



## A STUDY TO EVALUATE THE RISK FACTORS LEADING TO LOWER EXTREMITY AMPUTATION IN DIABETIC FOOT

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### ABSTRACT

**Aim:** To evaluate the incidence of lower extremity amputation among inpatients with diabetic foot. To assess the risk factors leading to lower extremity amputation in the same patients

**Materials and methods:** Diabetic foot patients who required admission during the study period were selected and evaluated. Clinical and laboratory analysis was done for all patients and comparison done between those whose treatment included minor or major amputation of lower extremity with those who were managed without amputation.

**Result:** The study consists of 100 patients of diabetic foot with 77 of them going for major or minor amputation and 23 of them treated without amputation. A detailed analysis between amputated and non-amputated group showed significant difference in the following factors: age, duration of diabetes, HbA1c, Ankle Brachial Index (ABI), Wagner grade of ulcer and history of previous amputation.

**Conclusion:** Among the many risk factors for diabetic foot, our group of patients had higher significance for duration of diabetes, HbA1c, ABI and history of previous amputation. The identification of specific population based risk factors for diabetic foot syndrome and advocacy of preventive measures, patient education and earlier treatment can help prevent significant morbidity and financial burden to the patient.

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### INTRODUCTION

Diabetic foot syndrome is defined as the presence of infection, ulceration and/or destruction of deep tissues associated with neurologic abnormalities and various degrees of peripheral arterial disease in the lower limb in patients with diabetes.<sup>4</sup> Diabetic foot syndrome is the leading cause of non-traumatic lower extremity amputation and precedes almost 85% of the cases.<sup>5</sup> Diabetic foot lesions are a significant health and socioeconomic problem. It has adverse effects on the quality of life and imposes a heavy economic burden on the patient and the State; it can lead to prolonged hospitalization and the need for rehabilitative and home care services.<sup>1</sup> According to the genetic profile and cultural features of a given population, there may be differences in the risk factor pattern of the clinical

complications of diabetes.<sup>12,13</sup> This study was undertaken to identify and quantify those risk factors that are more significant for lower extremity amputation amongst diabetic patients attending Rajah Muthiah Medical College and Hospital, Chidambaram.

### MATERIALS AND METHODS

In this study, 100 patients with diabetic foot admitted in the department of General Surgery, RMMC&H, Annamalai University from November 2015 to October 2017 were selected. The patients were divided into 2 groups – those whose treatment included amputation and those who were treated conservatively and a detailed analysis of the variables in the 2 groups was done. All patients with diabetic foot who had gangrene of part of foot or leg, an infected ulcer in the toe or foot that requires drainage and debridement, signs of cellulitis in foot or leg

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and deep ulcer with suspected underlying osteomyelitis were included in the study. Patients with small dry ulcer in toe or foot without infection, superficial ulcer of skin manageable in outpatient setting and ulcer and gangrene due to reasons other than diabetes were excluded from the study.

A detailed history was collected from the admitted patients with specific importance given to the duration of diabetes, type of medication for diabetes, adherence to treatment, history of previous amputation and other comorbidities such as hypertension, chronic renal insufficiency and retinopathy. Clinical assessment of the foot ulcer was done and an appropriate grading done based on Meggitt-Wagner's classification of diabetic foot ulcers. Routine blood sugar monitoring was done along with glycosylated hemoglobin (HbA<sub>1c</sub>) to assess recent long term control. Wound swab taken from the ulcer for all patients and sent for culture and sensitivity.

Ankle Brachial Index is a relatively simple and inexpensive method to confirm the clinical suspicion of arterial occlusive disease. It is performed by measuring the systolic blood pressure (by hand held Doppler probe) in the brachial, posterior tibial and dorsalispedis arteries. The highest of the four measurements in the ankles and feet is divided by the higher of the two brachial measurements. This ratio is referred to as the Ankle Brachial Index or ABI was measured in all patients.

