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Research Article

To Determine the Pattern and Type of Amputation Done In Diabetic Foot Patients in a Teaching Hospital

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Abstract: ***Aim-*** To study the type of amputations being done in patients with diabetic foot complications ***Methods & materials-*** A descriptive retrospective study was done in department of Surgery of Rajarajeswari medical college, Bengaluru, India. The study period was for 1 year. IEC approval was obtained for this study. SPSS 18 was used for statistical analysis.***Results-*** A total of 37 patients were included in this study. Right foot was most commonly involved foot affecting in 54.1% of the patients. The most common lesion was wet gangrene affecting 37.8%. Minor amputations accounted for 83.8% of the cases with toe amputation being the commonest minor amputation. Almost all the foot amputations done belonged to type 1 foot amputation (Simple). 16.2% of patients required major amputation. ***Conclusion –*** Diabetic foot is a leading cause for amputation. Our study showed wet gangrene to be the most common cause for amputation. Toe amputation is the most common type of amputation done in diabetic foot.
Keywords: Diabetic foot, Amputation, Gangrene, Amit Jain, Classification, Ulcer, Mortality.

INTRODUCTION

A well-known complication of diabetes is diabetic foot which today is associated with increased morbidity, mortality and a reduced quality of life especially if patient undergoes an amputation (Netten, J.J.V. *et al.*, 2017). More than 50% of the amputations in lower limbs occur in patients with diabetes (Salahuddin, O. *et al.*, 2013; Alzaharani, H.A. *et al.*, 2012).

In fact, the amputations occur 10-30 times more commonly in diabetes in comparison to non-diabetics (Saleem, S. *et al.*, 2017; Miyajima, S. *et al.*, 2006; Lacle, A., & Jaun, L.F.V. 2012). Diabetes related amputation shows great global variation (Netten, J.J.V. *et al.*, 2017).

In developed countries like Singapore, diabetic foot problems results in 700 amputations annually (Wony, K.L. *et al.*, 2013). In India, it was estimated that more than 40,000 legs were amputated every year (Ngim, N.E. *et al.*, 2012).

This research paper aims to determine the pattern and type of amputation that occurs in patients with diabetic foot problems in a teaching hospital and it also aims to provide essential information on current status of amputation in teaching hospitals.

METHODS & MATERIALS

A descriptive retrospective analysis was done in Department of Surgery of Rajarajeswari medical college, Bengaluru, India. This is a tertiary care teaching hospital. Most of the patients treated here are from rural side. The study period was from Nov 2016 to Oct 2017. The following were the inclusion and exclusion criteria.

Inclusion criteria

- All patients with diabetic foot complications who underwent amputation in department of surgery of our hospital

Exclusion criteria

- Amputation done in other department
- Patients with incomplete records
- Amputation done in diabetics for malignancy or road traffic accidents.
- Patients who got discharged against medical advice

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This study was approved by our institution ethics committee [RRMCH-IEC/167/2016-17].

Data Analysis

(Rosner, B. 2000; Riffenburg, R.H. 2005; Rao, P.S.S.S., & Richard, J. 2006; Suresh, K.P., & Chandrasekhar, S. 2012)**:** Data was analyzed using statistical software SPSS 18.0 and R environment Ver.3.2.2. Microsoft word and excel were used for general graphs and tables. Both descriptive and inferential statistical analysis was carried out in this study. Results on continuous measurements are presented on Mean SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5 % level of significance.

The Following Assumption On Data Is Made:

• Dependent variables should be normally distributed,
• Samples drawn from the population should be random
•Cases of the samples should be independent

Chi-square/ Fisher Exact test has been used to find the significance of study parameters on categorical scale between two or more groups, Non-parametric setting for Qualitative data analysis. Fisher exact test was used when samples were very small.

Significant Figures

+ Suggestive significance (P value: 0.05<P<0.10)
* Moderately significant (P value: 0.01<P 0.05)
** Strongly significant (P value: P≤0.01).

RESULTS

A total of 37 patients were included in this study. There were 32 males [86.5%] and 5 females [13.5%] [Figure 1].

