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A RETROSPECTIVE STUDY TO ASSESS THE RISK FACTORS ASSOCIATED WITH MAJOR LOWER EXTREMITY AMPUTATION IN A TERTIARY CARE HOSPITAL

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ABSTRACT

Background: Major Lower Extremity Amputation (MLEA) is a life-saving surgical procedure, with diabetes mellitus being the leading factor. This study aims to determine the pattern and indications for amputation in our region and analyze clinical and demographical design.

Methods: A retrospective cross-sectional study was conducted at the Victoria Hospital, a Bangalore Medical College and Research Institute component, to analyze patients undergoing major LEA. The study included 132 patients, including 87 patients treated with AKA and 45 patients with BKA. The analysis included demographic information, co-morbidities, amputation level, level of hospitalization, condition at discharge, and history of COVID-19 infection. The study used descriptive statistics, frequency analysis, percentage analysis, mean and standard deviation for categorical variables, and the Chi-square test for qualitative categorical data.

ISSN:0975 -3583,0976-2833 VOL14, ISSUE 10, 2023

Results: A total of 132 patients underwent major lower limb amputation at Victoria Hospital between January and August 2022, with a high prevalence of co-morbid medical conditions such as diabetes, hypertension, smoking, alcohol, and COVID-19 infection. The most common indication for amputation was diabetic foot, followed by peripheral vascular disease. Patients with diabetic foot were significantly more likely to undergo AKA than BKA ($p<0.05$). The most common complication encountered was surgical site infection, seen in 53(40.15%) patients.

Conclusion: Diabetes mellitus and vascular insufficiency are common indications for non-traumatic limb amputation. Despite advanced endovascular therapy, the number of patients requiring amputation has decreased marginally. Health education, early diagnosis, and follow-up are crucial to prevent complications and ensure patients can lead normal or near-normal lives with timely intervention.

Keywords: Lower limb amputation, diabetes, peripheral arterial disease

1. INTRODUCTION

Amputation, derived from the Latin word "amputare" (to excise, to cut out), has been defined as the "removal of part or all of a body part enclosed by skin" [1, 7]. It should be considered when part of a limb is dead, deadly or a dead loss. Amputation is the only choice when saving a limb cannot be done. Lower limb amputation is one of the ancient surgical procedures [2]. The life-saving Major Lower Extremity Amputation (MLEA) surgery has a considerable morbidity and mortality [3]. Limb loss to amputation is a significant problem, especially in developing countries like ours, where most cases are preventable. It burdens the patient and their caregivers, which imposes tremendous financial and psychological obligations upon them.

Lower extremity amputation (LEA) can be major or minor. MLEA is the one which is performed at the level of the ankle or above [4]. Around 100,000 legs are amputated annually in India, and the numbers are increasing. 7% of the patients with peripheral artery disease undergo MLEA. According to estimates, there are 0.62 amputees for every thousand people in India [11]. This corresponds to around a million people in the country who have had their legs amputated.

The most common indications for amputation vary from study to study. Trauma, complications of diabetes mellitus, peripheral vascular diseases, and neoplasm are some of the common recorded presentations [5, 6]. The consequences of diabetes mellitus are commonly acknowledged as the leading factor in major limb amputation, accounting for 25% to 90% of cases [8]. An estimated 463 million persons worldwide have diabetes; with 77 million patients, India has the second-highest number of patients after China [9]. The lifetime risk of a person with diabetes having a foot ulcer has been reported to be as high as 25%, with foot ulcers being the most frequent reason for hospitalized patients with diabetes (about 30%) [10]. In India, there are more people with diabetic feet in rural and urban settings, with 85% of amputations preceded by foot ulcers. Patients with

ISSN:0975 -3583,0976-2833 VOL14, ISSUE 10, 2023

diabetes mellitus have a 15-fold higher rate of lower limb amputation than those without the disease, and Diabetic Foot Ulcers (DFU) account for 50-70% of all lower limb amputations [12]. Diabetes is the most common reason for non-traumatic lower limb amputation, causing a lower leg to be amputated every 20 seconds. The most appropriate amputation to the right patient at the right time is a rarity in the Indian scenario. The time at which the patients report to the hospital where the surgeon, when removing a limb, is primarily concerned with saving a patient's life or getting rid of a diseased part of a limb under adverse conditions that the surgical exercise is carried out in haste. Additionally, the fact that it must be done doesn't change the reality that these procedures always place surgeons in a precarious situation about whether to amputate or preserve the limb.

