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Medical audit

Factors influencing the early outcome of major lower limb amputation for vascular disease

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A consecutive series of 349 primary lower limb amputations for vascular disease, done during 1992–1998, were reviewed for amputation level, revision, complications and death, seeking associations with the American Society of Anesthesiology (ASA) grade and pre-operative co-morbidities of patients. Attempted revascularisation, and seniority of surgeon supervising the amputation were also examined for their possible influence on outcome. There were 312 patients (163 male) aged 39–92 years (median, 76 years).

The majority of patients were ASA 3 or 4 (76%), and ASA 4 was associated with increased mortality ($P < 0.01$). Limiting heart problems ($P < 0.01$) and 'general frailty' ($P < 0.001$) also carried significantly higher risks of death, but limiting chest problems, dementia, and diabetes mellitus did not.

There was no significant association between attempts at revascularisation at any time before amputation, and amputation level or the need for revision. There were no differences between consultants, registrars, and senior house officers (most senior surgeon) for any outcome measure.

This study documents the medical status of amputees more clearly than usual, and demonstrates the effect of co-morbidity on the substantial mortality of these patients. The results support an aggressive policy of attempted revascularisation, and show that properly trained junior surgeons obtain satisfactory results.

Key words: Amputation – Arterial occlusive disease – Risk factors

Major amputation is attended by frequent early morbidity and mortality, with some reports in the last two decades describing incidences of 20% or more for early mortality (especially after transfemoral amputation)[1–6] and also for surgical revision (specifically for transtibial amputations)[1,5,8–13] in addition to other complications which are seldom well documented. Many series have, of course, reported lower rates than

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these, but postoperative mortality and complications remain a universal problem when dealing with this generally old and infirm group of patients. Surprisingly, the influence of pre-existing co-morbidities on early outcome has seldom been examined in any detail. Many of the studies examining healing rates have simply assessed different methods for prediction of healing at different levels,[14] but there has also been prolonged controversy about the possible influence of failed arterial reconstruction on healing at transtibial (below knee) level.[15–23] Finally, amputation is often undertaken by surgeons in training, but information about any effect of surgeon seniority on early outcome is elusive.[24]

This study reports the early results in a large cohort of major lower limb amputations, with regard to specific common co-morbidities, American Society of Anesthesiologists (ASA) grades, prior attempts at revascularisation (both during the same episode of ischaemia, and in the more distant past), and surgeon seniority.

The issues of prosthetic fitting, eventual mobility, and quality of life are of great importance when considering the long-term outcome of amputation, and we have already reported on aspects of these.[21,26] This study is concerned only with early results.

Patients and Methods

Case notes of all patients who had major lower limb amputations during the seven years 1992–1998 were retrieved from a computerised database: proformas had been completed by hand after each operative procedure and their entry onto the database was an essential part of each patient's discharge document. There were 372 consecutive primary amputations in 334 patients. Case notes could not be found for 22 (7%) patients (one bilateral amputee) and these were excluded from the study. The remaining 312 patients had 349 primary amputations, including five bilateral amputations under the same anaesthetic, and 32 bilateral amputations done at different times during the study period.

There were 178 (57%) men, aged 39–92 years (median, 73 years). and 134 (43%) women, aged 46–96 years (median, 79 years): the overall median age was 76 years.

After initial piloting and amendment, proformas were completed by all the authors, who included doctors, a research nurse, and a prosthetist. Table 1 shows the questions included in the proformas.

Table 1 Questions included in the proformas

1. The main condition precipitating amputation	
2. Co-morbidities	Limiting heart problems Limiting chest problems Dementia General frailty Diabetes (diet/tablets/insulin)
3. ASA grade recorded by the anaesthetist	
4. Previous treatment (this episode/earlier)	Arteriogram Arterial surgery Percutaneous angioplasty Minor amputation
5. Operation	Date Level of amputation Grade of surgeon and assistant
6. Postoperative	Major complications (any recorded in notes) Revision (date/level/operative details) Death within 30 days Length of stay and discharge destination

The postoperative 'major complications' included any documented in the medical records – both local problems with the wound or stump, and remote or 'general' complications. These two groups were analysed separately. General complications leading directly to death were not presented separately from the fatality they caused, although there was some inevitable overlap between patients who had major general complications and patients who died; and also between local wound problems and the need for revision. All these data were collected in an attempt to discover all recorded morbidity in one form or another.

Statistical analyses for differences between groups of patients were done by chi squared testing (with Yates' correction for small numbers) and comparisons were made between specified factors and the whole cohort. It should be noted that co-morbidities (and mortality) were recorded for each operation, and not for each patient, because only five of the bilateral amputations were done at the same procedure, and all the remainder were separated by variable lengths of time – often years. Each operation was, therefore, attended by a potentially different and individual risk of complications and death.