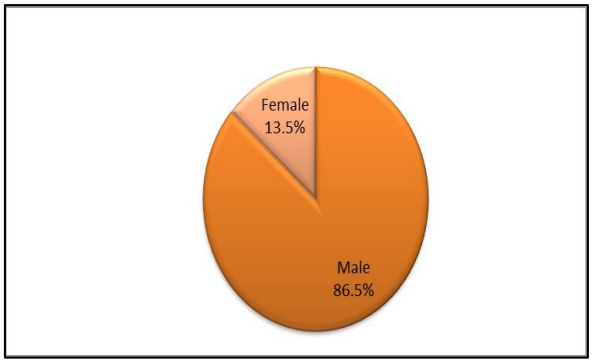

Figure.1 showing gender distribution of patients studied

The mean average age was 56.00 ± 11.12 years [Table 1].

Table.1 showing age distribution of patients studied

Age in years	No. of patients	%
<40	1	2.7
40-50	14	37.8
51-60	8	21.6
61-70	11	29.7
71-80	3	8.1
Total	37	100.0

20 patients [54.1%] had right foot involved whereas 17 patients had [45.9%] had left foot involved [Figure 2].

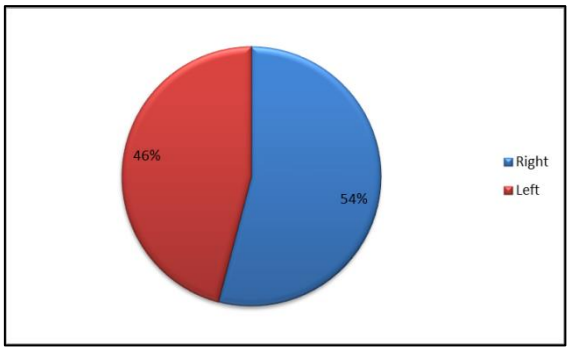

Figure.2 showing distribution of side of foot involved

37.8% of the patients did not have the duration of diabetes mentioned in the records. 43.2% of them had diabetes between 1 to 10 years [Table 2]. 15 patients [40.5%] had associated hypertension.

Table.2 showing Duration of Diabetes mellitus in patients studied

Duration of Diabetes mellitus	Total	%
Not mentioned	14	37.8
Less than 1 yr	4	10.8
1 to 10 yr	16	43.2
11-20	3	8.1
More than 20	0	0
Total	37	100

The most common entered diagnosis was wet gangrene affecting 14 patients [37.8%] and infected ulcers [37.8%]. 16.2% had abscess [Table 3]

Table.3 showing Diagnosis distribution of patients studied

Diagnosis	Total	%
Dry gangrene	2	5.4
Wet gangrene	14	37.8
Necrotizing fasciitis	1	2.7
Abscess	6	16.2
Ulcer	14	37.8
Total	37	100

The commonest surgery done was toe amputation [64.9%] followed by transmetatarsal amputation (16.2%]. 13.5% had below knee amputation [Table 4].

Table.4 showing Surgery distribution of patients studied

Surgery	Total	%
Toe amputation	24	64.9
Transmetatarsal amputation (TMA)	6	16.2
Below knee amputation (BKA)	5	13.5
Above knee amputation (AKA)	1	2.7
Partial toe amputation	1	2.7
Total	37	100

Major amputations were done in 16.2% of the cases [Figure 3]

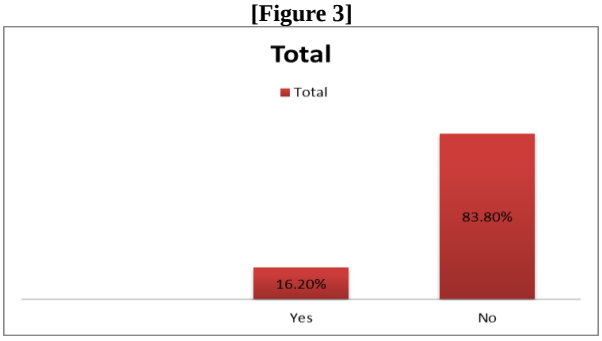

Figure.3 showing distribution of major amputation cases done in diabetic foot 48.6% had past history of surgeries on foot. 10.8% had some form of amputation being done in the past.