Understanding the risk factors that contribute to non-traumatic amputation, recognizing risk factors early, and taking preventive actions can all help to lower associated with it, early recognition of factors, and measures taken to the occurrence of the condition. This study aims to determine the pattern and indications for amputation in our environment and analyze the clinical and demographical design.

OBJECTIVES OF THE STUDY: To assess the risk factors associated with MLEA and to find the association of risk factors with MLEA.

2. MATERIALS AND METHODS:

2.1 Study design:

A retrospective cross-sectional study was conducted from January 2022 to August 2022 in the Department of General Surgery in Victoria Hospital attached to Bangalore Medical College and Research Institute, Bangalore.

2.2 Sample size and patient selection

After obtaining the institutional ethical committee, we reviewed our institution's medical record database and identified patients who underwent MLEA between January 2022 and August 2022. Standard demographic information, co-morbidities, level of amputation, length of hospitalization, condition at discharge, and history of COVID-19 infection were documented after retrieving electronic medical records. Patients who had minor amputations were exempt. Procedures that also lacked data regarding demographic profile, co-morbidity status, and peri-operative outcomes were excluded. Our final sample size of 132 included 87 patients treated with AKA and 45 patients treated with BKA (Fig.1).

ISSN:0975 -3583,0976-2833 VOL14, ISSUE 10, 2023

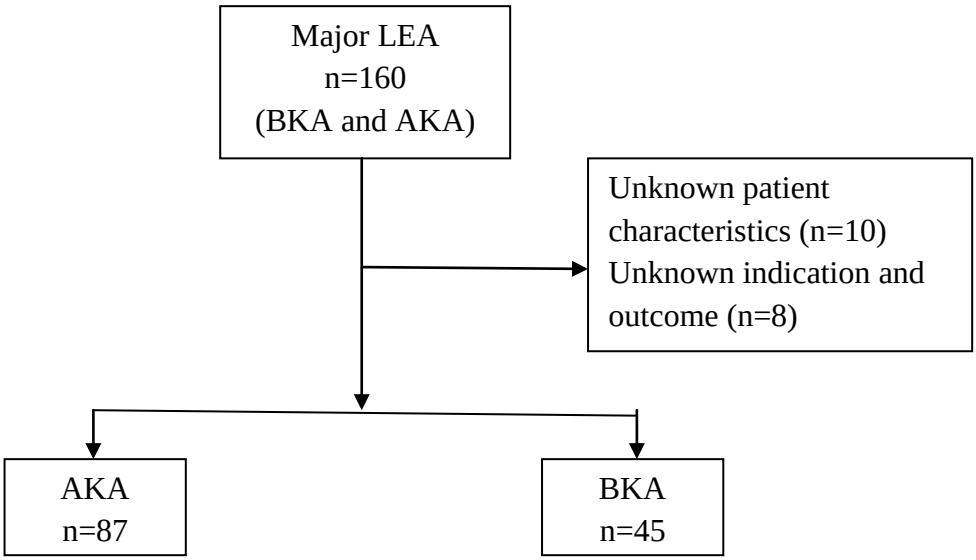


Fig.1. Patient study selection flowchart of patients undergoing lower extremity amputation in the Victoria Hospital January- August 2022.

Inclusion criteria:

- Age >18 years.
- Patients undergoing major LEA for the first time.
- All major non-traumatic LEAs [Below Knee Amputation (BKA) and Above Knee Amputation (AKA)] related to infections, diabetic foot and ischemic disease.

Exclusion criteria:

- Traumatic major LEA.
- Patients undergoing revision amputation.
- Patients undergoing minor amputation of lower extremities.

The AKA group consisted of patients who underwent AKA and BKA and were converted to AKA throughout the trial period. If the patient met one of the following criteria, they were diagnosed identified as having CKD:

- A diagnosis of CKD, according to hospital records.
- Use of dialysis.
- A history of kidney transplantation with renal impairment or relapse.
- Glomerular filtration rate <60ml/min.

