

Delayed Amputation in Lower Limb Trauma: An Analysis of Factors Leading to Delayed Amputation

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Abstract

An in-depth analysis of the course of events leading to 49 delayed amputation of the lower extremity in 47 patients with open lower limb fractures is presented. Seventeen amputations were performed within one month mainly for vascular reasons. Eleven were between one month and one year, due to persistent sepsis and 21 amputations were performed more than a year after the original injury for infected non-union.

Below-knee amputation was done in 32 limbs, above-knee amputation in 13 limbs and Symes' amputation in 4 limbs. The delay in timing of the amputation was analysed with respect to the nature of the injury, the primary treatment and the Mangled Extremity Severity Score (MESS). The MESS score was computed for all injuries and a score of 7 or more predicted an early amputation. We suggest that in all severe lower limb injuries, particularly in Type III C fractures with associated neurological injury, the benefits of an early amputation be considered as an alternative to a limb salvage procedure.

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Key words: Amputation, Delay, Mangled extremity, Trauma

Introduction

The decision whether to amputate or to attempt a limb salvage procedure in a mangled extremity is a difficult one. Numerous protocols have been published in the literature to help surgeons in the decision making.¹⁻⁵ None of these protocols are uniformly applicable, as most are based on small numbers and studied retrospectively. However, the initial management is not only dictated by the severity of the fracture but also on numerous other variables like age, underlying chronic diseases, duration of shock, warm ischaemia time, vascular injuries, neurological status and patient's desire.⁶

Particularly in Grade III C open fractures of the tibia with vascular as well as posterior tibial nerve injury, the prospect for a useful salvaged limb is dismal.⁷ Despite advancements in orthopaedic fracture fixation, vascular reconstruction and plastic reconstructive microsurgery, the chances of an amputation for Grade III C open fracture are still very high.⁷⁻¹⁰

Bondurant et al¹¹ have shown that a primary decision for amputation in a severe injury cuts the cost of medical care by half compared with costs incurred by delayed amputation. Delay in amputation was associated with a dramatic and statistically significant increase in hospital stay, average number of operations, disability and a

mortality rate of 20.7% from sepsis secondary to the lower extremity injury.

We retrospectively reviewed 49 amputations to analyse the factors that were responsible for the delay in performing these amputations.

Materials and Methods

From the computer records of the Southern General Hospital Amputee Clinic of the National Centre for Training in Prosthetics and Orthotics, University of Strathclyde, 114 patients who had 125 amputations for lower limb trauma were identified. Of these, 42 amputations in 38 patients were performed at the time of injury and 83 amputations in 76 patients were delayed. Details were available for 49 amputations in 47 patients to analyse the sequence of events leading to delayed amputation.

There were 38 males (81%) and 9 females (19%). The mean age was 35 years, with a range of 6 to 78 years (Fig. 1). The interval between injury and amputation ranged from 3 days to 12 years, excluding 2 patients who had an amputation at 30 and 40 years after the injury. The mechanism of injury and the type of fractures are shown in Figures 2 and 3. The classification system proposed by Gustilo and Anderson¹² and Gustilo et al¹³

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was used for grading open fractures. There were 35 (72%) Grade III fractures and of these 16 were Grade III C fractures (Table I).

TABLE I: RELATIONSHIP BETWEEN LEVEL OF AMPUTATION AND TIME INTERVAL FROM INJURY

	Above-knee	Below-knee	Symes'	All amputations
Within one month	9	7	1	17
One month to one year	2	9	0	11
More than one year	2	16	3	21
Total	13	32	4	49

Nineteen fractures were treated with plaster fixation following wound debridement. Thirteen fractures were managed with external fixation and a similar number had open reduction and internal fixation (Fig. 4). Of the 16 Grade III C fractures, 7 had vascular repair and fasciotomy at the time of initial management of the fracture following an angiogram assessment. There were 2 supra-popliteal, 4 popliteal and 10 infra-popliteal vascular injuries. It was not clear from the records whether the vascular repair was done prior to bony stabilisation.

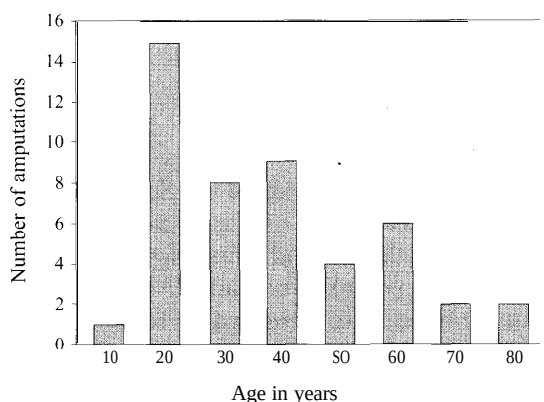


Fig. 1. Age distribution of patients

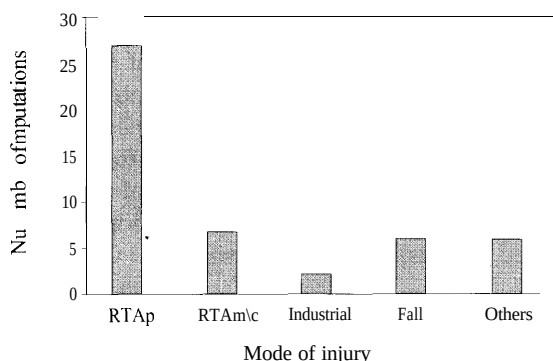


Fig. 2. Mechanism of injury.
RTAp: Road traffic accident Pedestrian
RTAm/c: Road traffic accident Motor cyclist

Seven of the 16 patients had combined vascular and neurological injuries at the time of the original injury.