Results

Amputation levels were transtibial in 192 (55%) limbs, transfemoral in 122 (35%), Gritti Stokes in 34 (10%) and hip disarticulation in 1 (0.3%). Revision rates and mortality after each of these is shown in Table 2. The overall revision rate was 12%, and the 30 day mortality was 18%.

The prevalences of pre-operative co-morbidities are shown in Table 3. Anaesthetists had recorded an ASA grade prior to 300 operations – the majority were ASA 3

Table 2 Rates of revision to a higher level, and 30 day mortality after each type of amputation (values in parentheses are percentages)

Level of primary amputation	Revision to a higher level	Mortality
Transtibial	36/192 (19)	28/192 (15)
Transfemoral	4/122 (3)	29/122 (24)
Gritti Stokes	2/34 (6)	8/34 (24)
Hip disarticulation	0/1 (0)	0/1 (0)
Total	42/349 (12)	65/349 (19)

Table 3 Prevalence of major co-morbidities specified on the proforma. Note that some patients had more than one major co-morbidity

Co-morbidity	Number of patients
Limiting heart problems	108 (31)
Limiting chest problems	51 (15)
Dementia	19 (5)
General frailty	127 (36)
Diabetes mellitus	143 (41)

(184, 61%), with 68 (23%) ASA 2, and 45 (15%) ASA 4: and three patients ASA 5 (2%). No patient was graded ASA 1.

Tables 4 and 5 show the relationships of specific co-morbidities and ASA grades with the need for revision, major 'general' complications, and mortality. Most of the general complications recorded were cardiac (23): others were pulmonary (11), cerebrovascular accidents (8), renal failure (5), gastrointestinal problems (5), venous thrombo-embolism (2), and miscellaneous complications (6).

A total of 114 legs had undergone revascularisation procedures – 56 (16%) during a previous episode, 53 (15%) shortly before their major amputation, and 5 (1%) at both times. An additional 96 limbs had arteriography during the episode leading up to amputation, but were found to be unsuitable for reconstruction. There was no significant differences between the proportion of amputations done below the knee among limbs which had had prior attempts at revascularisation (either during the same episode of ischaemia, or in the more distant past) and those which had not. In addition, there was no significant relationship between attempted revascularisation (recent or longer ago) and the need for revision to a higher amputation level (Table 6).

The most senior surgeon present at operation was a consultant in 86 (25%) procedures, a registrar (including senior registrars and specialist registrars) in 230 (66%) and a senior house officer in 24 (7%): no record was available for nine operations. Table 7 shows the revision rates (to a higher level) the recorded incidence of local complications, general complications, and mortality for each grade of surgeon. There were no significant differences in the occurrence of any of these adverse outcomes related to the most senior surgeon present at operation.

Table 4 Percentages of amputations done at different levels, and the need for revision to a higher level, shown for each major co-morbidity and ASA grade

	Trans-tibial %	Trans-femoral %	Gritti Stoke %	Revision to higher level %
Whole series	52	39	9	12
Limiting heart problems	52	39	9	19
Limiting chest problems	47	39	14	28
Dementia	16	53	32	5
General frailty	38	45	17	11
Diabetes mellitus	73	18	9	10
ASA 2	59	37	4	12
ASA 3	57	32	10	13
ASA 4	38	44	16	9
ASA 5	0	100	0	0

Table 5 Relationship of co-morbidities with major complications, and with mortality.

	Major 'general' complications	Mortality
Whole series	55 (16)	65 (19)
Limiting heart problems [108]	28 (26)	32 (30) $P < 0.01$
Limiting chest problems [51]	10 (20)	16 (31)
Dementia [19]	1 (5)	9 (44)
General frailty [127]	27 (21)	43 (40) $P < 0.001$
Diabetes mellitus	22 (15)	27 (19)
ASA 2 [68]	9 (13)	9 (13)
ASA 3 [184]	27 (15)	32 (17)
ASA 4 [45]	13 (29)	16 (36) $P < 0.01$
ASA 5 [3]	2 (67)	2 (67)

Statistical comparisons for mortality were between groups of patients with each co-morbidity or ASA grade, and the whole patient cohort: except where indicated, differences were not significant. Values in parentheses are percentages.

Discussion

Despite the considerable literature on morbidity and mortality after amputation, it is difficult to find data on the effects of different co-morbidities on outcome. Some series simply identify 'high risk' patients,[27] and we included 'general frailty' among our co-morbidities because this is a clinical state which is readily recognisable among elderly patients with gangrenous legs, even in the absence of any specific system failure. A few

Table 6 Prior attempts at revascularisation; amputation level; and the need for revision

	Transtibial amputations	Transfemoral amputations	Gritti Stokes amputations	Revision to higher level
No prior revascularisation (n = 235)	130 (55)	73 (31)	32 (14)	26 (11)
Attempted revascularisation this episode (n = 53)	25 (47)	27 (51)	0 (0)	6 (11)
Revascularisation at a previous time (n = 56)	34 (61)	20 (36)	2 (4)	8 (14)
Revascularisation both this episode and before (n = 5)	3 (60)	2 (40)	0 (0)	2 (40)

The one patient who had a hip disarticulation had undergone attempted revascularisation during that episode. Figures in parentheses are percentages.

