removed. The fibular muscle group (m. extensor digitorus longus and m. fibularis longus), the m. flexor hallucis longus, m. tibialis posterior, m. popiteus and the m. soleus are resected as far proximally to the tibial division as possible. Thus only the m. gastrocnemius medialis and lateralis remain. The m. gastrocnemius medialis, which very rarely shows ischaemic pathology, is used to cover the end of the tibia by folding it anterolaterally.

To avoid haematoma and also pad the lateral aspect of the stump, the loose end of the m. gastrocnemius medialis is inserted into the cavity created by the excision of the m. tibialis

anterior and the fibula. If, however, complete coverage with the m. gastrocnemius medialis is not entirely possible, then a part of the m. gastrocnemius lateralis has to be sutured into place at the former origin of the m. tibialis anterior. The latter procedure almost always results, due to the shifting of the muscles, in unnecessary excess muscle tissue of the m. gastrocnemius lateralis. In the interest of good stump formation and to reduce unnecessary muscle bulk, which would require extra circulation, this excess muscle has to be reduced. The musculature is fixed to the tibial periosteum using absorbing sutures. Special care has to be taken to avoid the formation of any cavities.

To avoid haematoma a Rendon drain is inserted for 2–3 days. The skin closure is achieved with 3–4 equally spaced atraumatical stitches and completed with steri-strips to avoid possible wound complications.

The removal of any musculature with a poor blood supply is indicated, especially the m. soleus. At this point one should note, that the m. soleus is not, in most cases, histopathologically and biochemically affected. The muscle may, however, cause problems through its thrombosis-prone venous plexus. The removal, therefore, constitutes an effective prophylaxis against gas gangrene and with it primary closure of the wound is possible.

The surgical wound is covered with sterile gauze pads. Stump and thigh are padded with resilient bandages. An elastic bandage is lightly applied to prevent oedema and to avoid cirulatory restriction. Everything is then covered with a paper bandage. This paper bandage separates the elastic bandage from the then applied posterior plaster splint, which is put into place to prevent a possible knee flexion contracture. For stump control and to avoid pressure areas, dressing changes occur one day postoperatively and daily thereafter up to 4 days, in some cases longer. After that period dressing changes are done as individually required (Brückner, 1986; Brückner, in press). Baumgartner *et al.* (1989) states that the standardised trans-tibial amputation technique primarily produces short stumps, thus reducing stump leverage. The average stump length produced by the author measures 8–9.5 cm. This length permits problem free rehabilitation and permits total contact socket fitting.

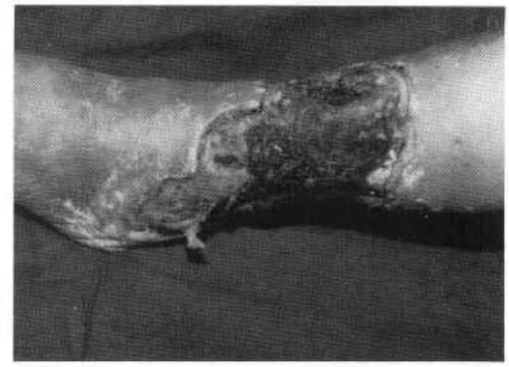

Fig. 1. Patient: R. J.; 63 years Ulceration at the left lower leg. Chronic occlusive arterial disease.

Stump healing

Some 86 trans-tibial amputations were performed with this standardised technique. The knee joint was preserved in 93% of the cases. While previously in 128 trans-tibial amputations, performed according to Burgess *et al.* (1971) (from April 1975 to April 1982), the knee joint was preserved in only 83% of the cases (Brückner, 1988).

Rehabilitation

The results of this procedure in relation to rehabilitation outcome have been assessed by questionnaire in 38 patients 2 to 10 years after they experienced standardised trans-tibial amputation. These are shown in Tables 1 and 2.

Discussion

Sanderson *et al.* (1975) and the author observed that the macroscopic assessment of the viability of muscle tissue during surgery is very difficult. This takes on a special meaning as amputation surgery in certain geographic

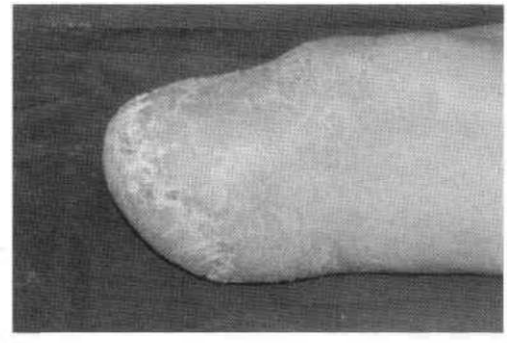

Fig. 2. The same patient, 4 weeks after the operation. The length of the stump is 90 mm.

Tale 1. Prosthetic rehabilitation.

Prosthetic consideration	Patients
Supply of modified KBM prosthesis	94.7%
Early use of prosthesis following amputation	66.0%
Use of the prosthesis	
– daily, with short breaks	41.0%
– daily, but only for some hours	27.8%
– more than once every week	13.9%
Independent donning and doffing of the prosthesis	
– without assistance	71.1%
– with assistance	28.9%
Walking with prosthesis and with a maximum of one walking aid	78.9%
Security at slow pace	73.7%
Walking upstairs and downstairs without assistance	71.1%

areas is often performed by junior residents and perhaps even at the end of the operating schedule. Therefore, in an attempt to reduce the possibility of subjective error by visually assessing muscle tissues during surgery and to establish a better necrosis, specifically gas gangrene phrophylaxis by taking histological and biochemical results into account, the author revised and standardised the Burgesss *et al.* (1971) original surgical procedure for trans-tibial amputations. In this manner, all surgeons, including colleagues who do not have a wide experience in the assessment of musculature, can perform these amputations. This standardised method is part of a programme which also includes postoperative care as well as rehabilitation.