The last documented laboratory values were used for the analysis just before the major LEA. The evaluation of total counts as numerical variables, with typical ranges of 4,000 - 11,000 cells/mm3.The time from hospital admission to discharge after the amputation was used to define the length of hospital stay.

ISSN:0975 -3583,0976-2833 VOL14, ISSUE 10, 2023

Setting

Our institute's non-vascular surgeon-led amputation service included consultant general surgeons and post-graduate year 2/3 general surgery trainees and senior residents. All operations were done in a single academic facility, the Victoria Hospital, affiliated with the Bangalore Medical College and Research Institute.

Statistical analysis

The gathered information was imported into Microsoft Excel 2016 and analyzed with IBM SPSS Statistics for Windows, Version 29.0. (Armonk, NY: IBM Corp). For categorical variables, descriptive statistics, frequency analysis, and percentage analysis were used to characterize the data, while the mean and SD were employed for continuous variables. To find the significant difference between the bivariate samples in Independent groups, the Independent sample t-test was used. The Chi-Square test was used similarly to find the significance in qualitative categorical data; if the expected cell frequency is less than 5 in 2x2 tables, then Fischer's Exact was used. The probability value of 0.05 is considered a significant level in all the statistical tools.

RESULTS

A total of 132 patients underwent major LEA at Victoria Hospital between January 2022 and August 2022 (45 BKA, 87 AKA). Approximately four-fifths of these patients were men (78%). (Table 1)The age of the patients ranged from 20 to 92 years, with the average age of the amputee patients being approximately 55 years (54.2 years for AKA; 55.2 years for BKA). There was a high prevalence of co-morbid medical conditions (Table 2). The most common co-morbidity was diabetes, hypertension, smoking, alcohol, and COVID-19 infection.

The most common indication for amputation, as defined by the 9th edition of the International Classification of Diseases, was DFS, followed by lower limb ischemia. The preoperative and postoperative characteristics of these patients are provided in Table 2.

Table 1: Gender distribution

Gender	**Frequency**	**Percentage**
Male	103	78.0%
Female	29	22.0%
Total	132	100%

Table 2: Demographic distribution of major lower limb amputation in Victoria Hospital between January and August 2022

Preoperative and Postoperative variables	**Number Mean+/-SD**	**%**
Sex		
Male	103	78.0%
female	29	22.0%

ISSN:0975 -3583,0976-2833 VOL14, ISSUE 10, 2023

Age (years)	55.08+/-12.40	
Co-morbidities • Diabetes mellitus • Hypertension • Chronic kidney disease • Acute Kidney Injury • Cardiac issue • History of past MI • Stroke	 79 41 7 25 15 11 12	 59.8% 31.1% 5.3% 19.2% 11.4% 8.5% 9.1%
Smoking	82	62.1%
Alcohol	59	44.7%
Tobacco	23	17.4%
COVID-19 infection	43	43.4%
Indication for amputation • Diabetic foot • Acute limb ischemia • Chronic limb ischemia • Necrotizing fasciitis	 65 18 38 11	 49.25% 13.64% 28.78% 8.33%
Level of amputation • BKA • AKA	 45 87	 34.09% 65.91%
Side • Right • Left • Bilateral	 63 65 4	 47.7% 49.2% 3.0%
Death	11	8.3%

SD standard deviation, BKA below knee amputation, AKA above knee amputation

Level of amputation

There was no significant association between the level of amputation and the age and sex of the patients. In addition, there was no significant association between the level of amputation and different co-morbidities, except diabetes mellitus. Patients with diabetic mellitus were significantly more likely to undergo AKA instead of BKA ($P<0.05$). This study indicated that diabetic foot was the most common reason for amputations (Table 3). The most common complication encountered was surgical site infection, which was seen in 53(40.15%), Figure 1.

Patient's hospital stay ranged from 2 to 30 days, with a mean stay of 10.827 days. The outcomes of the patient after amputation are recorded (Fig 2).

ISSN:0975 -3583,0976-2833 VOL14, ISSUE 10, 2023

Figure 1: Distribution of organisms cultures from the SSI.

