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STUMP REVISIONS IN LOWER LIMB AMPUTEES – WHY, WHEN AND HOW ?

Surgery

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ABSTRACT

Stump revisions are sometimes unavoidable additional surgical procedures performed on amputation stumps. Factors like indication for primary amputation, persistent infections, poor prosthetic fitting, chronic pain due to neuromas and bony prominences contribute to stump revisions. To some extent, they can be avoided by taking meticulous care during primary amputation. Knowledge about the why, when and how of stump revisions will help the primary surgeon take necessary steps in trying to reduce possible complications which result in these additional surgical procedures for amputees.

KEYWORDS

Amputations, Stump Revision

INTRODUCTION

Amputation of a limb is indicated classically due to the "dead, deadly or dead loss" state of the limb. Overall, salvageability of limbs has improved with improvements in emergency casualty care, better surgical technology and critical care both for trauma as well as non-trauma situations.Rehabilitation with a view to enable optimal functional outcomes is now possible due to advancements in biomaterials and functional designing of prosthetic limbs.

Amputation stumps sometimes need to be revised, either at the first prosthetic fitting or during prosthetic revisions. Awareness of the indications of stump revisions, the temporal profile of such revisions in the life of the amputee and the likely procedures which are performed will help surgeons reduce primary stump complications, as well as intervene appropriately whenever revision is unavoidable.

This study was conducted as a cross sectional observational study at an apex prosthetic rehabilitative centre to analyse the clinical profile of lower limb amputees who underwent stump revisions with a view to answer the questions (a) why does a stump require revision? (b) when does a stump require revision?, and (c) how is the revision performed?

MATERIALAND METHODS

Study setting, inclusion and exclusion criteria: After clearance from institutional ethics committee, the study was conducted in a tertiary care prosthetic rehabilitation centre from November 2015 to October 2017. All lower limb amputees who presented for initial prosthetic fitting or for periodic review were included in the study.

Stump Revision was defined as any surgical procedure done to correct problems with amputation stump causing symptoms and / or interfering with optimal prosthetic rehabilitation after six weeks of initial amputation.

Study design: Observational (Cross sectional) study. Direct patient interview and review of clinical records were used to obtain data including socio-demographic details, indication and level of initial amputation, stump symptoms and complications resulting in revision, chronology and outcome of revision procedures.

Surgical procedures: Revision procedures were grouped as (a) for treating infections (b) for better prosthetic fitting in an otherwise asymptomatic amputee (c) for chronic pain. Results were tabulated and statistical analysis performed to examine the significance of each factor in determining chances of stump revision.

RESULTS

Demographic profile of amputees: 659 lower limb amputees with 710 amputation stumps (51 patients had bilateral amputations) underwent review during the study period. 110/710 stumps (15.4%) had undergone revisions. No bilateral amputee underwent revision of stumps on both sides. Maximum primary amputation were in the age group of 20 – 50 years (76%) when they suffered loss of their limb. (Table 1)

Table 1 : Age at primary amputation

Age group	Numbers	Percentage
1 - 10 years	3	3%
11 – 20 years	7	6%
21 – 30 years	37	34%
31 – 40years	27	25%
41 – 50 years	19	17%
51 – 60 years	10	9%
61 – 70 years	07	6%
Total	110	100%

Indications and levels of initial amputations: Rates of revision surgeries according to indication and levels of primary amputation are summarized in Table 2. 60.7% were the result of emergency amputations while the remaining 39.3% were performed electively for chronic conditions or failure of limb salvage attempts after trauma. Revision rate for emergency primary amputation stumps was 18.1% compared to 11.5% for elective primary amputation (p = 0.0177) Revision rates for initial amputations done for trauma were 14.1 % compared to a significantly higher 22.4% for non traumatic indications (p= 0.0238). Primary amputations at various levels in the foot ("minor" amputations) had a 38% revision rate which was significantly higher than all the other "major" levels. (p = 0.0002)

