

## Nutritional status of diabetic foot infection patients - Type 2 Diabetes Mellitus

Anitha<sup>\*</sup>, Uma mageshwari<sup>\*</sup>, Patricia Trueman<sup>\*</sup>, Dharini Krishnan<sup>\*\*</sup>, Vijay Viswanathan<sup>\*</sup>

<sup>\*</sup> M.V.Hospital for Diabetes & Prof.M Viswanathan Diabetes Research Centre  
(WHO Collaborating Centre for Research, Education and Training in Diabetes) Royapuram, Chennai, India

<sup>\*\*</sup> D V Living Sciences Pvt Ltd, Chennai, India

Corresponding author: drvijay@mvd diabetes.com

### Abstract

Diabetic foot ulcers are the consequences of multiple factors which includes obesity, HbA1c, peripheral neuropathy decreased blood supply etc. The nutritional status of 29 patients who underwent debridement for foot infection were evaluated. The mean age of the patients recruited for the study was  $56.4 \pm 10.4$  and the duration of diabetes was  $12.3 \pm 6.7$  years. Nutritional status was recorded on mini nutritional assessment (MNA). Biochemical parameters were evaluated for all the 29 patients. Their fasting and post prandial blood sugars were abnormal. The mean HbA1c values were  $9.3 \pm 2.0$ . According to the MNA screening score 65.5% of the patients nutritional status was adequate. 31% were at risk of malnutrition and 3.5% were in the malnourished state. 24 hrs dietary recall was assessed for all 29 diabetic foot ulcer patients. Pre debridement calorie intake was sufficient according to RDA. The post debridement calorie intake was significantly reduced ( $p < 0.001$ ) to reduce weight. The protein intake was not significantly reduced however the protein was of high biological quality. We conclude that consuming a low carbohydrate diet among diabetic patients helps in maintaining a good glycemic control with HbA1c  $< 7\%$ .

**Keywords:** Nutritional status, Diabetes, Diabetic foot ulcer

### Introduction

India has approximately 42 million cases and is ranked first in the list of the ten nations most affected with Diabetes<sup>1</sup>. Uncontrolled Diabetes can lead to various complications like

nephropathy, cardiomyopathy, neuropathy. Prolonged Neuropathy can lead to foot infection. Diabetic foot infection, affects the soft tissue and can lead to bone infection, which is one of the most common complications of diabetes mellitus leading to hospitalization and the most frequent cause of non traumatic lower extremity amputation almost 70 to 90%<sup>1</sup>. Foot infections when prolonged, leads to foot ulceration<sup>2</sup>. Diabetic foot ulceration in diabetic patients also causes morbidity. Annually 2-3 % of diabetics will develop a foot ulcer, fifteen percent of these patients mostly heal, others will develop a chronic ulcer during their lifetime <sup>3,4,5,6,7</sup>.

The etiology of diabetic foot ulceration is multifactorial, and care should reflect this fact. The advent of the interdisciplinary diabetic foot clinic has seen a dramatic improvement in care, leading to increased healing rates of diabetic foot ulcers. Furthermore, it has also contributed to a reduction in the previously very high rates of amputation so characteristic of diabetic foot ulceration. Indeed, the incidence of amputations in patients treated in dedicated multidisciplinary diabetic foot clinics has dropped by 50 and 70% <sup>8,9,10</sup>.

Diabetic foot ulcers arise through a complex interplay of three major factors: neuropathy and ischemia are the primary causes, with super added infection completing the triad, often leading to a downward spiral in the condition of the ulcer. It will be obvious that before deciding on an appropriate dressing a thorough assessment of the diabetic foot and ulcer should be undertaken and the effects of neuropathy, ischemia and infection addressed.



Foot ulceration is preventable, and relatively simple interventions can reduce amputations up to 80%. Good control of hemoglobin, blood pressure, and lipid levels are well established as being crucial elements in the reduction of risk for complications of diabetes<sup>11,12</sup>. Regular evaluation and early treatment are the most effective mechanisms to prevent the devastating diabetic foot complications<sup>13</sup>.

Foot ulcers due to peripheral neuropathy or peripheral vascular disease and in combination of both seen in diabetic patients. The infection, depth, size and duration of wound also involved in impaired healing. All these factors lead to non-healing and amputation of foot.<sup>14,15</sup> The wound healing needs collagen synthesis and recovery of muscle injury<sup>16</sup>.

The incidence of diabetes has increased worldwide and so also simultaneously the incidence of diabetic foot ulcers<sup>17</sup>. The prognosis for diabetic foot ulcers (DFUS) remains poor, although our understanding and treatment of this late-stage complication of DM have improved<sup>18</sup>. As a common and serious complication of diabetes, DFUS are associated with significant mortality.

### **Importance of nutrients**

#### **Carbohydrates:**

The body's first priority is for adequate energy (kilocalories) provided from carbohydrate, protein and fat. When the total amount of calories consumed is too low, protein from both the diet and the individual's muscle stores will be used as an energy source, thus increasing the caloric requirements needed to promote anabolism and reverse catabolism<sup>19</sup>.