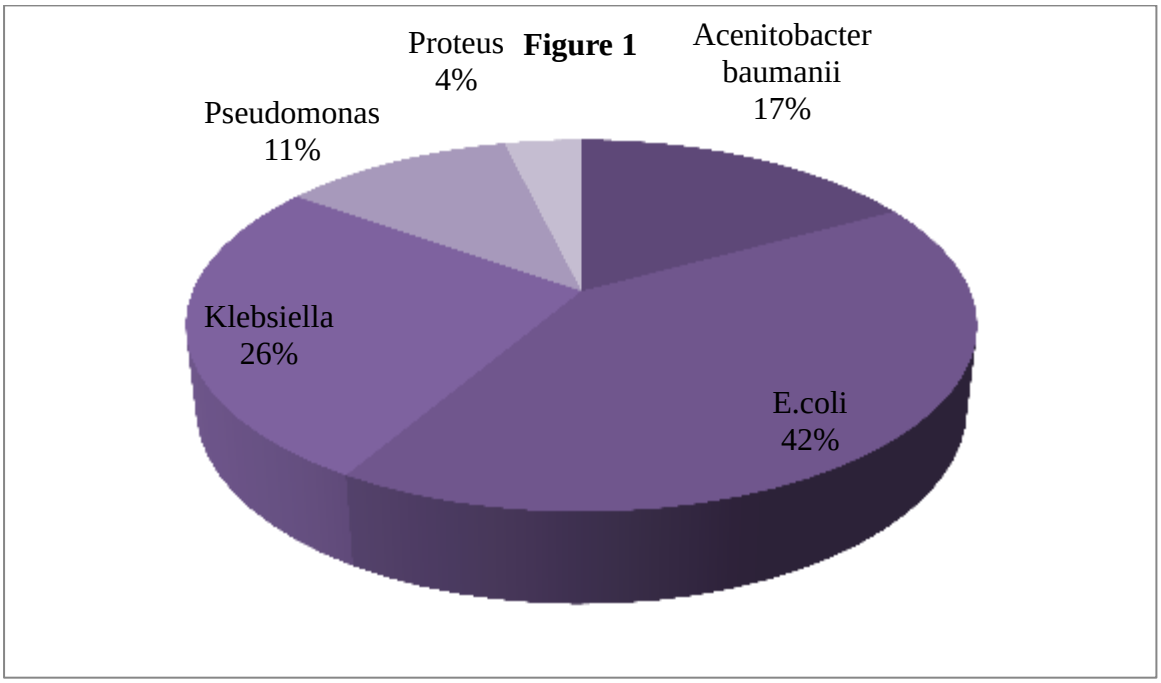


Table 3 Distribution and analysis of preoperative and postoperative factors associated with major lower limb amputation in Victoria Hospital according to the level of amputation.

Preoperative and postoperative variables	**BKA N (% from BKA)**	**AKA N (% from AKA)**	**P-value**
Sex • Male • Female	 34(75.6) 11(24.4)	 69(79.3) 18(20.7)	 NS
Age (mean+/-SD, years)			
Smoking • Yes • No	 26(57.8) 19(42.2)	 56(64.4) 31(35.6)	 NS
Alcohol • Yes • No	 17(37.8) 28(62.2)	 42(48.3) 45(51.7)	 NS
Tobacco chewing • Yes • No	 8(17.8) 37(82.2)	 15(17.2) 72(82.8)	 NS
Co-morbidities • Diabetes mellitus(Fig 3) • Hypertension • Ischemic heart disease • Stroke • Chronic kidney disease	 34(75.6) 16(35.6) 5(11.4) 3(6.7) 3(6.7)	 45(51.7) 25(28.7) 20(23.3) 9(10.3) 4(4.6)	 0.008* NS NS NS NS

ISSN:0975 -3583,0976-2833 VOL14, ISSUE 10, 2023

Indication for amputation • Diabetic foot • Acute limb ischemia • Chronic limb ischemia • Necrotizing fasciitis	 26(57.8) 6(13.3) 10(22.2) 3(6.7)	 39(44.8) 12(13.8) 28(32.2) 8(9.2)	NS
COVID infection • Present • Absent	 11(34.4) 21(65.6)	 32(47.8) 35(52.2)	NS

SD Standard deviation, BKA Below knee amputation, AKA Above knee amputation, NS Not Significant

