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A prospective randomized comparison of healing in Gritti-Stokes and through-knee amputations

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Summary

Twenty-two patients with a median age of 79 years had 24 amputations about knee joint level. The patients were randomised to undergo either Gritti-Stokes or through-knee amputations. In two-thirds of limbs transcutaneous oxygen was less than 4.65 KPa (35 mmHg) or there were no audible Doppler signals at the ankle, indicating that a below-knee amputation would have been at risk of failing to heal, and in the remainder an amputation at the knee joint was considered the preferable site for a variety of reasons.

Nine of 12 (75%) Gritti-Stokes amputations underwent uncomplicated primary healing compared with only 2 of 12 (17%) through-knee procedures (P=0.04). Two through-knee amputations required revision to above the knee (17%) while all Gritti-Stokes amputations healed.

Three patients in each group became mobile on a prosthesis, the remainder being bilateral amputees or unable to manage an artificial limb.

Introduction

Major amputation for peripheral vascular disease should aim to provide rapid uncomplicated healing and the optimum functional result for the individual patient. In many cases a below-knee amputation achieves these ends best. However, poor blood supply to the leg, or uselessness of the knee joint (caused, for example, by hemiplegia, flexion contracture, or dementia) may make amputation at a higher level preferable. A mid-thigh amputation provides only a short stump, and wheelchair or bed bound patients may benefit from a longer lever with good muscle control. In addition, elderly patients who can be mobilised on a prosthesis may find an above knee device particularly difficult *(1)*.

Advantages have been claimed both for the Gritti-Stokes *(2–4)* and for the through-knee amputation *(1,5–10)*. The Gritti-Stokes has been in routine use on our unit for a number of years. However, limb fitters seem to favour the through-knee procedure *(5,7,9,10–12)* although this has a poor reputation for healing *(1,10,11,13)*. With a view to resolving this dilemma a prospective randomised comparison was carried out to assess healing after Gritti-Stokes and through-knee amputations.

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Patients and methods

Twenty-two patients requiring 24 lower limb amputations were studied. This was a consecutive series comprising all patients presenting between December 1983 and November 1984 with severe rest pain, ulceration or gangrene in whom an amputation about knee joint level was considered the treatment of choice. Patients were randomised to undergo Gritti-Stokes (11 patients) or through-knee amputation (11 patients): two patients requiring bilateral procedures were randomised once only, to provide a symmetrical result. There were six men and five women in each group (one bilateral procedure in each group) with age ranges of 49 to 98 years (median 82) for Gritti-Stokes, and 57 to 89 years (median 75) for through-knee amputations. Indications for surgery and the major medical problems of each patient are shown in Table I.

Before operation patients were assessed by measurement of ankle Doppler systolic pressures (results given as absolute values rather than pressure indices for these severely ischaemic limbs); and also by measurement of transcutaneous oxygen levels ($tcPO_2$) *(14)* 10 cms below the knee, just lateral to the subcutaneous border of the tibia, using a Draeger transoxode® recorder.

Gritti-Stokes amputations were performed using anterior and posterior flaps *(3)*. The ligamentum patellae was sutured to the tissues behind the femur with monofilament nylon. The first four through-knee amputations were performed using equal medial and lateral flaps *(12)* but the remainder were done with a 'no flap' technique through a circumferential incision, closed in the sagittal plane *(15)*. The patella was left *in situ*.

All amputations were closed in two layers using a continuous chromic catgut suture for the subcutaneous tissues and a monofilament dermal suture for skin closure. A single Redivac® suction drain was inserted and wounds were covered by a bulky protective dressing of gauze, wool, and a crepe bandage applied without ten-

TABLE I *Details of the clinical state and objective measurements on patients prior to amputation. The outcome of amputation is graded as: (1) Uncomplicated primary healing, (2) Delayed or complicated healing. (3) Failure to heal, necessitating revision.*

