



A Comparative Study of Diabetic Foot Outcome between Normal vs. High BMI Individuals - Is Obesity Paradox a Fallacy in Ulcer Healing?

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Abstract

Background: Persons with diabetes, the prevalence of foot ulcers ranges from 4% to 10% and its lifetime incidence may be as high as 25%. Modifiable factors including BMI and HbA1c have gained special attention of researchers and have been extensively studied in relation with diabetic foot ulcers, gangrene, and limb amputation.

Methods: A prospective study on 102 patients with diabetic foot in Bowring and Lady Curzon and Victoria hospital between July 2018 to December 2018. We sought to compare the outcome of diabetic foot healing between individuals with normal and high BMI and assess the relative risk of modifiable factors (BMI, HbA1C and smoking) in lower extremity amputation in diabetic foot.

Results: Higher BMI and HbA1C were strongly associated with non salvageability of lower limb, though smoking was found to have a moderate correlation. Normal BMI individuals were found to have a relatively good healing than high BMI cases.

Conclusion: BMI, HbA1C and smoking, these three modifiable risk factors prove to be primary predictors of outcome in diabetic wound healing. From the present comparative study, persons with higher BMI had a more risk of lower extremity amputation hence "Obesity paradox proves to be a fallacy in diabetic foot healing".

Keywords: Lower Extremity Amputation (LEA); BMI; HbA1C

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Received Date: 24 Oct 2019

Accepted Date: 16 Dec 2019

Published Date: 20 Dec 2019

Citation:

Manikanta KS, Monisha G. A Comparative Study of Diabetic Foot Outcome between Normal vs. High BMI Individuals - Is Obesity Paradox a Fallacy in Ulcer Healing?. Clin Surg. 2019; 4: 2693.

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Introduction

In Diabetes, the prevalence of foot ulcers is 4% to 10% and lifetime incidence may be as high as 25% [1]. Diabetic foot is the single most common cause of non-traumatic lower limb amputation 40% to 60% [2]. There is a need for spot on predictors in diabetic foot patient, for identification of high-risk patients, for early intervention, to plan a management strategy and decrease lower extremity amputations. The predictors of complications in diabetic foot are HbA1C, Hypertension, and Peripheral arterial diseases, Age, Gender, Grade, Depth, Site, Smoking, Neuropathy, Recurrence, Fibrinogen and Obesity. Defining modifiable factors is the first step to reduce Lower Extremity Amputation (LEA) rates. Most common modifiable factors are Obesity, Glycemic Control and Smoking. Obesity Paradox-Reverse Epidemiology? Inverse correlation between BMI and morbidity has been observed [3]. In some studies, protective effect of overweight and obesity in chronic diseases have been reviewed [4]. Chronic diseases like Stroke, thromboembolism, COPD, Critically ill ICU-peripheral artery disease in which protective effect of overweight-obesity have been observed [5]. In our studies we want to see whether there exists any protective effect of overweight-obesity in diabetic patient with respect to lower extremity amputation.

Objectives of the Study

- To determine the significance of modifiable risk factors as predictors of prognosis in diabetic foot ulcers.
- To compare the outcome of diabetic foot healing in individuals with normal vs. high BMI with respect to salvageability of limb.

Materials and Methods

- Study design: prospective study

Table 1: BMI IN Lower Extremity Amputation.

	Major Amputation	Minor Amputation	Limb saving procedures
Normal BMI	8.60%	8.60%	82.60%
BMI: 25-29.9	19.35%	25.80%	54.83%
BMI: 30-34.9	30.40%	26.08%	43.47%
BMI: >35	100%		

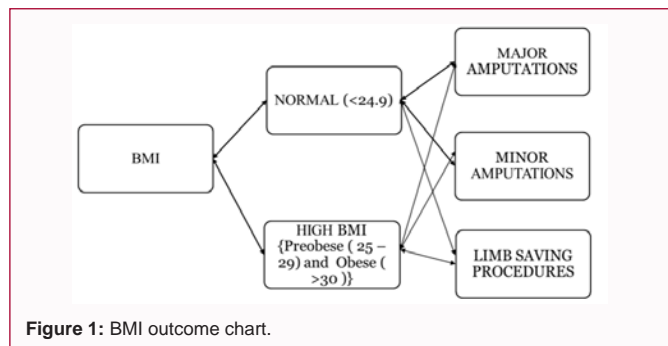


Figure 1: BMI outcome chart.

