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## Revision Surgery of Major Limb Amputations, Indications, Surgical Management and Outcome

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**Abstract- Background:** The rate of revision following major limb amputations remains high despite the availability of a variety of methods to select amputation level. The purpose of this study was to outline the common indications, surgical management and outcome of revision surgery of major limb amputations in Khartoum teaching hospital, and to compare our experience with that of other published data. **Methods:** This is a prospective cross sectional hospital based study conducted in Khartoum teaching hospital (KTH) during the period November 2012 to January 2014.

**Results:** A total of 62 patients required revision surgery for their major limb amputation were entered into the study. Their age ranged between 3-90 years with mean age of 47.35 years and standard deviation of 19.06 years. Males outnumbered females by a ratio of 2.8:1. Diabetes found in 34 patients (54.8%), hypertension in 22 (35.5%), and 8 patients (12.9%) had other comorbid diseases including cardiovascular disease and renal impairment.

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# Revision Surgery of Major Limb Amputations, Indications, Surgical Management and Outcome

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**Methods:** This is a prospective cross sectional hospital based study conducted in Khartoum teaching hospital (KTH) during the period November 2012 to January 2014.

**Results:** A total of 62 patients required revision surgery for their major limb amputation were entered into the study. Their age ranged between 3-90 years with mean age of 47.35 years and standard deviation of 19.06 years. Males outnumbered females by a ratio of 2.8:1. Diabetes found in 34 patients (54.8%), hypertension in 22 (35.5%), and 8 patients (12.9%) had other comorbid diseases including cardiovascular disease and renal impairment. The most common cause of initial amputation was diabetes related sepsis (46.8%), followed by trauma (32.3%) and peripheral vascular disease (17.7%). Lower limbs were involved in 75.8% of cases and upper limbs in 24.2% of cases giving a lower limb to upper limb ratio of 3.12:1. Below knee amputation was the most common level performed (54.8%). There was one bilateral lower limb amputation. Most of the revision surgeries performed in the first six weeks after the amputation (87.7%).

The most common indication for revision surgery was wound infection (53.2%). Other more frequent indications include prominent bone (19.4%), stump necrosis (11.3%), and fissuring & ulceration (9.7%). Less frequent indications include painful neuroma (3.2%) and prosthesis unfitting (3.2%). The most common revision procedures performed was wound debridement & secondary suture (25.8%), followed by skin grafting (22.6%), wedge resection (16.1%), muscle flap (9.7%), and excision of neuroma (3.2%). Reamputation was required in 14 patients (22.6%). Staged operations were required in 25 of patients (40.3%). Complete relieve of the complication that required revision was achieved in 51 patients (82.26%) and partial relieve in 11 patients (17.74%). The length of hospital stay ranged between 14 and 35 days with mean of 21.35 days and standard deviation of 4.88 days. The perioperative mortality rate was 12.9%.

**Conclusion:** Revision surgery is necessary if the primary amputation fails to heal, or the residual limb is unsatisfactory for prosthetic fitting. In our study diabetes related sepsis and peripheral vascular disease were the most common cause of initial amputation, and the commonest indication for revision was wound infection. Revision surgery had good outcome in our study. Better education, more research, and additional refinement of surgical technique are needed to avoid unnecessary revision surgery.

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## I. INTRODUCTION

Therapeutic amputation has a history of more than 2500 years. In 500 BC, Hippocrates advocated amputation of infected limbs as a means of preserving lives. Supporting evidence came in the form of a 300BC Roman leg prosthesis made of wood, bronze, and leather, which was unearthed in 1858 (1).

Despite the long history of this surgery, the outlook for patients remains poor namely, a high mortality rate, frequent complications concerning stump healing, and difficulty in rehabilitation (2).

The rate of revision following major amputation remains high despite the availability of a variety of methods to select amputation level. Determination of risk factors for the need of revision surgery among amputees and selection of the effective procedures presents major problem in surgical wards.