#### **Fat:**

Fat is the most concentrated source of energy and triglycerides. Fat carries the fat-soluble vitamins (A, D, E, K) and provides insulation under the skin and padding to bony prominences. Meats, eggs, dairy products, and vegetable oils contain fat.

#### **Protein and Amino Acids:**

Protein is required for the repair and synthesis of enzymes which helps in wound healing, cell multiplication, collagen, connection tissue synthesis and production of antibodies.

#### **Assessment of nutritional status:**

Nutritional status was recorded on Mini Nutritional Assessment (MNA) Nestle Nutritional institute which contains screening; self questions and scales to assess adult nutrition. It contains three degrees of nutrition according to obtained score <17 malnourished, 17-23.5 risk of malnutrition, >24 is normal status<sup>20</sup>.

#### **BMI and obesity:**

Increased body weight would result in higher plantar foot pressures. An increase in foot dimensions, as well as a redistribution of plantar loads from areas of high pressures towards areas of lower pressures, was the cause of diabetic foot ulcers<sup>21</sup>.

#### **HbA1c:**

Haemoglobin A1c (HbA1c) is an established marker to monitor blood glucose in diabetic patients. As an elevated HbA1c predicts poor prognosis for ulcer healing in patients with diabetes, it has been observed that ulcer healing rate is significantly slower if the HbA1c levels are high. The prime objective of our study was to determine the significance of HbA1c levels as predictors of prognosis in patients with diabetic foot ulcers<sup>22,23,24</sup>.

**Aim of the Study:** To analyze the Nutritional Status of foot infection in patients with Type 2 Diabetes Mellitus using the MNA tool.

#### **Objective:**

(1) To analyze the nutrient intake of calories, carbohydrate, protein in the diet of patients with diabetes who underwent debridement.

#### **Material and methods:**

This study was conducted at tertiary care centre for Diabetes in Chennai, South India. The nutritional status of 29 patients (19 men and 10



women) with foot infection who had undergone debridement by surgical method was evaluated. All the patients recruited for the study were in Grade 3 according to Wagner -Meggitt classification of diabetic foot <sup>25</sup>. Nutritional status was evaluated using the Mini Nutritional Assessment Screening Tool (MNA). The 24 hour dietary recall was taken before debridement and one year after debridement. The intake of proteins, calories, fat and carbohydrates was calculated. The biochemical parameters were evaluated. The fasting and post prandial glucose was measured enzymatically on an automatic analyzer (BS-400mind ray). HbA1c was quantified using immuno turbi metric method (Cobas 311). Total cholesterol and triglyceride using enzymatic method and LDL by direct measurement (BS-400mind ray) and HDL was measured using immuno inhibition method.

#### Statistical Analysis:

Statistical analysis was performed using IBM SPSS version 2.0. Statistical analysis was done for baseline data for all biochemical parameters using t-test for independent samples. Frequency, percentage was done by Fishers exact test. Pre debridement and post debridement intake was analyzed using paired t-test.

#### Results and Discussion:

A total of 29 patients (19men and 10 women) who underwent debridement by surgical method were recruited for the study. All patients were assessed using the MNA screening score. The baseline anthropometric variables are given in Table 1.

Table-1 Anthropometric Variables

Results	
Variables	
Age(Years)	56.4±10.5
Height(cms)	162±8.7
Weight(Kg)	71.5±10
Duration of diabetes	12.3±6.7

The above table shows that the mean age was 56.4±10.5, duration of diabetes was 12.3±6.7 years and average weight 71.5±10. In other studies it was noticed that foot ulcers started even as early of five years after the onset of the disease<sup>26</sup>.

The BMI of the subjects were calculated and is given in Table- 2. It shows 13.7% of the subjects were normal, 61% were in class I and class II obese category<sup>27</sup>.

Table-2 BMI of subjects

BMI range	Percentage of subjects	Classification
18.5-22.9	13.7%	Normal
23-24.9	14.4%	Overweight
25-29.9	47.3%	Obese class I
>30	24.6%	Obese class II

It is a well-researched fact that obesity affects the plantar foot pressures and causes an increase in foot dimensions as well as plantar loads from areas of low pressure<sup>28</sup>. It has also been reported that obesity affects gait which is an extremely complex biochemical process involving an interplay between muscular and inertial forces. This difference in gait in an obese individual causes ulcers. The results of the study showed that 86.3% of the subjects in this study were either overweight or obese as compared to 13.7% with normal weight. None of our patients were underweight.

Table -3 Biochemical parameters

Biochemical parameters	
Characteristics	
FBS	150±74mg/dl
PPBS	210±75mg/dl
Serum albumin	3.7±0.57mg/dl
Urea	31±18.3mg/dl
Creatinine	1.1±0.41mg/dl
Total cholestrol	151±32mg/dl
Triglycerides	137±60mg/dl
HDL	30.3±11.6mg/dl
LDL	92±19.8mg/dl



Above results shows fasting and post prandial blood sugar were abnormal. However all other biochemical parameters were within normal limits. However, in this study serum albumin levels were normal. Serum albumin has been used in a few studies to evaluate nutritional status.