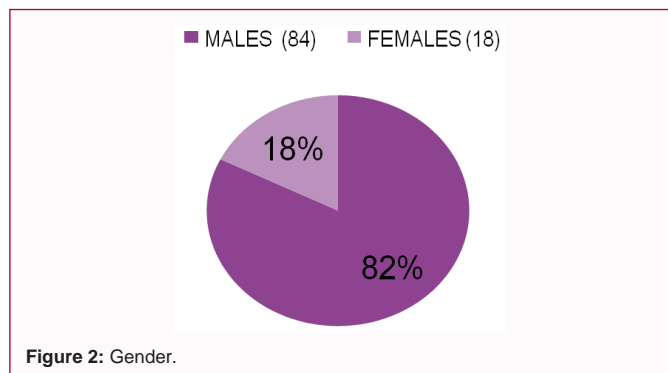


Figure 2: Gender.

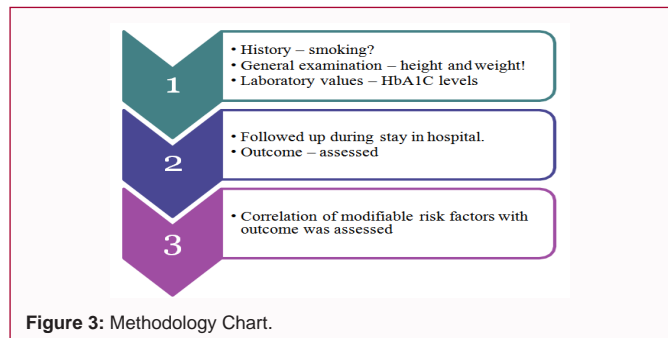


Figure 3: Methodology Chart.

- Study period: June 2018 to December 2018
- Place of study: The study was conducted at the General Surgery department in the hospitals attached to Bangalore Medical College and Research Institute, Bangalore.

• Sample size: 102

Inclusion criteria

- Admitted diabetic foot ulcers: (TRUST NHS guidelines)
- Willing for management including grafting, amputation etc.

• Feasible for follow-up.

Exclusion criteria

- Non diabetic foot ulcers.

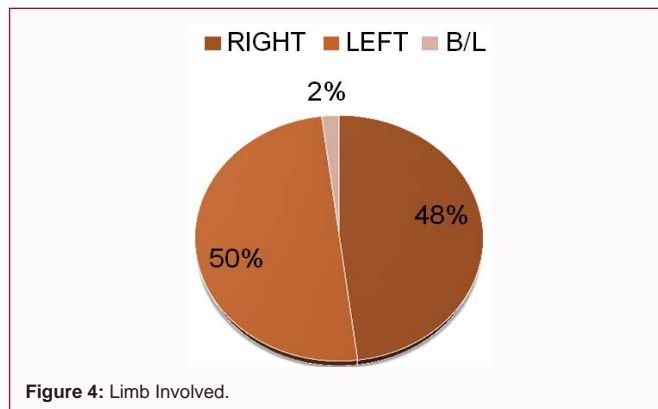


Figure 4: Limb Involved.

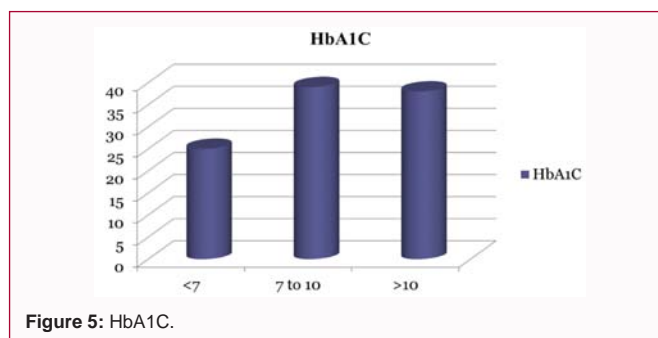


Figure 5: HbA1C.

- Peripheral occlusive vascular diseases.

Methodology

The study was conducted in the Department of General Surgery in Victoria Hospital and Bowring & Lady Curzon hospital, on 102 patients who fulfilled the inclusion/exclusion criteria.

Results

BMI outcome chart

- Relevant History with smoking, general examination, laboratory values, follow-up in hospital with outcome was recorded.
- Correlation between different modifiable risk factors with outcome assessed (Figures 1).