When strandardising the surgical procedure, the removal of muscle tissue and the provision of sufficient stump coverage have to be viewed in perspective. The m. tibialis anterior is totally excised, therefore the remaining part of the fibula must also be removed to avoid the formation of a cavity and to avoid creating potential pressure points in the socket of the prosthesis which will in the future be fitted.

The advantage of this intensive muscle reduction is that muscle tissues which cannot be conclusively assessed and could be rather ischaemic, will not remain in the stump. One could also hypothesise, that, whatever blood supply there is will be sufficient nutrient for the reduced muscle bulk in the stump.

The folding of the entire posterior skin-muscle flap over the end of the tibia, and the suturing of the m. gastrocnemius medialis result in the application of a tensile force to the remaining segment of this muscle. This according to Goldspink (1977), counteracts muscle atrophy and loss of tissue, protein, and according to Hansen-Leth (1982), avoids the formation of arterio-venous shunts, which may accompany secondary reduction of circulation.

According to the author's experiences, the meticulous removal of ischaemic tissue (standardised surgical procedure) does not

Table 2. Occupational rehabilitation.

Pre-amputation	Classification	Post-amputation
28.9%	Working people	15.8%
5.3%	disability pensioner	10.5%
65.8%	old-age pensioner	73.7%
100%		100%

increase the risk of gas gangrene infection. In 2 cases of all the trans-tibial amputations (1975–1991) where such complications occurred, the surgical procedure deviated from the standardised procedure. Both cases occurred in 1975 and 1976 when efforts to improve trans-tibial amputations were in the starting phase.

Gas gangrene prophylaxis as demanded in Chirugerie der Infektionen (1981), the removal of all necrotic and suspected necrotic tissue, is strictly adhered to in the prescribed surgical technique. It is believed that the advantage over the original procedure by Burgess *et al.* (1971) is the elimination of the subjective assessment of the musculature during the operation.

Gas gangrene prophylaxis also requires, that preoperatively on the ward, gangrenous regions are covered, so that there will be no contact with these infected areas once the patient is in the operating room.

Of major importance is the lumbar anaesthesia which is almost always used with its vasodilatory effect. It is also helpful that, with this anaesthetic, patients experience no additional respiratory restrictions postoperatively. Since there is always suspicion of an insufficient oxygen supply to the stump, there is at least sufficient oxygen breathing postsurgically.

Another decisive factor which avoids jeopardising the stump's circulation is the technique in which the immediate postoperative stump bandage is applied. This bandage, carefully applied, must supply sufficient tension to minimise stump oedema, while simultaneously avoiding circulatory restriction and provide a stump rest position without causing knee flexion. Special care is required to avoid pressure spots on the already compromised stump circulation. Furthermore, stump positioning shall be neutral, neither too high nor too low.

Usually the prophylactic antibiotic treatments that several authors demand are not administered. Also, wound spray, which results in an airtight coating, must not be used for post-operative dressings.

The first dresssing change is done on day one postsurgically to assess the condition of the wound and to relieve any possible pressure spots. To attempt a first dressing change after several days, as several authors recommended, is considered risky. Dressing changes are always done by the surgeon who performed the amputation. Further dressing changes are done daily for 4 consecutive days. Thereafter dressing changes depend on individual conditions. Indirect wound control (by means of body temperature, smell, evidence of pain)

Table 3. Comparative results of trans-tibial amputation procedures.

Trans-tibial amputation procedure, Burgess:			
1970	Sorensen	82%	
1970	Jones *et al.*	71%	21 amputations
1971	Burgess *et al.*	92% (Diab.mell.)	91 amputations
1971	Burgess *et al.*	88.5% (Art.scl.)	68 amputations
1974	Kolind-Sorensen	63%	
1975	Murdoch	90%	29 amputations
1975	King *et al.*	89%	28 amputations
1977	Termansen	73%	88 amputations
1977	Couch *et al.*	78%	119 amputations
1978	Tabatabai *et al.*	94%	17 amputations
1981	Persson *et al.*	75%	
1981	Vinz *et al.*	80.5%	36 amputations
Standardised trans-tibial amputation procedure, Brückner:			
1986	Brückner *et al.*	95.5%	44 amputations
1989	Putziger *et al.*	83%	29 amputations

without changing the dressing, as recommended by Persson *et al.* (1981) is not accepted. In this context the author concurs with the opinions of Morscher (1978), Tabatabai *et al.* (1978) and Helmig (1978) who state that trans-tibial amputations for chronic occlusive arterial disease belong in the hands of the experienced surgeon.

Every surgically active colleague who has been involved in trans-tibial amputations knows, that the removal of all the musculature except the medial head and small part of the lateral head of the m. gastrocnemius, while still producing a stump that has functional and weight bearing properties, requires experience.

Close liaison with the Department of Internal Medicine is necessary. Special consideration has to be given to prosthetic fitting. Truly optimal results, however, will only be achieved through individual physiotherapy treatments and controlled gait training.

Statistical comparison

With the introduction of this standardised surgical procedure (Brückner, 1986) it was possible to preserve the knee joint in 93% of the 86 cases.

Comparative results of other authors (in chronological order) are shown in Table 3. These results indicate that valuable results can be obtained with this standardised amputation procedure by Brückner.

Conclusion

One can conclude that the decision not to amputate below the knee in patients with chronic occlusive arterial disease (class IV Fontain) is unjustified. It is also possible by strictly adhering to the standardised technique and the described follow-up treatment immediately to close the surgical wound, thus avoiding a broad scar. Amputees who have mature, functional and weight bearing stumps demonstrate, regardless of age, satisfactory rehabilitation results.

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