Results

Of the 49 amputations in 47 patients, 32 amputations (30 patients) were below-knee amputation, 13 (13 patients) were above-knee and 4 were Symes' amputations (4 patients). The reason for delayed amputation is shown in Figure 5. Seventy per cent of the delayed amputations were as a result of either sepsis or vascular compromise. One patient in this group developed squamous cell carcinoma at the sinus tract requiring an amputation 40 years after sustaining the original injury.

The timing of delayed amputations was analysed with respect to the level of amputation and the results are shown in Table I. Seventeen (35%) of the amputations were performed within one month, mainly for vascular compromise. Of the 16 patients with Grade III C fractures, only 7 had vascular reconstruction and the remaining 9 patients were thought to have adequate collateral blood supply to maintain limb viability (Table II).

Eleven (22%) of the amputations were performed after one month but before one year. The remaining 21 (43%) amputations were performed after one year following the injury. In this group, 13 amputations were per-

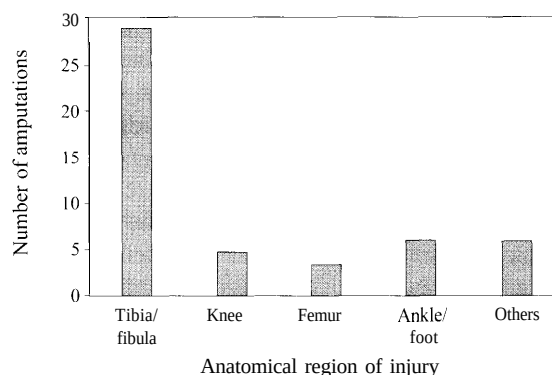


Fig. 3. Types of fracture/dislocation.

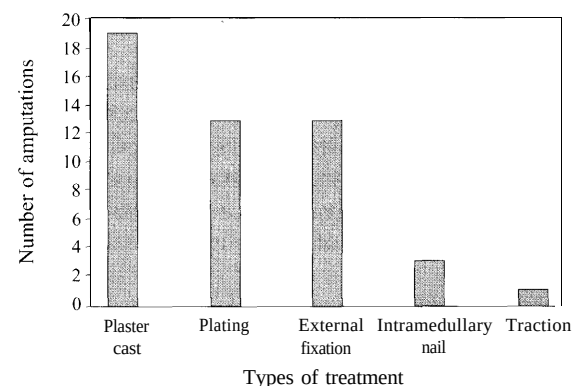


Fig. 4. Method of initial treatment

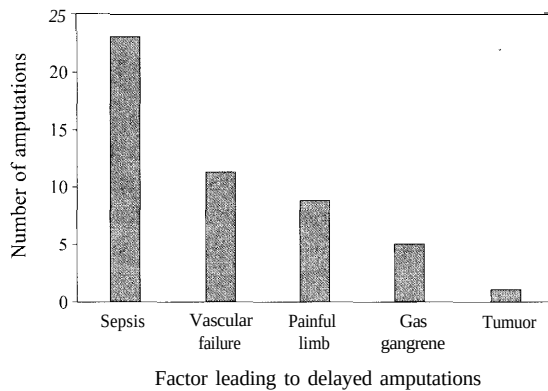


Fig. 5. Reasons for delayed amputation

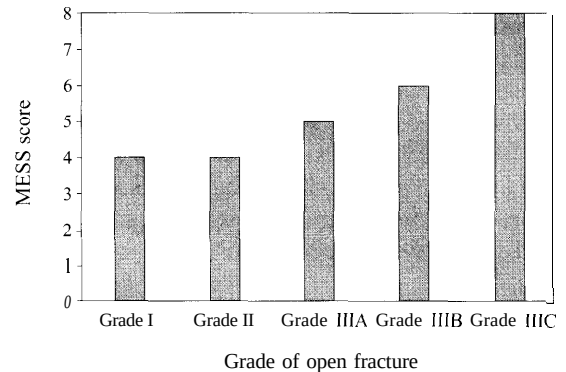


Fig. 6. Mangled Extremity Severity Score (MESS) versus grade of fracture.

TABLE II: RELATIONSHIP BETWEEN GRADES OF FRACTURE AND TIME INTERVAL BEFORE DELAYED AMPUTATION

	Grade I	Grade II	Grade IIIA	Grade IIIB	Grade IIIC
Within one month	0	0	0	5	12
One month to one year	0	4	2	2	3
More than one year	8	2	4	6	1
Total	8 (16%)	6 (12%)	6 (12%)	13 (27%)	16 (33%)

formed for uncontrollable sepsis and or associated non-union, and 7 were as a result of a painful and non-functional limb.