Table 2 : Initial amputation – Indications and levels

	Total stumps N = 710	Revision stumps N =110	Revision rate	P value
TOTAL	**710**	**110**	**15.5%**	
1. Operative setting				0.0177
a) Emergency	431 (60.7%)	78 (70.9%)	18.1%	
b) Elective	279 (39.3%)	32 (29.1%)	11.5%	
2. Indications				0.0238
a) Traumatic (all trauma)	594 (83.7%)	84 (76.4%)	14.1%	
• Combat related	223 (31.4%)	27		
• Road accidents	227 (32%)	36		
• Rail accidents	115 (16.2%)	20		
• Thermal (Frostbite/ Burns)	29 (4.1%)	1		
b) Non Traumatic	116 (16.3%)	26 (23.6%)	22.4%	
• Diabetes and Vascular disease	103 (14.5%)	22		
• Congenital anomalies	3 (0.42%)	3		
• Malignancies	10 (1.4%)	1		
3. Levels of amputation				0.0002
a) Major	676	97	14.3%	
• Hip disarticulation	7	0		

• Transfemoral	157	17		
• Through Knee	56	7		
• Transtibial	409	67		
• Symes	47	6		
b) Minor (Foot)	34	13	38%	
• Choparts	19	6		
• Transmetatarsal	9	4		
• Ray	6	3		

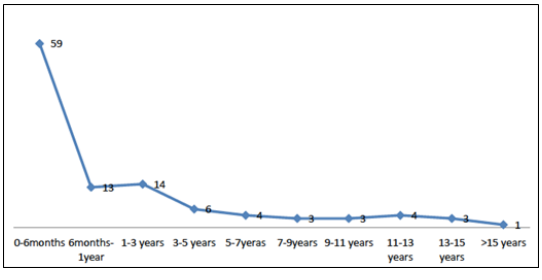
Symptomatic Indications and procedures for revisions are summarized in Table 3. A significantly higher proportion (56.4%, p <0.0001) were revised due to infections. Almost 1/3rd of stumps (30.9%) were revised due to poor prosthetic fitting. The proportion of stumps revised due to chronic pain was significantly lesser at 12.7%, (p <0.0001) Specific surgical procedures performed were reduction of soft tissue bulk with or without revision of bony length at same or higher anatomical level, debridemnt of unhealthy tissue and closure with or without skin grafts, and excision of neuromas and painful bony spurs.

Table 3 : Stump Revision : Indications and Procedures

	No of stumps revised	% of revision stumps	P value
1. Poor prosthetic fitting	34	30.9%	0.639
• Shortening of bony length at same anatomical level - 5			
• Shortening and revision to higher anatomical level - 8			
• Transfemoral - 2			
• Transtibial - 6			
• Reduction of soft tissue bulk - 21			
2. Infections	62	56.4%	<0.0001
• Discharging sinus - 23			
• Sequestrectomy - 8			
• Excision of suture granulomas - 9			
• Debridement and SSG - 6			
• Unstable scar with recurrent bursitis/ cellulitis - 39			
• Excision of unstable scar and secondary closure - 15			
• Shortening of bony length at same anatomical level - 13			
• Shortening and revision to higher anatomical level - 11			
• Transfemoral - 4			
• Through knee - 1			
• Transtibial - 5			
• Syme's - 1			
3. Chronic pain	14	12.7%	<0.0001
• Excision of Neuroma - 5			
• Excision of Bony spur - 9			

Temporal profile of revisions : The number of stump revisions was plotted against time gap between primary amputation and revision was plotted as a graph (Fig 1). Revision of stumps were more common in the initial period of rehabilitation. 86/110 (78.2%) stumps were revised within the first 3 years, 59 of them (53.63%) within the first 6 months of amputation. Thereafter the rate of revision seemed to stabilize at approximately 2% per year. Only one patient in the study had a stump revised after 15 years of initial amputation.

Fig 1 : Temporal profile of revisions following primary amputation



DISCUSSION

The ultimate goal of amputation is the early rehabilitation of the patient on suitable prosthesis [1]. An ideal stump has been classically described bone covered with adequate soft tissues and sensate skin. The surgeon's job, therefore, is to provide a functional and durable reconstruction for prosthetic rehabilitation [2].

Definition of Stump Revision: Stump revisions performed 6 weeks after the primary amputation was included in the study. Thus they were revised after the period during which the two initial phases of wound healing (i.e. inflammatory and proliferative phases) is expected to be achieved. Similar criteria to define revision surgeries have been used by other authors in their studies [2,3].