After thorough assessment and obtaining consent, the patient is taken up for wound debridement or abscess drainage. All Wagner grade 4 ulcers went in for direct amputation of that particular toe. Deep seated abscess and osteomyelitis were drained and part or whole of the bone excised for the latter. Major amputation done for Wagner grade 5 ulcers Postoperative wound care given by daily dressings, appropriate antibiotics and titration of insulin or oral hypoglycemic agent as per medical opinion.

A detailed analysis was done between the amputated and non-amputated groups using Chi square test for the following factors: Age, duration of diabetes, HbA<sub>1c</sub>, Wagner grading and ABI.

## RESULTS

**Table 1** Age Incidence

Age Level	Group		Total
	Not Amputated	Amputated	
40 – 50 yrs	5	6	11
50 – 60 yrs	12	27	39
60 – 70 yrs	6	31	37
>70yrs	0	13	13
Total	23	77	100

In our study, out of 100 patients, 69 were males and 31 were females. Among them 77 patients went in for amputation of minor or major type while 23 patients were managed without amputation. Among the 77 patients who underwent amputation, 69 was of minor type and 8 was of major type.

**Table 2** Sex Incidence

Sex	Age	Group		Total
		Not Amputated	Amputated	
Male	40 – 50 yrs	4	4	8
	50 – 60 yrs	7	16	23
	60 – 70 yrs	3	20	23
	>70yrs	0	7	7
	Total	14	47	61
Female	40 – 50 yrs	1	2	3
	50 – 60 yrs	5	11	16
	60 – 70 yrs	3	11	14
	>70yrs	0	6	6
	Total	9	30	39

The age and sex incidence of both groups are presented in the above tables. The incidence of amputation increases with age. Though many studies point to male sex being a risk factor, there was no significant difference in our study between male and female amputation.

**Table 3** Duration of diabetes

Duration of DM	Group		Total
	Not Amputated	Amputated	
0 – 4 yrs	12	8	20
5 – 8yrs	11	42	53
9 – 12yrs	0	19	19
> 12yrs	0	8	8
Total	23	77	100

### Chi-Square Tests

	Value	df	P value
Pearson Chi-Square	23.676	3	<0.001 (S)

Duration of diabetes is one of the most significant factors leading to amputation as well as other complications of diabetes. The non-amputated, minor and major amputated group had a mean duration of diabetes of 4.65 years, 7.48 years and 12.5 years respectively.

**Table 4** HbA<sub>1c</sub> Level

HbA <sub>1c</sub> Level	Group		Total
	Not Amputated	Amputated	
6 – 7.9	9	3	12
8 – 9.9	13	45	58
10 – 12	1	25	26
> 12	0	4	4
Total	23	77	100

### Chi-Square Tests

	Value	df	P value
Pearson Chi-Square	24.914	3	<0.001 (S)

HbA<sub>1c</sub> level is also a major predictor of amputation in diabetic foot. The non-amputated, minor and major amputated group had a mean HbA<sub>1c</sub> levels of 8.23, 9.74 and 10.56 respectively.

**Table 5** Wagner grading of ulcer

Wagner grading of ulcer	Group		Total
	Not Amputated	Amputated	
2	8	0	8
3	15	27	42
4	0	47	47
5	0	3	3
Total	23	77	100

  

Chi-Square Tests			
	Value	df	P value
Pearson Chi-Square	45.551	3	<0.001 (S)

The non-amputated group had Wagner grading of 2 or 3 whereas the minor amputated group had grades of 3 or 4 and major amputated group had grades 4 or 5.

**Table 6** Ankle Brachial Index

ABI	Group		Total
	Not Amputated	Amputated	
0.60 – 0.70	0	7	7
0.71 – 0.80	0	33	33
0.81 – 0.90	9	28	37
> 0.90	14	9	23
Total	23	77	100

  

Chi-Square Tests			
	Value	df	P value
Pearson Chi-Square	30.609	3	<0.001 (S)

Diabetes and peripheral vascular disease have a close association and accordingly the amputated group had significant lower ABI values compared to the non-amputated group. The non-amputated, minor and major amputated group had a mean ABI value of 0.95, 0.82 and 0.70 respectively.