The reason for delayed amputation was computed against the time interval from injury and the results are shown in Table III. Six patients had an amputation within one month of injury due to overwhelming sepsis and of these 5 developed gas gangrene. The other 11 patients developed vascular compromise which required an amputation.

The Mangled Extremity Severity Score (MESS)³ was computed for all the fractures and the result was correlated with the grade of open fracture. The MESS score was 4 in Grade I fractures, 4 in Grade II fractures, 5 in Grade III A fractures, 6 in Grade III B fractures and 8 in Grade III C fractures (Fig. 6). A MESS of 7 or more predicted an early amputation ($P = 0.005$, chi-square test). The amputations performed within one month of

the injury had a mean MESS score of 7.5 compared with a score of 4.3 for those performed after one year.

Grade III C fractures had a mean delay of 2.7 months before the amputations was performed. In contrast Grade I fractures had a mean delay of 182 months before undergoing an amputation.

Ten patients had an average of less than 5 operations, 14 patients underwent between 5 and 15 operations and 23 patients had more than 15 operations, mainly in Grade III fracture group.

Discussion

In patients who had an amputation within one month of injury, vascular compromise and overwhelming sepsis accounted for the failure of limb salvage. There were 5 amputations as a result of gas gangrene and these did not respond to serial debridement and antibiotic therapy. Amputation in this group of patients could not have been avoided.

Of the 16 patients with Grade III C fractures, attempt at revascularization in 7 of the patients was successful only in 2 supra-popliteal and 2 popliteal reconstructions. The 9 patients who did not have any vascular reconstructions were thought to have adequate collateral blood supply to maintain limb viability. Eventually 12 of the patients (75%) with vascular injury had an amputation within one month of the injury. Our results are similar to those reported in the literature.^{4,7,9,13}

In retrospect, all the patients with vascular compromises should have had an angiogram to delineate the pathology and appropriate revascularization done at the time of initial surgery.¹⁴

The author agrees with Pozo et al⁴ that an early combined assessment by an orthopaedic surgeon and a plastic surgeon is very crucial in determining the ultimate prognosis for limb salvage. Seven patients (15%) with associated vascular and significant neurological injury should have had a primary amputation instead of limb salvage.^{7,9}

TABLE III: RELATIONSHIP BETWEEN REASON FOR DELAYED AMPUTATION AND TIME INTERVAL FROM INJURY

	Sepsis	Vascular failure	Painful useless limb	Gas gangrene	Tumour
Within one month	1	11	0	5	0
One month to one year	9	0	2	0	0
More than one year	13	0	7	0	1
Total	23	11	9	5	1

In Grade III C fractures the mean MESS score was 7.5 and this predicted an early amputation. The MESS score is simple to use and is thought to have a 100% positive predictive value if the score is more than seven.³ In Grade III A and B fractures the MESS score did not predict an early amputation. The MESS score, applied retrospectively, was found to be useful means of predicting limb salvage or amputation.

Eleven patients had an amputation between one month and one year after the injury (Table III). Four patients who had vascular reconstruction required an amputation between six weeks and three months. The reason for failure was due to progressive ischaemic muscle necrosis and consequent infection combined with failure to achieve adequate wound cover. Two amputations were performed as a result of a painful useless limb and 5 were due to chronic sepsis and associated non-union. These 5 patients had their injuries treated in a plaster cast following wound debridement. This is probably not recommended as stability is important not only for the fracture healing but also to control sepsis.

Amputation, a year or more after the original injury, was performed in 21 patients. In 14 Grade I and II fractures the amputation was performed as a result of chronic osteomyelitis. Majority of these patients had primary open reduction and internal fixation. Clearly, internal fixation is not recommended in these patients.¹⁵

Eleven of Grade III fractures had an amputation performed more than a year after the injury. These were mainly due to chronic osteomyelitis combined with non-union and a painful useless limb. The reported incidence of wound infection in Grade III fractures varies from 10% to 50%.^{12,16-19} In this group, the delay in providing wound cover could have been a major factor, as 69% of the wounds were closed after 14 days or later.²⁰

Nine patients complained of severe pain associated with a cosmetically unacceptable limb. Majority of these patients ultimately requested for an amputation having realised the benefits of a prosthesis compared to a painful useless limb.

The incidence of delayed amputations in severe lower limb trauma was 66% in this study. Our retrospective analysis suggests that delayed amputations are not only seen in Grade III C fractures but also in Grade I and II fractures. Better initial management could have avoided the amputations in Grade I and II fractures.

In severe open fractures, particularly Grade III C fractures, early vascularization should be attempted provided there is no associated neurological injury that will compromise limb function. Angiogram is recommended early to assess vascular status. Plaster casting and open reduction and internal fixation are not the best means of stabilising open fractures. Primary amputation should be considered seriously early in Grade III C

fractures with associated neurological injury that will preclude a useful functioning limb.

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