Methodology chart (Figure 2)

Gender

- Age: 30 years to 90 years; Mean age: 56.71 (Figure 3)
- Limb involved
- Duration of disease: 2 days to 3 years; Mean: 90 days (Figure 4)

Smoking:

- Valid No: 40.20%; Valid Quit: 15.69%; Valid Yes: 44.12% (Figure 5)

HbA1C:

- Mean: 9.18; Minimum: 5.0; Maximum: 15.1 (Figure 6)

BMI:

- Mean: 25.1; Minimum: 17.5; Maximum: 36.9 (Figure 7)

Stay in hospital:

- Median: 18.02; Minimum: 5 days; Maximum: 60 days

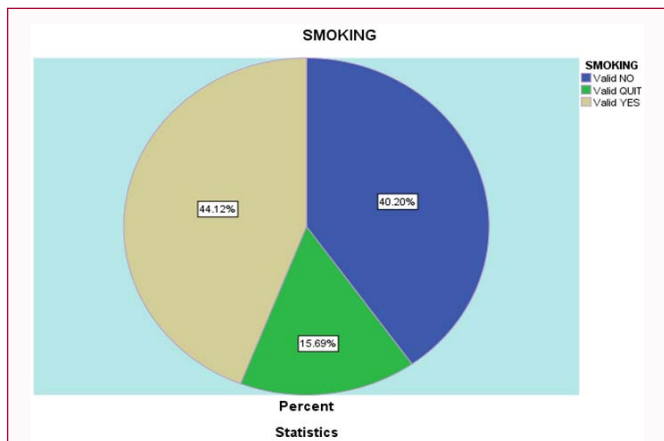


Figure 6: Smoking.

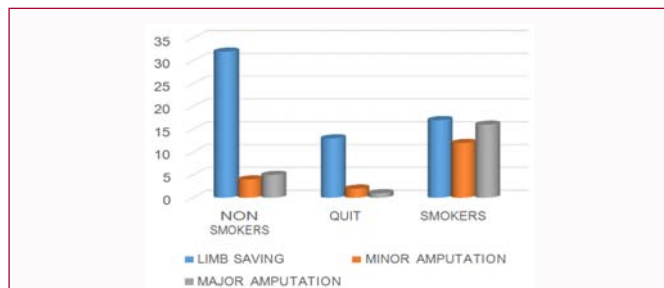


Figure 9: Smoking and Outcome.

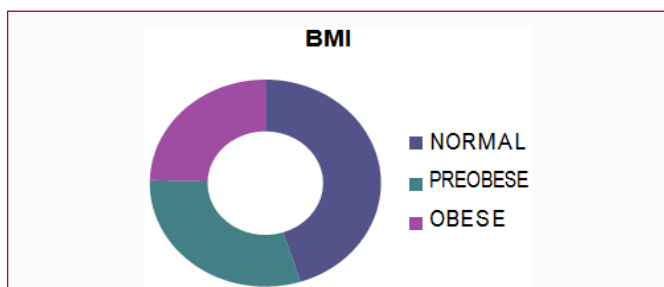


Figure 7: BMI.

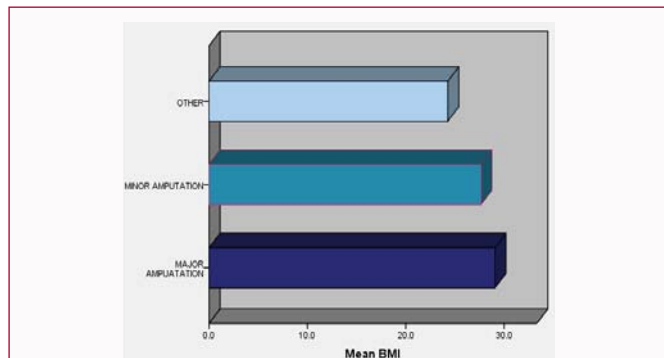


Figure 10: BMI and outcome.

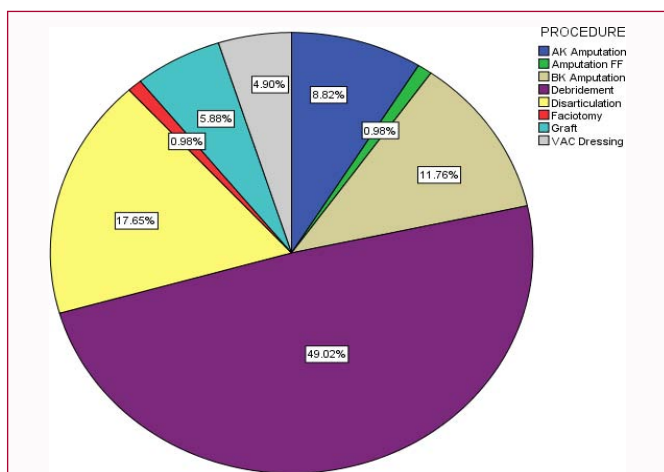


Figure 8: Course of treatment.