Various factors have been associated with high risk of revision such as Diabetes (twice the risk) and atherosclerosis. Indications for such a procedure include: infection of the stump, symptomatic bone spurs, fissuring or ulceration, stump pain and/or phantom limb pain, and improvement of the stump for prosthetic fitting.

Revision surgery include management of infection, removal of bone spurs, wedge resection, muscle flap, excision of neuroma, proximal amputation, skin graft and adjustment of soft tissues for better prosthetic fitting.

Outcome of revision vary according to the indications and the revision procedures. M.R. WOOD et al document that the value of revision surgery when performed for stump and/or phantom limb pain alone, only 35% obtained satisfactory results after one revision; 26% of the patients required four or more surgical procedures without relief of pain. When carried out for local specific pathology, the results of surgical revision were 100% successful, even if the procedure had to be repeated once in 15 % of this group of patients (3). Numerous studies over the past two decades have reported early mortality from a major amputation and for surgical revision as high as 20% or more (4).

## II. METHODOLOGY

### a) Study Design

This is a prospective cross sectional hospital based study done on patients of major limb

amputations who required revision surgeries in Khartoum teaching hospital (KTH) from November 2012 to January 2013.

*b) Study Setting*

The study was conducted in the surgical, orthopedic and plastic surgery wards of Khartoum teaching hospital (KTH) situated in Khartoum city in the center of Sudan. KTH have surgical outpatient department, casualty, short stay ward, emergency septic & aseptic theater, elective theater, long stay admission, HDU and ITU. It is a governmental hospital with a bed capacity of 1000, provides services to patients from neighboring towns in Khartoum state and those referred from peripheral hospitals. Also it is teaching hospital for many faculties of medicine in Khartoum city and other paramedic institutes.

*c) Study Population*

The study population included all patients of all age group and gender who required revision surgeries for major limb amputations who were admitted to Khartoum teaching hospital during the period of the study.

*d) Selection Criteria*

All patients of all age group and gender required revision surgery for major limb amputations who consented for the study were included in the study. Patients who declined consent and those who were previously operated in other hospitals, but required stump revision were excluded from the study.

*e) Recruitment of Patients*

Recruitment of patients was conducted after the indications for revision presented. The decision of the revision surgery, indications and the procedure were determined by the attending surgeon based on clinical evaluation, and investigations.

A variety of revision surgeries were performed by the attending surgeon who also prescribed the postoperative care of the patient. Simple procedures such as wound debridement and secondary suture were done in the department of general or orthopedic surgery, other indications required reconstructive procedures such as skin graft and muscle flaps were done in department of plastic surgery, and those required complex reconstruction such as joint salvage were done by team works. Patients were followed up till discharge and relief of the presenting indication. Patients who developed complications were managed appropriately.

*f) Data Collection and Analysis*

Data were collected using a pre-tested, coded questionnaire. Data were analyzed using statistical package for social science (SPSS) version 19 computer software, and compared with the global literature on revision surgery for major limb amputations to document

our local trends and variations.

*g) Ethical Consideration*

The study was carried out after the approval by the department of surgery and KTH ethical committee. All patients who met the inclusion criteria were consented to participate in the study.

*h) Result*

A total of 62 patients required revision surgery for their major limb amputation were entered into the study. Forty six of them were males (74.2%) with a male: female ratio of 2.8:1.

Their age ranged between 3-90 years with mean age of 47.35 years and standard deviation of 19.06 years.

Diabetes was found in 34 patients (54.8%), hypertension in 22 (35.5%), and 8 patients (12.9%) had other comorbid diseases such as cardiovascular disease and renal impairment. The common cause of initial amputation was diabetes related sepsis in 29 patients (46.8%), followed by trauma 20 patients (32.3%) and peripheral vascular disease 11 patients (17.7%) (Table-1). The cause of amputation in the remaining two patients was electrical burn and post vasoocclusive crisis of sickle cell anemia.