Patient demographics : The study population ranged from 2-68 years with a mean age 37.01± 13.56 yrs. The youngest patient was a case of congenital transverse deficiency right leg, where revision was done for bony overgrowth, which is documented as the commonest stump problem in children [4]. Adults in 3rd and 4th decade of life accounted for 59% of patients undergoing primary amputations. This is well explained by active life styles, high rate of exposure to occupational hazards in this relatively younger age group especially in developing countries [5,6]. Most studies report a significantly higher proportion of male amputees due to occupational and social reasons [7,8]. Our study had an almost negligible proportion of female amputees (3%) since it was conducted in a center which almost completely catered to male population by nature of its functional mandate.

Overall Rate of revision : Out of the 710 stumps studied, 110 (15.4%) had revision surgery. MacKenzie et al in their study reported stump complication rates in 29.8% of patients requiring readmission, with 14.8% requiring stump revisions [9]

Why stump revisions? – factors at primary amputation affecting rate of revisions

1. Emergency vs elective setting: In our series he rate of revision was significantly higher for primary emergency amputations at 19.5% compared to 12.3% for elective amputations (p= 0.0177) Attempted salvage of length by amputating through the traumatic wound, inadequate flaps and chronic wound infections contribute to higher rate of revision in such patients.

2. Trauma vs non trauma indication : In our series, Road Traffic Accidents (32%), Combat related injuries - Blasts, Gunshot injuries (31.4%) Railway Accidents (16.2%) and Thermal Injuries – frostbite, burns (4.1%) were the modes of trauma. Among road traffic accident related amputations, 15.8% of stumps underwent revision procedure later. This is less than the revision rates reported by Loro et al [10] (38%) due to road accidents in a population in Tanzania, possibly due to better primary care in India.

In our study, only 12.1% of combat victims needed revision procedures in comparison to the overall average of 15.4%, probably reflecting on the better implementation of protocol based care, better availability of specialized centers and prompt evacuation of causalities to these centers. In the study by Barawi et al in Iran, mine blast injuries contributed to 45% of lower limb amputations [11].

In our study 14% of amputations resulted due to rail accidents. The rate of revision procedures in train accident victims in our series was slightly higher (17.4%) than the overall average. We did not find other studies which have specifically commented on such injuries.

Stumps resulting from non traumatic causes underwent a significantly high rate of revision procedures (22.4%, p=0.0238) This finding is similar to other studies. [12] Stumps in ischemic limbs setting often fail to heal primarily necessitating secondary procedures like repeated debridement and skin grafting.

4. Level of initial amputation : Amputations below the knee joint level (Transtibial, Symes, and Foot) comprised 70% of all the stumps compared to 23% of above knee amputations (transfemoral, hip) and 8% through the knee. This is comparable to similar studies. [8] Differences in the rate of revision according to anatomical levels of amputation were not found to be statistically significant except in case of foot amputations.

Although amputations of the foot (Choparts, transmetatarsal, ray) accounted for only 5% of patients, a significant proportion of these

(38%) underwent revision procedures. Several forefoot amputees carry on with normal activities without a formal prosthetic fitting. The foot amputees who were evaluated at our centre were those who required some modification of prosthetic or the stump itself for better function. Hence the revision rates would also be expected to be higher in them. Since the rate of revision in all levels of major amputation (14.3%) corresponds roughly to the overall revision rate of 15.4%, our study suggests that the rate of revision is independent of the level of primary amputation for stumps above the ankle level.

5. Specific symptoms after primary amputation : Stump revisions are usually indicated due to three main symptoms which preclude optimal rehabilitation (a) infections (b) poor prosthetic fitting and (c) chronic pain. In our study, we considered the most prominent symptom for the purpose of defining the symptomatic indication for stump revision. Significantly, more than half of the revisions (62/110 stumps, 56.4%) were due to infections ($p<0.0001$). Almost one third of revisions (34/110, 30.9%) were done to improve prosthetic fitting. Chronic pain by itself was the main cause of revision in a significantly lower number (14/110, 12.7%, $p<0.0001$)

Infections manifesting as persisting sinuses and ulceration are the commonest indication for revision in most series with reported rates as high as 35 - 70 % [13, 14] The wide range of rates of infection as a cause for stump revisions reported by various studies could be because of the differing definitions of stump revision according to the time of initial amputation. We considered cases who have completed 6 weeks of initial surgery to exclude most of the revisions due to primary infection.