*Statistically significant difference

Figure 2: Distribution of outcomes of amputation

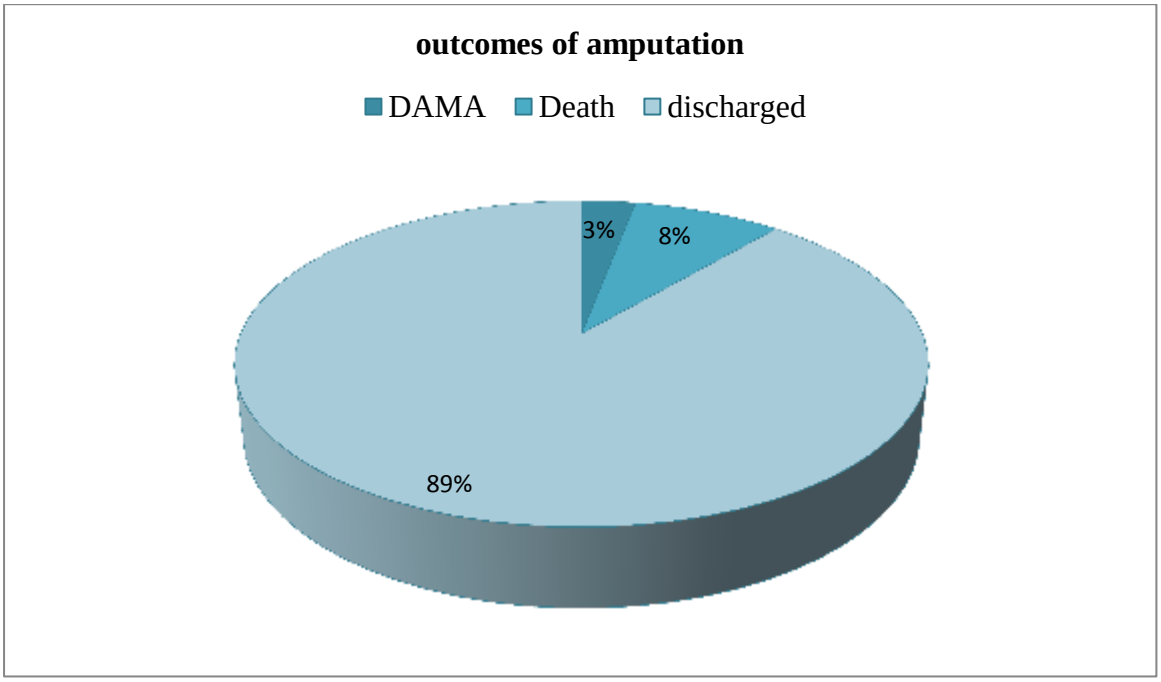
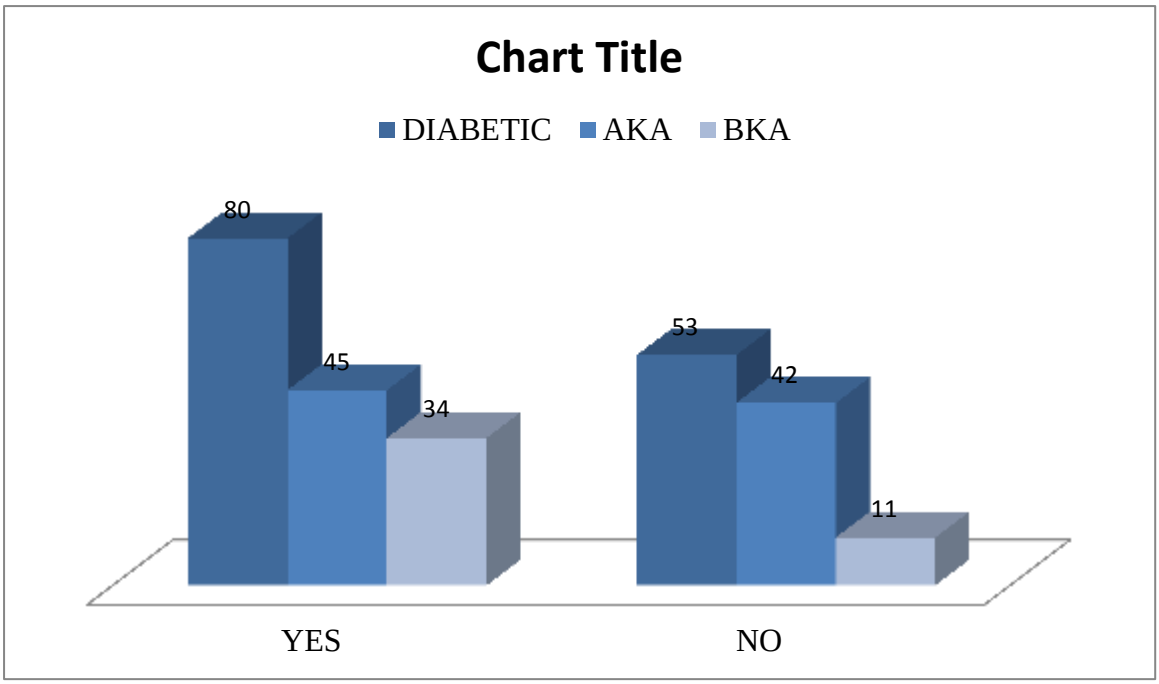