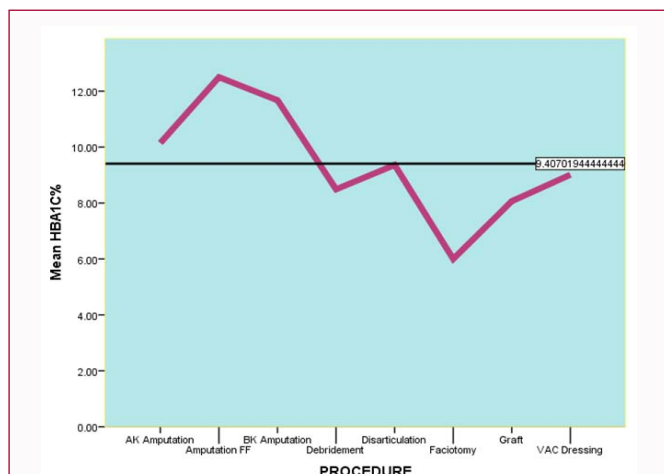


Figure 11: Correlation of HbA1c and outcome.

- Course of treatment:
- Infection control (Microbiological guided). Non-viable tissue excision (debridement/grafting/Fasciotomy /amputation). Glycemic control.
- Procedures: (Figure 8)
- Above Knee Amputation Forefoot (FF)
- Below Knee Amputation Debridement Disarticulation Fasciotomy
- Graft
- VAC dressing

Clinical Outcome

- Smoking and Outcome: (Figure 9)
- BMI and Outcome: (Figure 10)
- Correlation of Hba1c and Outcome: (Figure 11)
- Normal BMI vs. High BMI: (Figure 12)
- BMI IN Lower Extremity Amputation (Figure 13)
- HbA1C Procedure (Figure 14)
- Smoking Procedure (Figure 15)
- BMI Procedure (Figure 16)

Discussion

In Michell et al. [6] study, high BMI is found to have a lower risk

Table 2: HbA1C procedure.

			Procedure			P value
			Limb Saving	Major Amputation	Minor Amputation	
hbalccat	<7	Count	21	2	2	<0.001 (19.139) df - 4
		%	84.00%	8.00%	8.00%	
	7-10	Count	26	4	9	
		%	66.70%	10.30%	23.10%	
	10-15	Count	15	16	7	
		%	39.50%	42.10%	18.40%	
Total		Count	62	22	18	
		%	60.80%	21.60%	17.60%	

Table 3: Smoking procedure.

			Procedure			P value
			Limb saving	Major amputation	Minor amputation	
Smoking	NO	Count	32	5	4	<0.001 (18.285) df - 4
		% within smoking	78.00%	12.20%	9.80%	
	QUIT	Count	13	1	2	
		% within smoking	81.30%	6.30%	12.50%	
	YES	Count	17	16	12	
		% within smoking	37.80%	35.60%	26.70%	
Total		Count	62	22	18	
		% within smoking	60.80%	21.60%	17.60%	

Table 4: BMI procedure.

			Procedure			P value
			Limb Saving	Major Amputation	Minor Amputation	
bmicat	1.00	Normal	38	4	4	<0.001 (23.738) Df - 4
		%	82.60%	8.70%	8.70%	
	2.00	Preobese	17	6	8	
		%	54.80%	19.40%	25.80%	
	3.00	Obese	7	12	6	
		%	28.00%	48.00%	24.00%	
Total		Count	62	22	18	
		%	60.80%	21.60%	17.60%	

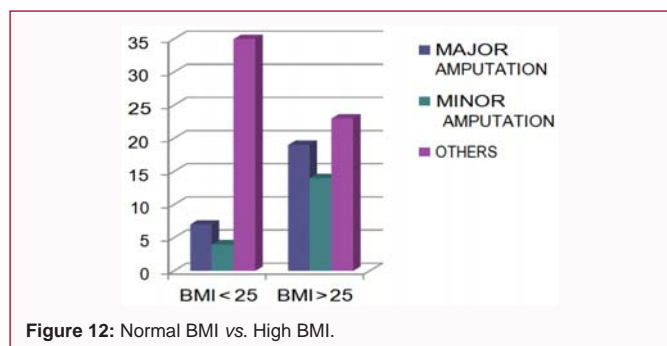


Figure 12: Normal BMI vs. High BMI.