Table 7 Grade of the most senior surgeon present at operation, shown alongside the need for subsequent revision to a higher level of amputation, and the occurrence of major postoperative complications. Figures in parentheses are percentages

Grade of most senior surgeon	Number (%) of primary amputations	Revision to a higher level	Local complications	Major general complications
Consultant	86 (25)	5 (6)	8/82 (10)	14/82 (17)
Registrar (including senior and specialist registrars)	230 (66)	32 (14)	28/194 (14)	32/194 (17)
Senior house officer	24 (7)	(13)	7/64 (11)	7 (29)

series have enumerated specific co-morbidities,[4,7,28] but in general they have not examined their individual impact on results. Keagy *et al.*[29] analysed the effect of a number of factors on healing, and found significantly negative influence for cardiac disease and diabetes; age, sex, and history of hypertension had no influence. There is a dearth of data on the effect of co-morbidities on survival, although a large recent study of amputees in Scotland showed a significant relationship between increasing age and mortality.[30]

Our overall mortality of 19% is higher than the 14% in our previously reported cohort of patients immediately preceding the present series:[21] in particular, our mortality for transtibial amputation has increased (from 8% in 1987–1991 to 15% in this series). This is disturbing and we cannot currently provide an explanation apart from advanced age: our mortality for transtibial amputation compares poorly with many other series[1,3,5,6,9,29,31,12] (but note that comparison with reports from the US is difficult, because the age of their patients is often substantially lower[9,29,31,32]). Dementia and a clinical impression of 'general frailty' were associated with significantly increased mortality, as was ASA grade 4. Other factors, including diabetes and limiting chest disease were not found to confer an increased risk of death.

We acknowledge that case note review may not have detected all major complications which occurred in these patients, and lack of confidence in data collection may be a reason why they are absent from many reports on amputation. There were insufficient numbers to detect any statistically significant differences between groups of patients, but a trend to increased complications seemed to exist for patients with cardiac and chest disease, ASA grade 4, and those who were generally frail.

There has been considerable debate about the relationship between attempts at revascularisation and amputation level. A number of series have suggested that failed attempts at revascularisation may prejudice amputation level,[15–17,19] but this observation has been countered by reports which have demonstrated no adverse effect.[18,20,21] More detailed analyses have suggested that secondary procedures and the use of synthetic grafts may be associated with a higher proportion of transfemoral amputations.[22] A recent meta-analysis concluded that failed arterial reconstruction did not increase the ratio of transfemoral to transtibial amputations, but was associated with a greater number of revisions.[23] In the present study, we found similar proportions of transtibial amputations and revisions both in patients who had attempted revascularisation during the same episode as the major amputation, and in the more distant past. This concurs with the weight of evidence supporting aggressive use of revascularisation, although it must be acknowledged that failed attempts at revascularisation may confer disadvantages for some individuals.

Considering the fact that major amputations are often done by trainees, information about any effect of surgeon seniority on results is sparse. White *et al.*[24] documented a 50% incidence of 'stump related complications' when amputation was done by senior house officers or registrars, compared with 25% (significantly less) for senior registrars and consultants. Similar poorer results have also been documented for partial foot amputations done by trainees.[33] We regard supervision as a key factor and, therefore, analysed results for the most senior (supervising) surgeon, but found no relationship between grade of surgeon and outcome (local complications, the need for revision, general complications, or mortality). Our trainees are not left to operate unsupervised until they have performed a number of procedures under supervision and are judged competent. Thereafter, we believe that the opportunity to operate unsupervised is a vital part of the preparation for independent practice, and our results testify to the fact that this policy has no significant disadvantage for patients. During the period of this review, a number of senior house officers became sufficiently experienced to operate without supervision: this is less likely to be the case in the future, with less experienced trainees in that grade.

This study confirms that the majority of vascular amputees are unfit (mostly ASA 3 or 4) as a result of specific, or often non-specific, medical co-morbidity. Attempts to optimise their medical status pre-operatively are therefore vital, but these may be limited by the need to remove an ischaemic limb which is causing the patient's condition to deteriorate. Aggressive attempts at limb salvage do not compromise amputation level, but need to take into account the potential mobility and quality of life of each individual patient. Amputation can be performed by experienced trainees with results similar to those of their consultants.

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