Figure 3: Distribution of co-relation of Diabetes mellitus with patients undergoing AKA and BKA

ISSN:0975 -3583,0976-2833 VOL14, ISSUE 10, 2023



DISCUSSION

In developing countries, the impact of major LEA is increased by poverty, lack of medical insurance, and cost containment policies in deprived nations [13]. Furthermore, there is a wide variation in the reported indications for major LEA. Unlike developed countries, where peripheral arterial disease remains the most common indication for major LEA[14-16], in our study, Diabetic foot syndrome (DFS) was the leading indication for major LEA, and this was consistent with other reports from developing nations [1,17,18]. This is not surprising given that diabetes leads to peripheral arterial disease and is known to precede amputation in 85% of cases [19, 20]. Diabetes is the leading cause of non-traumatic lower limb amputation, claiming a lower limb every 20 seconds [21].

This cross-sectional study was conducted at Victoria Hospital, BMCRI Bangalore, on 132 patients who underwent major LEA. As the indication and patterns of amputation vary between the different hospitals in the country and between different countries, this study was undertaken to analyze the demographic pattern in a large tertiary care centre in Karnataka, South India.

As our institute is a tertiary care hospital, the patients who come to the hospital with foot ulcers or infections usually come at a stage where salvaging the limb is almost impossible, and the procedure to be done on the patient where priority is given to save the life rather than save the limb. Negligence of foot ulcers is generally noted among the patients and their attendees.

Age

The mean age of the population is 55.08 years, which was not similar to the findings in other studies, which showed the mean age to be around 30 to 50 years of age [22]. This difference is probably because, in those studies, trauma was the second most common

ISSN:0975 -3583,0976-2833 VOL14, ISSUE 10, 2023

indication for amputation, and the younger age group are affected more. As the age of onset of diabetes reduces and the age of survival increases, more time exists for complications of diabetes, including LEA, to develop [24]. However, it is comparable to that presented in developing countries' studies [1]. This observation can be explained by the fact that diabetes is known to increase the risk of amputation at a younger age, mainly when it is acquired at a young age, and the vast majority of our patients have diabetes and its related complications [28].

Gender

In our study, a notable male preponderance (78%) was noticed, similar to all the studies undertaken [23]. Ebskov et al. reported male: female ratios from the UK, USA and Scandinavia are 2:1, and this has not altered over the last 20 years. Males are always at risk of trauma, especially in developing countries where the male population work outside and is thus exposed to accidental hazards; moreover, males are more prone to risk factors for PVD like cigarette smoking and tobacco chewing countries of Southeast Asia than females, who mostly take care of households and are indoors

Indication

In our analysis, diabetic foot ulcer complications were the most common indication for major limb amputation, followed by chronic vascular insufficiency, acute limb ischemia and necrotizing fasciitis. Diabetic foot and vascular insufficiency together constitute up to 91.6% of the cases of limb amputation. According to Masood et al., the most common indication in developing countries is complications of diabetic mellitus and trauma [25]. In developed countries, atherosclerosis is the most common indication for lower limb amputation, while in developing countries, diabetic foot and trauma are the leading causes [1].