Patient	*Age*	*Medical problems*	*Indications for amputation*	*Ankle pressure (mmHg)*	*$PtcO_2$ (kPa)*	*Outcome*
(a) Gritti-Stokes amputations						
PB	49	Hemiplegia Contracture of knee Diabetes	Rest pain Gangrene	54	1.3	1
PP	59	Severe cardiac failure Myocardial infarcts Angina	Rest pain Infected foot (right side)	0	2.8	1
PP	59	Contralateral amputation	Rest pain (left side)	0	1.3	1
RR	71	Hemiplegia Incontinent Diabetes	Rest pain Gangrene	—	3.0	2
PF	76	Contralateral amputation Diabetes	Ulcers Infection	50	5.2	1
MM	80	Parkinson's disease Myocardial infarcts	Rest pain	0	6.6	1
GT	82	—	Rest pain Gangrene	0	4.7	1
BB	85	Obese	Rest pain Gangrene	40	4.9	2
HL	85	Cardiac failure	Rest pain	40	7.6	1
PB	88	—	Ulcer Flexion contracture	Failed below-knee amputation		1
HP	91	Cardiac failure Polymyalgia rheumatica	Rest pain Ulcer	84	8.1	1
CF	98	—	Gangrene	50	5.7	2
(b) Through-knee amputations						
IM	57	Myocardial infarction	Non-viable foot (thrombosed popliteal aneurysm)	0	0.4	2
VB	65	Paraplegia	Gangrene (recurrent embolism)	0	8.2	2
LH	78	Diabetes mellitus	Rest pain Ulcer	45	2.5	2
RG	74	Confused Immobile	Extensive ulcers (right side)	Not feasible due to ulcers	4.2	1
RG	74	Confused Immobile	Extensive ulcers (left side)	Not feasible due to ulcers	3.7	2
CG	75	Dementia C.O.A.D. Cardiac failure	Rest pain Gangrene	35	3.5	3
RR	75	Contralateral amputation Toxic and confused	Ulcers Infection Osteomyelitis of tibia	Not feasible due to infection		2
ST	77	Contralateral amputation Diabetes Incontinent	Rest pain Ulcers	Not feasible due to ulcers	8.5	2
MD	79	Contralateral amputation Contracture of knee Diabetes	Ulcers (calf)	70		3
AW	81	Recent graft for ruptured aortic aneurysm	Non viable foot (thrombosed popliteal aneurysm)	0	6.1	1
EM	83	Dementia Cardiac failure	Rest pain Ulcers	—	—	2
FB	89	Alcoholic Obese and immobile Diabetes	Rest pain Gangrene	0	—	2

sion. Antibiotic prophylaxis was used in all cases (ampicillin and flucloxacillin, with the addition of metronidazole in the presence of grossly infected ulcers or gangrene). All operations were performed by one surgeon (WBC).

After operation wound healing was graded as:

1 Uncomplicated primary healing.
2 Complicated or delayed healing—including any evidence of wound infection, ischaemia or dehiscence, but with eventual complete healing.
3 Failure to heal, with revision required at a higher level.

Comparisons of healing between the two groups of amputations were made by the χ^2 test with Yates' correction for small numbers.

The number of patients who became mobile on a prosthesis, and the reasons for the remainder failing to do so, were determined.

Results (Table I)

PRE-OPERATIVE MEASUREMENTS

Ankle systolic pressures Seventeen limbs were assessed. Of these 8 (47%) had no detectable signals, 8 (47%) had pressures of 70 mmHg or less, and 1 (6%) had a pressure of 84 mmHg.

Transcutaneous oxygen measurements (10 cm below the knee) Nineteen limbs were assessed of which 9 (47%) had $PtcO_2$ values less than 4.65 KPa (35 mmHg). Values below this level are often associated with delay or failure to heal below knee amputations *(14,16)*.

HEALING

Nine of 12 (75%) Gritti-Stokes amputations showed uncomplicated primary healing. One of these subsequently discharged a small abscess three weeks postoperatively after the patient had returned home. In the three cases with delayed healing, infection was responsible in one, while the other two each developed a small area of necrosis on the anterior skin flap but healed without any surgical revision. None of this group required revision of the stump to a higher level.

Only two (17%) of the through-knee amputations healed without any complication or delay, although ten of 12 (83%) healed without revision. Of the two which required revision to an above knee level, one was subject to urinary incontinence and trauma in a demented patient, and the other was performed for deep ulceration of the calf muscles. Complications in this group were mostly ischaemic, involving a part of one or both flaps in five cases. The remaining three developed transient infection, manifest by redness and some discharge from the wound. Two of these infections occurred more than one week after operation.

The differences in the number of amputations undergoing uncomplicated primary healing between the Gritti-Stokes amputations (9 of 12) and through-knee amputations (2 of 12) was statistically significant ($P=0.04$, χ^2 with Yates' correction). Inclusion of the late abscess complicating one Gritti-Stokes amputation does not affect the statistical significance of better primary healing in this group.

REHABILITATION

Three patients in each group (25%) achieved mobility on a prosthesis. In the Gritti-Stokes group three of the remainder declined prostheses, two were bilateral amputees, two were hemiplegic and one died. In the through-knee group, three were bilateral amputees, and three were unsuitable as a result of paraplegia, dementia and pre-existing immobility. One of the patients requiring revision to above-knee level was a bilateral amputee and the other suffered from senile dementia.

Each of the three Gritti-Stokes amputees who became mobile only received a 'pylon' with a metal socket, and full ischial tuberosity weight bearing. One was felt to be too frail to manage a definitive prosthesis, one died before receiving a definitive limb, and the third developed disabling contralateral claudication. The three through-knee amputees were all younger and fitter, and all achieved good mobility with definitive prostheses. Two received metal limbs with leather sockets; one partially ischial and partially end bearing, and the other fully end bearing. The third through-knee amputee proved a difficult limb fitting problem because of fixed hip flexion, but achieved reasonable function with an endoskeletal end bearing prosthesis.

Discussion

The Gritti-Stokes amputation has been criticized as a poor alternative to the through-knee *(6,9)*. However, eventual healing rates around 90% and relatively low incidences of delayed healing have been consistently reported for Gritti-Stokes amputations *(2–4)*. It has been suggested that the good healing rate is due to preservation of collateral circulation around the knee, and especially the superior geniculate artery *(2)*.