of lower extremity amputation. A J-shaped association between high BMI and diabetic foot healing has been described. No pathological or physiological basis has been explained. Lower fat-free mass has been linked to reduced antioxidant capacity and poor outcomes maybe the possible explanation of obesity paradox [7-9]. In Abdul

et al. [8] study, high BMI has been proved to be associated with poor prognosis in diabetic ulcer healing, possible explanation may be BMI irrespective of neuropathy, retinopathy nephropathy, hyperlipidemia, previous foot ulcer or grade of ulcer, can be an independent predictor of diabetic foot outcome. Significant and established modifiable risk factor- HbA1C: poor glycemic control leads to glycated immune particles which make more prone to infections [2]. Cigarette smoking has been reported to be associated with diabetes and its macrovascular complications [10]. Nicotine induced vaso- constriction hydrogen cyanide induced oxidative stress inside the cells. Carbon-monoxide decreased oxygen transport (Figure 17).

Conclusion

Patients with high HbA1C>10 about 65% underwent major and minor amputation. Smokers >20 years and those who had recently quit smoking <5 yr had a poor outcome with 71% underwent lower extremity amputations. In group with BMI <25, 78% were successfully treated with limb saving procedures. Hence the 3 modifiable risk

	MAJOR AMPUTATION	MINOR AMPUTATION	LIMB SAVING PROCEDURES
NORMAL BMI	8.6%	8.6%	82.6% ↑
BMI: 25-29.9	19.35%	25.80%	54.83%
BMI :30-34.9	30.4%	26.08%	43.47%
BMI:>35	100% ↑		

Figure 13: BMI in Lower Extremity Amputation.

		procedure			P value	
		limb saving	major amputa	minor amputa		
bmicat	1.00	Normal	38	4	4	<0.001 (23.738) Df-4
			82.6%	8.7%	8.7%	
	2.00	Preobese	17	6	8	
			54.8%	19.4%	25.8%	
	3.00		7	12	6	
		obese	28.0%	48.0%	24.0%	
Total			62	22	18	
		%	60.8%	21.6%	17.6%	

Figure 16: BMI Procedure.

		procedure			P value	
		limb saving	major amputation	minor amputation		
hba1ccat	<7	Count	21	2	2	<0.001 (19.139) df- 4
		%	84.0%	8.0%	8.0%	
	7-10	Count	26	4	9	
		%	66.7%	10.3%	23.1%	
	10-15	Count	15	16	7	
		%	39.5%	42.1%	18.4%	
Total		Count	62	22	18	
		%	60.8%	21.6%	17.6%	

Figure 14: HbA1C Procedure.

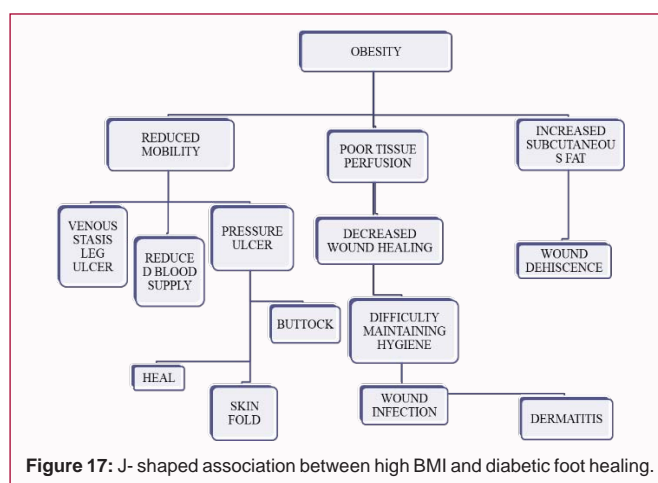


Figure 17: J- shaped association between high BMI and diabetic foot healing.

- Cardio respiratory fitness
- Body fat distribution
- Other factors affecting health
- Off-loading devices were not used in our study

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factors prove to be primary predictors of outcome in diabetic wound healing. From the present comparative study, persons with higher BMI had a more risk of lower extremity amputation hence “Obesity paradox proves to be a fallacy in diabetic foot healing”.

Limitations of Our Study

- BMI is a crude and flawed anthropometric biomarker
- It does not take into account
- Nutritional status
- Fat mass/fat-free mass ratio

- diabetic foot ulcer healing in type 2 diabetic subjects using routine clinical and laboratory parameters. *Res Rep Endocrine Dis.* 2016;6(6);11-16.
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