*Table 1 : Causes of the Initial Amputation the Study Population*

	N= 62	
	N	%
Diabetes	34	54.8
Trauma	28	55.2
PVD	22	35.5
Others	8	12.9

Lower limbs were involved in 47 cases (75.8%) and upper limbs in 15 cases (24.2%) giving a lower limb to upper limb ratio of 3.12:1. Below knee amputation was the most common level performed (54.8%). The initial amputation was on the right side in 37 patients (59.7%), on the left side in 24 patients (38.7%) and there was only one case of bilateral lower limb amputation.

Forty four of the initial amputation operations were emergent (71%) and the remaining 18 were elective (29%). The stump of the initial amputation closed primarily in 39 patients (62.9%), and leaved open for further assessment and revision in the remaining 23 patients (37.1%).

The common indication for revision was wound infection in 33 patients (53.2%), prominent bone in 12 patients (19.4%), stump necrosis in 7 patients (11.3%), and fissuring & ulceration in 6 patients (9.7%). Less frequent indications include painful neuroma in two patients (3.2%) and prosthesis unfitting in two patients (3.2%) (Table-2).

**Table 2 :** Indications for Revision Surgery among the Study Population

	N= 62	
	N	%
Infection	33	53.2
Prominent bone	12	19.4
Necrosis	7	11.3
Fissuring and ulceration	6	9.7
Neuroma	2	3.2
Prosthetic un fitting	2	3.2

The majority of revision surgeries performed in the first six weeks after the amputation. The most common revision procedures performed was wound debridement & secondary suture counted for 25.8% of cases (n=16), followed by skin grafting 22.6% (n=14), wedge resection 16.1% (n=10), muscle flap 9.7% (n=6), and excision of neuroma 3.2% (n=2). Reamputation was required in 14 patients (22.6%) (Table-3). Two-stage operation was required in 25 patients (40.3%). Complete relieve from the complication that necessitated the revision surgery was achieved in 51 patients (82.26%) and partial relieve in 11 patients (17.74%). The length of hospital stay ranged between 14 and 35 days with mean of 21.35 days and standard deviation of 4.88 days. The perioperative mortality rate was 12.9% (n=8).

### III. DISCUSSION

In this study we tried to evaluate the common indications for revision surgery of major limb amputation, their surgical management, and the overall outcome.

In our series the common cause of the initial amputation was diabetes related sepsis (46.8%), followed by trauma (32.3%) and peripheral vascular disease (17.7%) (Table-1), this was same with the finding of El Bushra Ahmed Doumi (2006) in his study of major limb amputations in El Obeid hospital as he reported the common cause of amputation was sepsis (40%) followed by trauma (32%) and vascular diseases (16%) (5). While Mohamed IA et al (1997) reported that trauma was the commonest cause (42.4%) followed by sepsis (30%) (6).

The males outnumbered females because males have a more active life style and therefore exposed more to trauma. The lower limb to upper limb ratio of 3.12:1 was same to that reported by El Bushra Ahmed Doumi (6).

Below knee amputation was the most common level performed (54.8%), this was same with the finding of Mohamed Osman et al (7).

The majority of the initial amputations were emergent because they presented with unsalvageable extremities in case of trauma, and uncontrolled sepsis or gas gangrene in case of diabetic patients. The relatively

high percent of amputation stumps that leaved open justified by the fact that most of our patients came late and the wound was not amenable for primary closure because the high risk of wound failure, so it preferred to leave it opened for further assessment and revision.

In our series the most common indication for revision was wound infection (Table-2), this was same with that reported by Mohamed Osman et al (2003). Also they reported a revision rate of 27% and the most frequent revision procedures performed was debridement (7). Wound infection was more prevalent in diabetic patients compared with non-diabetic patients (70.59% vs. 32.14%).

In our series debridement and secondary suturing was the most frequent revision procedures performed (Table-3).