Some patients presented after they developed sepsis due to neglect and poor personal hygiene. Most of these patients could have saved their limbs if shown early to the hospital. It reflects a lack of health education and awareness among the general population. Easy and early access to healthcare must be provided to identify such patients before they develop advanced disease with timely intervention, which can lead to normal or near-normal life [1].

Level of amputation

Dormandy and Thomas, in 1988, reported that saving the knee joint increases the amputee's rehabilitation potential [26]. Although globally there is a fall in the number of AKA as there are more and more efforts to save knee joint, our study showed that the most common level of amputation done is Above Knee Amputation (65.91%). According to Nwadiaro et al., this could be because most of the patients present late with advanced gangrene or sepsis, where the surgeon is forced to go for a higher level of amputation [27].

Complication

In our study, the complication rate was 21.2 percent. The most prevalent complication was infection at the surgical site. E. coli was the most commonly isolated organism. This differs from other studies where staphylococcus and streptococcus were the most common

ISSN:0975 -3583,0976-2833 VOL14, ISSUE 10, 2023

organisms cultured [17]. This high rate of postoperative complications is probably because of the patient's sepsis prior to amputation.

Mortality

The mortality rate was noted to be 8.3%, which was lower than other studies like that of Essoh et al., which reported a mortality rate of up to 16% [23]. It was, however, comparable to that reported by Massod et al., which was based in Pakistan [25]. The main reasons for mortality in our study are diabetic-related complications, wound sepsis and the delayed presentation of the patients to the hospital.

Covid-19

Out of the entire cases whose COVID-19 status was known in our investigation (n=99), 43.9% (43) had a history of COVID-19 infection and required amputation. We collected COVID-19 infection history from patients, and testing was limited to those who had symptoms later in this study, as COVID-19 testing was not mandatory after May 2022.

The Mean length of hospital stay in our study was 10.827 days, significantly less than the data from other studies, which ranged from 59 to 65 days. The lengthier hospital stay is observed in other research because the patient is usually discharged after the rehabilitation process. Once the patient's condition improves or the incision heals, the patient is discharged with rehabilitation and prosthesis planning done on an outpatient basis in our hospital [17].

CONCLUSION

Complications of diabetes mellitus and vascular insufficiency were the most common indications for limb amputations with AKA: BKA=1.93:1 in our region. The patient presented to the hospital late, and so at the point of presentation where priority was given to saving the life rather than considering the limb, it is not only challenging to salvage the limb, but we are, more often than not, forced to go for a higher level of amputation.

Even in the year of advanced endovascular therapy minimally invasive revascularisation, the number of patients requiring amputation has decreased, although only marginally. The death rate associated with major limb amputation has not dropped considerably.

Health education, early diagnosis and follow-up are needed to prevent the patient with diabetes from developing complications. Early and easy access to healthcare needs to be provided, which can identify such patients before they develop advanced disease and, with timely intervention, can lead a normal or near-normal life.

Limitations of our study

- This study is retrospective
- The duration of the study is small

ISSN:0975 -3583,0976-2833 VOL14, ISSUE 10, 2023

Abbreviations

AKA: Above Knee Amputation; MLEA: Major Lower Extremity Amputation; CKD: Chronic Kidney Disease; DFS: Diabetic Foot Syndrome; DFU: Diabetic Foot Ulcer; MLEA: Major Lower Extremity Amputation; SD: Standard Deviation.

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Author's contributions

All authors have read and approved the final manuscript. RS: study concept and design, critical revision, drafting, final approval, accountability for all aspects of work; SM: critical revision, drafting, final approval, accountability for all aspects of work; PA: critical revision, drafting, final approval, accountability for all aspects of work, AL: data collection, data analysis and interpretation, drafting, final approval, accountability for all aspects of work, PR: data collection, drafting, accountability for all aspects of work.

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Availability of data and analysis

The datasets generated and analyzed during the current study are available from the corresponding author.

Ethics approval

The study is reviewed and approved by the Institutional Ethical Committee Board review of Bangalore Medical College and Research Institute.

Consent to participate

This is not applicable in this study due to the retrospective nature of the study.

Competing interests

The authors declare that they have no competing interests.

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