There were no failures of eventual healing of Gritti-Stokes amputations in this study. Delay occurred in only three of 12 (25%) with a late abscess in one further patient; significantly better than the group of through-knee amputations. Indeed the difference between the two groups in this respect was so marked that we did not feel justified in continuing the study. The incidence of complications in the through-knee group is higher than that reported elsewhere, although the 83% of through-knee amputations which eventually healed is similar to other series *(7,10)*. The use of a long anterior flap has been incriminated as an important reason for ischaemic complications after through-knee amputation *(1,2,11)* and it was for this reason that initially short lateral flaps *(10,12)* and subsequently a circumferential incision with no flaps at all *(9,15)* were adopted in this study. The vertical closure following circumferential incision below the knee comes to lies in the intercondylar notch of the femur and 'dog ears' at the ends of the wound settle well with time.

The through-knee amputation has been claimed to offer the best mechanical advantage of any amputation which ablates the knee joint *(9)*. Its bulbous stump holds a prosthesis well and prevents its rotation *(7)*. These patients more often become proficient at walking than those with a prosthesis following an above-knee procedure *(1)*. For the old and feeble it has been claimed sometimes to offer a better chance of walking on a prosthesis than a below-knee amputation *(10)*. However, for those unlikely to walk again the long lever it provides probably has no extra advantage over the Gritti-Stokes and the considerable problem with healing poses a special disadvantage to the health and morale of these elderly patients.

There are those who contend that circumstances which allow healing of through-knee or Gritti-Stokes amputations will almost always allow a below-knee procedure to heal equally well *(15)*. However, our objective measurements of ankle pressure and more particularly of $tcPO_2$ suggest that below-knee amputations would have been at risk in many of the patients in this series. Sixty-seven per cent of limbs assessed had either no detectable Doppler signals at ankle level *(17,18)*, or a $tcPO_2$ level below the knee less than 4.65 kPa (35 mmHg) *(14,16)* (47% of each). Infection also played a part in producing poor results and both the through-knee amputations which required revision became floridly infected. The late onset of infection in some cases perhaps suggests that contamination at the time of

surgery was less likely as a cause than entry of bacteria at a later date. Certainly urinary soiling played a part in two patients. Surgical technique is important and the performance of the operations by a single surgeon reduced the variables encountered in larger series *(13)*. We did not observe persistent collections or leakage of synovial fluid which are potential problems causing delayed healing following through-knee amputation. Following Gritti-Stokes amputation failure of union of the patella to the femur is sometimes a source of trouble. Mobility of the patella was noted in some patients but did not hamper limb fitting in any of the three who managed prostheses.

Conservation of the knee joint should be the aim in amputation where the chances of healing are high. However, there are some circumstances where this is not an advantage, for example, the patient with a hemiplegia of flexion contracture of the knee, and the demented or feeble who are unlikely to walk. Among these, some patients improve substantially after amputation and can be fitted with a satisfactory prosthesis for limited mobility. Although the through-knee amputation appears to offer some advantage in this minority of patients, we believe that this is outweighed by the significantly better healing of the Gritti-Stokes.

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Bupivicaine squirting

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A technique of squirting bupivicaine into a wound at the end of surgery, has been used at Eastbourne for a few years.

It started when there was a problem with a particular patient. He had previously injured the flexor tendons of one hand and although they had been successfully repaired, they were bound down by scar tissue. The surgeon had freed the tendons on two previous occasions but, because of post-operative pain, the patient was not able to move the fingers as soon as he woke up from the anaesthetic. Conventional intra-muscular papaveretum did not help sufficiently, and, as a result of lack of movement, scar tissue formed and fixed the tendons again.

At the end of the third operation to free the tendons, just before the skin was closed, the surgical field was sprayed with 10 mls of 0.5% bupivicaine solution. On this occasion, the patient awoke pain free and exercised his hand straight away. The ultimate result was good.

Since this episode, I have done this *Squirting* more frequently in order to achieve postoperative analgesia. I have found by experience that the bupivicaine needs to be in contact with the raw area for about ten seconds to be effective. It should be applied just before the wound is closed, when all surgery is finished. Presumably it works on the actual nerve endings, which have been exposed by the surgeon. Sometimes, the wound is such that a pool of anaesthetic solution can be left in it. On other occasions, the solution can be allowed to flow over the area.

I find that it works better in situations where all the affected area can be covered with the local anaesthetic solution. For example, it is not so good after an appendicectomy, presumably because it only affects the skin and subcutaneous tissues and not the peritoneum.

The pain relief lasts for a few hours and tides the patient over the worst of his procedure. If any further analgesia is needed, this may well be by the oral, rather than intramuscular route.

This method is so simple that I would be very surprised if it had not been done before. It is so effective that I do not propose to do a formal study on it. This would mean using it on some patients and not on others. I do not consider it ethical to deprive patients of such a useful technique.