**Table 3 :** Procedures of the Revision Surgery

	N= 62	
	N	%
Debridement	16	25.8
SSG	14	22.6
Re amputation	14	22.6
Wedge resection	10	16.1
Muscle flap	6	9.7
Excision of neuroma	2	3.2

It was indicated for all stumps complicated by infection or necrosis extends more than 1.2 cm from wound edge as described by McCullough NC (8). The Procedure performed under local or regional anesthesia usually once or multiple and followed by secondary suture.

Bone related complications in our study occurred due to retraction of muscle occur over the stump with erosion of bone through the skin in some cases, and in other cases bone exposed within a dehiscd wound. We found wedge resection described by Murdoch (1977) appropriate for this type of complication and sometimes accompanied by reduction of bone. Also wedge resection used in cases presented with stump necrosis or deep wound infection. The stumps healing rate after wedge resection was 90% after 28 days from operation compared to healing rate of 74% by W. Hadden et al (9).

For those cases of short stump with prominent bone the stump was salvaged by local muscle flap, myodesis, and soft tissue shaping.

There was two cases of neuroma underwent successful excision, and the nerve divided at a more proximal level.

M. R. WOOD et al recommended the use of split skin grafting in the early management of the stump following traumatic limb amputation in the adult despite the fact that more revision surgery may often be necessary at a later date to provide skin with normal

sensation, allowing the surgeon the ability to preserve the proximal joint above the amputation (10). We use skin grafting in eleven patients of traumatic limb amputation to preserve the stump length. Full take of the graft was recorded in nine patients on the fifth postoperative day, and the remaining two patients complained of occasional minor ulceration at the junction of the graft with normal skin. Also we used split skin grafting in stump of diabetic amputees as recommended by S.M. Mahmoud et al and the result was satisfactory (11).

Fourteen patients required reamputation to higher level, five of them performed to control the infection, four due to failure of stump healing because of ischemia, two due to prominent bone in short stump that can't be salvaged by muscle flap, two done to reduce the length of the too long stump that not fit well to the prosthesis, and the remaining one due to extensive fissuring and ulceration of the stump that not relieved by skin graft.

Our overall reamputation rate of 22.6% was less than the 38% and 26% reamputation rate reported by Kanade R et al and Dillingham TR et al respectively (1, 12). Diabetic patients had high rate of reamputation compared with non-diabetic patients (26.5% vs. 17.86%).

The 26.5% reamputation rate in diabetic patient was less than 46% reamputation rates in diabetic population reported by Kanade R et al (1).

Combination of more than one procedure needed to salvage the short stump in order to preserve the joint the thing that reduce the energy expenditure in the future when start using the prosthesis. Staged operations were required in 25 patients (40.3%).

M.R. Wood et al reported that when revision surgery was carried out for the treatment of infection, removal of bone spurs, revision of skin grafts or to provide a better stump for prosthetic fitting, the results were successful in 85% of patients after the first revision and 100% successful after a second revision procedure (3). Our overall outcome was reasonable to our facilities as complete relieve from the complication that necessitated the revision surgery was achieved in 82.26% of patients and partial relieve in 17.74% of patients. In bivariate analysis we found male gender was associated with good outcome ( $P=0.023$ ), while diabetes was associated with poor outcome ( $P=0.026$ ).

The perioperative mortality rate was 12.9% ( $n=8$ ). Four of them died because of sepsis, two due to myocardial infarction and the causes of death were not ascertained in two patients who died at home. The mortality rate of 12.9% was less than 33% mortality rate reported by Dillingham TR et al (12).

#### IV. CONCLUSION

Revision is necessary if the primary amputation fails to heal, or the residual limb is unsatisfactory for prosthetic fitting.

In our study diabetes related sepsis and peripheral vascular disease were the most common cause of initial amputation, and the commonest indication for revision surgery was wound infection.

Revision surgery had good outcome in our study. Better education, more research, and additional refinement of surgical technique are needed to avoid unnecessary revision amputations.

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