There was no correlation of major amputation with duration of diabetes mellitus [Table 5] or gender [Table 6]

Table.5 showing Correlation of major amputation to duration of diabetes mellitus

variables	Duration DM					Total (n=37)	P value
	Not mentioned (n=14)	Less than 1 yr (n=4)	1 to 10 yr (n=16)	11-20 (n=3)	More than 20 (n=3)		
Major Amputation							
• Yes	2(14.3%)	0(0%)	3(18.8%)	1(33.3%)	0(0%)	6(16.2%)	0.678
• No	12(85.7%)	4(100%)	13(81.3%)	2(66.7%)	0(0%)	31(83.8%)	

Chi-Square/Fisher Exact Test

Table.6 showing correlation of major amputation with gender

Major Amputation	Gender		Total
	Male	Female	
Yes	6(18.8%)	0(0%)	6(16.2%)
No	26(81.3%)	5(100%)	31(83.8%)
Total	32(100%)	5(100%)	37(100%)

P=0.567, Not Significant, Fisher Exact Test

There was also no correlation between age, gender, diagnosis, duration of diabetes, diagnosis with type of amputation being done [Table 7] although some association was seen between hypertension and type of amputation (P=0.037, significant).

Table.7 showing correlation of variables with type of amputations

	Surgery					Total (n=37)	P value
	Toe amputation (n=24)	TMT (n=6)	BKA (n=5)	AKA (n=1)	Partial amputation 5 (n=1)		
Age in years							
• ≤50 yrs	11(45.8%)	2(33.3%)	1(20%)	1(100%)	0(0%)	15(40.5%)	0.566
• >50 yrs	13(54.2%)	4(66.7%)	4(80%)	0(0%)	1(100%)	22(59.5%)	
Gender							
• Male	20(83.3%)	5(83.3%)	5(100%)	1(100%)	1(100%)	32(86.5%)	1.000
• Female	4(16.7%)	1(16.7%)	0(0%)	0(0%)	0(0%)	5(13.5%)	
Diagnosis							
• Dry gangrene	2(8.3%)	0(0%)	0(0%)	0(0%)	0(0%)	2(5.4%)	0.534
• Wet gangrene	11(45.8%)	1(16.7%)	2(40%)	0(0%)	0(0%)	14(37.8%)	
• Necrotizing fasciitis	0(0%)	1(16.7%)	0(0%)	0(0%)	0(0%)	1(2.7%)	
• Abscess	3(12.5%)	1(16.7%)	1(20%)	0(0%)	1(100%)	6(16.2%)	
• Ulcer	8(33.3%)	3(50%)	2(40%)	1(100%)	0(0%)	14(37.8%)	
Duration of Diabetes							
• Not mentioned	9(37.5%)	3(50%)	2(40%)	0(0%)	0(0%)	14(37.8%)	0.498
• Less than 1 yr	4(16.7%)	0(0%)	0(0%)	0(0%)	0(0%)	4(10.8%)	
• 1 to 10 yr	10(41.7%)	3(50%)	2(40%)	1(100%)	0(0%)	16(43.2%)	
• 11-20	1(4.2%)	0(0%)	1(20%)	0(0%)	1(100%)	3(8.1%)	
• More than 20	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	
Hypertension							
• Yes	12(50%)	1(16.7%)	0(0%)	1(100%)	1(100%)	15(40.5%)	***0.037****
• No	12(50%)	5(83.3%)	5(100%)	0(0%)	0(0%)	22(59.5%)	

Chi-Square/Fisher Exact Test

There is also no correlation between diagnosis and present amputations with past amputation [Table 8]. There was one mortality in this study.