30.9% of stump revisions in our study were done for improving the prosthetic fitting. Other studies have reported upto 20% rate of poorly fashioned stumps which required to be revised for optimal prosthetic fitting. [15,16] Constant improvements in technology have resulted in availability of lightweight and more functional prosthetics which have specific fitting requirements.

Revisions for chronic pain are expected to give poorer symptomatic relief compared to the infection group and poor prosthetic fitting group. Careful selection of cases needs to be done to provide optimal symptomatic relief. Phantom pain and other pain syndromes with psychosomatic overlay are rarely relieved by stump revision.

When do stump revision occur?

Majority of stump revisions occured within the first six months of primary amputation(54%), the rate decreasing sharply thereafter to 12 % for the remaining part of the first year and 13 - 14 % per year during the subsequent two years. After the initial three years the rate of stump revision plateaus out to about 4 % every two years during the next ten years. There were minimal revisions thereafter. The high rate of revisions in the first year is due to persistence of stump complications in form of infection and osteomyelitis, or before first prosthetic fitting for refashioning of the stump for fitment of prosthesis. Patients in our centre report for review and refit of prosthesis every 2 years. During these regular reviews any delayed complications like symptomatic neuroma or protruding bony spur is addressed.

How are stumps revised?

Reshaping for better prosthetic fitting: by excision of redundant soft tissues, excision of scar, revision/shortening of bone length was done in 34% of stumps.

Procedures for chronic pain: 5 patients in our series underwent excision of neuroma over a range of follow up period from 6 months to 15 years. Historically, symptomatic neuromata have been reported to occur in up to 30% of major limb amputations. The recent LEAP study findings suggested a relatively lower 2% neuroma rate among their 149 amputees[17] (Fig 2)

Fig 2 : Excision of painful neuroma from transfemoral stump

Excision of long protruding bones was done in 9 cases. Bony spurs and heterotrophic ossifications are known complications of traumatic amputations, the incidence is similar to previous studies. [18,19] Excision of fibula 2cm proximal to tibia, anteriorly sloped edge of tibia with careful rasping of the cut edge of the bone followed by myoplasty would reduce the chances bony complications. [3]

Procedures for infections: In our study 56.4 % of revisions involved debridement, excision of unhealthy scar and split skin grafting to achieve healing. Careful excision of contaminated primary wound, delayed primary or secondary closure of wounds with compromised vascularity would ensure better primary wound healing and decrease revision procedures. [11,16]

Revision to higher level: Conversion of transtibial to transfemoral level was necessitated in 8% of stump revisions, though this deprives the patient of vital knee joint movement and increases the energy expenditure involved in ambulation.

7% of stumps at foot level were revised to transtibial level. Prosthetic rehabilitation requires an ideal range of stump length. Also, prosthetics for transtibial stumps are considered the most energy efficient and comfortable to use. Patients who have high demands may be better with an elective transtibial revision of an initial stump at Syme's or foot level. There was a typical case where a young male patient underwent intramedullary nailing of tibia with a Symes amputation. However, he had poor prosthetic outcome and opted for a transtibial amputation with a more functional prosthesis. (Fig 3)

Fig 3 Revision of Symes amputation stump to transtibial for better functional prosthetic fitting

(A) Symes amputation with poor functional rehabilitation
(B) Radiograph of stump with Interlocking Nail in situ
(C) Ill fitting prosthesis
(D) Interlocking Nail extracted
(E) Stump closure
(F) Functional Below Knee Prosthesis

Stump Revisions – are they useful?

Of our study population of 110 stump revisions in 110 amputees, 87 patients recovered and rehabilitated without complications or sequelae. Fifteen patients complained of continued pain and eight patients had persistent stump infection. In other words, despite stump revision, 3.2% of all amputation stumps which presented during the period of study had persistent symptoms of chronic pain and infections. However, the rate of symptomatic lower limb amputation stumps were brought down from 110/710 (15.4%) to 23/710 (3.2%) by stump revision surgeries.

CONCLUSION

Stump Revision is an added surgical event in the life of an amputee who is already compromised due to his loss of limb. Ambulation is the

important postoperative goal after lower extremity amputation. [20] Successful initial amputation and subsequent early rehabilitation requires meticulous planning and technique even in emergency situations.

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