**Table 7** History of Previous amputation

Group	History of Previous amputation		Total
	Positive	Negative	
Non-amputated	1	22	23
Minor amputated	19	50	69
Major amputated	8	0	8

Regarding history of previous amputation, only 5% of the non-amputated group had a positive history while 25% of minor amputated and 100% of the major amputated group had positive history.

## DISCUSSION

The development of a diabetic foot ulcer is traditionally considered to result from a combination of peripheral vascular disease, peripheral neuropathy and infection.<sup>10</sup> In addition, many more factors are implicated in progression and amputation of diabetic foot. Some of the risk factors for amputation described in various studies include:

1. Age
2. Gender
3. Duration of diabetes
4. History of previous amputation
5. Elevated HbA<sub>1c</sub>

6. Presence of foot deformity
7. Presence of infection
8. Presence of neuropathy
9. Presence of nephropathy
10. Presence of ischemia
11. Presence of retinopathy

In our study, the more significant risk factors included age, duration of diabetes, HbA<sub>1c</sub>, ABI and history of previous amputation. Age as a risk factor gets significance due to other added entities. Elderly patients in our study being more of rural origin have comparatively poor nutritional status as well as poor self-care. The awareness about diabetic foot lesions is low along with poor compliance to treatment. Other co-morbidities such as anaemia, hypertension, ischemic heart disease, mental health problems increase with age adding to its significance.

Duration of diabetes is an important risk factor for amputation. All diabetic related complications such as neuropathy, peripheral vascular disease, nephropathy, retinopathy increase with duration of diabetes most of which contribute to amputation also. In our study, the non-amputated group has a significantly low duration of diabetes compared to the amputated group.

Glycosylated haemoglobin or HbA<sub>1c</sub> reflect the average blood glucose levels over a period of 3 months. It is an independent risk factor for amputation.<sup>2</sup> It is superior when compared to assessment of control using fasting blood glucose levels.<sup>3</sup> Many studies have revealed a linear relationship between blood glucose levels and diabetic foot amputation. Our study also reveals similar results. Younger patients undergoing minor amputation were observed to have a higher HbA<sub>1c</sub> regardless of age and duration of diabetes. Similarly elderly patients with longer duration of diabetes (>5years) undergoing minor or major amputation were found to have higher HbA<sub>1c</sub> attributable to recent non-compliance of treatment or development of insulin resistance.

Peripheral vascular disease (PVD) in diabetic foot can be diagnosed by the absence of two or more pulses in both feet.<sup>6</sup> It can be clinically confirmed by simple non-invasive measurement of the Ankle Brachial Index (ABI). Normal ABI is 1 to 1.3. ABI < 0.9 suggests PVD.<sup>8,11</sup> Based on this criteria, most of the patients undergoing amputation in our study had PVD. Major amputation patients had significantly lower mean ABI (0.70).

The mean duration of hospital stay and antibiotic administration is significantly higher in the amputated group compared to non-amputated group.<sup>9</sup> The majority of our patients had minor amputations and they could continue to walk on their feet. Patients with major amputation had to undergo rehabilitative procedures including counselling and prostheses.

Diabetic foot lesions leading to amputation are a significant health and socioeconomic problem, having adverse effects on quality of life and imposing a heavy economic burden on the patient.<sup>7</sup> To avoid or delay amputations and the consequent adverse impact on the patient's daily activities, the first requirement is strict control of diabetes, which is the primary disease. Early

detection and treatment of lesions and regular foot care is also important.

## CONCLUSION

The importance of identifying these risk factors is that such knowledge is useful for developing methods to detect them at an early stage and thus prevent limb amputation. Whenever risk factors are detected, relevant advice can be given to the patient.

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