Table.8 showing correlation of clinical variables with past amputation

variables	Past Amputation		Total (n=37)	P value
	Yes (n=4)	No (n=33)		
Surgery				
• Toe amputation	2(50%)	22(66.7%)	24(64.9%)	0.314
• TMA	0(0%)	6(18.2%)	6(16.2%)	
• BKA	2(50%)	3(9.1%)	5(13.5%)	
• AKA	0(0%)	1(3%)	1(2.7%)	
• Partial amputation	0(0%)	1(3%)	1(2.7%)	
Diagnosis				
• Dry gangrene	0(0%)	2(6.1%)	2(5.4%)	0.875
• Wet gangrene	2(50%)	12(36.4%)	14(37.8%)	
• Necrotizing fasciitis	0(0%)	1(3%)	1(2.7%)	
• Abscess	1(25%)	5(15.2%)	6(16.2%)	
• Ulcer	1(25%)	13(39.4%)	14(37.8%)	
Major Amputation				
• Yes	2(50%)	4(12.1%)	6(16.2%)	0.115
• No	2(50%)	29(87.9%)	31(83.8%)	

Chi-Square/Fisher Exact Test

DISCUSSION

Amputation of the limb is one of the oldest procedure in surgery dating back to days of Hippocrates (Ndukwu, C.U., & Muoneme, C.A. 2015; Chalya, P.L. *et al.,* 2012). Limb amputations are often distressing to patient and families. It often conveys horror to the patient as they consider it a mutilating operation (Damme, H. V., & Limet, R. 2007). To the surgeon, a major amputation is considered as a personal failure of his capacities (Damme, H. V., & Limet, R. 2007).

However, the perception regarding amputation has changed. It is now considered as a treatment and not a tragedy (Barawi, O. A. R. 2005) . The amputation surgeries are considered by many as reconstructive surgeries rather than ablative surgery in order to restore ambulation (Damme, H.V., & Limet, R. 2007; Barawi, O. A. R. 2005).

Limb amputations have been performed for various conditions including trauma, tumour, peripheral vascular disease, infections and congenital anomalies (Chalya, P. L. *et al.*, 2012).

Diabetic foot today is a leading cause of amputation in most countries and it is characterized by triad of neuropathy, ischemia and infection (Ngim, N. E. *et al.*, 2012).

Different studies have shown different lesions in diabetic foot to be cause of amputation. Some have found foot ulceration to result in 85% of amputation in diabetic patients (Lacle, A., & Jaun, L.F.V. 2012; Ngim, N. E. *et al.*, 2012; Eskelinen, E. *et al.*, 2006).

Viswanathan et al (Viswanathan, V., & Kumpatla, S. 2011) found that major cause of occurrence of amputations in diabetic patients was infection. Ngim et al (Ngim, N. E. *et al.*, 2012) found gangrene (58%) to be the commonest lesion followed by ulcer (31%). Often the ulcer was considered to be the most common cause of amputation accounting for 855 of limb amputation in diabetics (Lacle, A., & Jaun, L. F. V. 2012; Ngim, N. E. *et al.*, 2012). This was due to the fact that diabetic foot was often studied worldwide through ulcer classifications like Wagner's classification (Kalburgi, E. B. *et al.*, 2017).

Recently, a new classification was proposed that included almost all the lesions seen worldwide in diabetic foot (Jain, A. K. C. 2012; Jain, A. K. C., & Joshi, S. 2013; Gopal, S., & Haridarshan, S. J. 2019; Gopal, S. 2018). The Amit Jain's universal classification for diabetic foot complications categorizes diabetic foot into 3 types namely type 1 diabetic foot complications that is infective and includes abscess, wet gangrene, cellulitis, necrotizing fasciitis, etc. The type 2 diabetic foot complications are non infective and includes dry gangrene, trophic ulcer, claw toe, hammer toe , etc and type 3 diabetic foot complications are mixed category wherein the type 2 diabetic foot complications gets infected. Example in this category is an infected ulcer with osteomyelitis (Jain, A. K. C. *et al.*, 2018). Various studies done through this new universal classification showed that type 1 diabetic foot complications are the most common complications seen in diabetic foot ranging from 67% to 91% and wet gangrene and abscess are the 2 most common lesion encountered (Jain, A. K. C., & Viswanath, S. 2013; Kalaivani, V. 2014). This study on amputation in diabetic foot shows that the most common type 1 diabetic foot complications are wet

gangrene [Figure 4] accounting for 37.8% followed by abscess. The infected trophic ulcer accounting for 37.8% was the most common type of type 3 diabetic foot complications resulting in amputations.

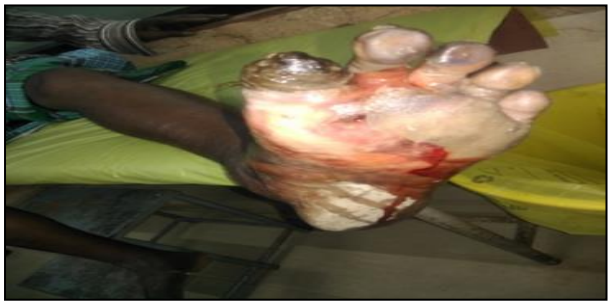

Figure.4 showing wet gangrene of the left foot

There are different studies which show different amputation to be common in their region. Amputations in lower limb are often classified into minor amputation (Foot amputations) and major amputation (Netten, J. J. V. *et al.*, 2017; Alzaharani, H. A. 2012). Amputation distal or through ankle are considered to be minor amputations and amputation proximal to ankle were considered major amputation (Netten, J. J. V. *et al.*, 2017).

In Viswanathan et al study (Viswanathan, V., & Kumpatla, S. 2011), minor amputations occurred in 70.9% of diabetic patients and major amputations accounted for 29.1%. In Ngim et al series (Ngim, N. E. *et al.*, 2012), 53% had lower limb amputation out of which 63% had major amputation with below knee amputation being common and 37% had minor amputation. In our study, 83.8% had minor amputation and 16.2% had major amputations with below knee amputation [Figure 5] being common major amputation [Table 9].

Figure.5 showing below knee amputation

Table.9 showing the type of amputations in different studies

Type of amputation	Viswanathan et al study	Ngim et al study	Our study
Minor amputation	70.9%	37%	83.8%
Major amputation	29.1%	63%	16.2%

The commonest minor amputation (foot amputation) was toe amputation (64.9%) [Figure 6] followed by transmetatarsal amputation (16.2%). None of the patients had any Chopart, Lisfrancs etc types of foot amputations in this study.

Figure.6 showing great toe amputation on the left foot

If we apply Amit Jain's extended 'SCC' classification (Jain, A. K. C. 2019) for diabetic foot for foot amputation (Minor), then all the toe amputation including partial/ray's and transmetatarsal amputation can be considered simple amputation [Type 1], Lisfranc and Chopart amputation are complex amputations [Type 2] and Pirogoff's, Boyd's and Syme's amputation can be considered complicated amputations [Type 3]. When we distributed the minor amputations done in our study, we found that all the foot amputations done in this series belonged to type 1 amputations (Simple) and none were in type 2 or type 3 categories [Table 10].

Table 10 showing the Amit Jain's SCC classification being extended to Foot amputations

Type of foot amputation (Minor)	Description	Amputation level	Examples	Our study (Number)	Percentage
Type 1	Simple	Forefoot	Toe amputations, transmetatarsal amputation	31	100%
Type 2	Complex	Midfoot	Lisfranc, Chopart amputation	0	0%
Type 3	Complicated	Hindfoot	Boyd, Pirgoff, Syme's amputation	0	0%

Often, once amputations are done in diabetic foot, the problem with disease is not solved. Various complications like re-ulceration, deformities, wound healing problems, re-amputation, mortality, etc ensues

(Nather, A., & Wong, K.L. 2013). There are studies showing great risk of re-amputation in same limb within 6 months (Izumi, Y. *et al.,* 2006). Further, mortality after amputation is quite high. It was observed in a study that after below knee amputation, 52% of patients died within 2 years (Izumi, Y. *et al.,* 2006).

CONCLUSION

Diabetic foot is a disabling complication of diabetes that often leads to poor quality of life. There are different causes of amputation in diabetic foot. Our study showed wet gangrene, infected trophic ulcer and abscess to be common lesions leading to amputation. Minor amputations accounted for 83.8% of the cases with toe amputation being the commonest minor amputation. All the foot amputations done belonged to Amit Jain's type 1 foot amputations (Simple). Major amputation accounted for 16.2% of the cases.

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