Table- 4 HbA1c Values

No of subjects (%)	HbA1c % Values
12 (41%)	8.1 ± 3.0
6 (21%)	8.93 ± 0.02
6 (22%)	9.6 ± 2.26
5 (16%)	9.83 ± 0.007

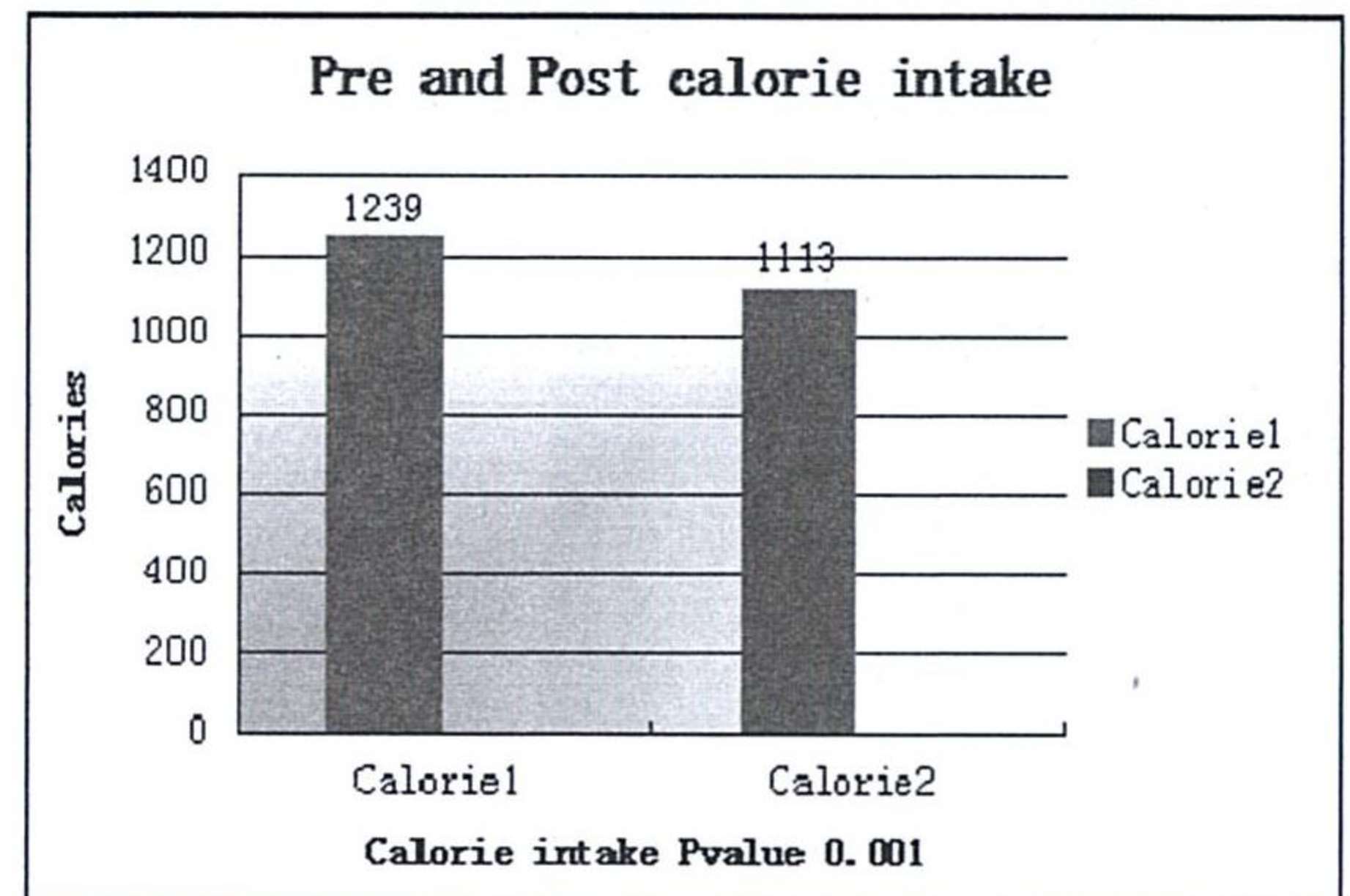
It is generally considered that a persistently elevated glucose level due to compromised glycemic control in the body results in impaired oxygen and nutrient supply to the ulcer area and a concomitantly compromised immune response due to impaired chemotaxis and phagocytosis. Given that HbA1c is reliable marker of glycemic control spanning over the previous 2-3 months, it is now being recommended by the American Diabetes Association and World Health Organization as a reliable marker for diagnosis of diabetes. A validated relationship has also been established between HbA1c levels and various pathological complications in diabetic patient such as diabetic retinopathy and foot ulcers<sup>29</sup>.

Table-5 MNA screening Score

Screening Score	Percentage of subjects
0-7 points (malnourished)	3.5%
8-11 points (At risk of malnutrition)	31%
12-14 Points (normal)	65.5%

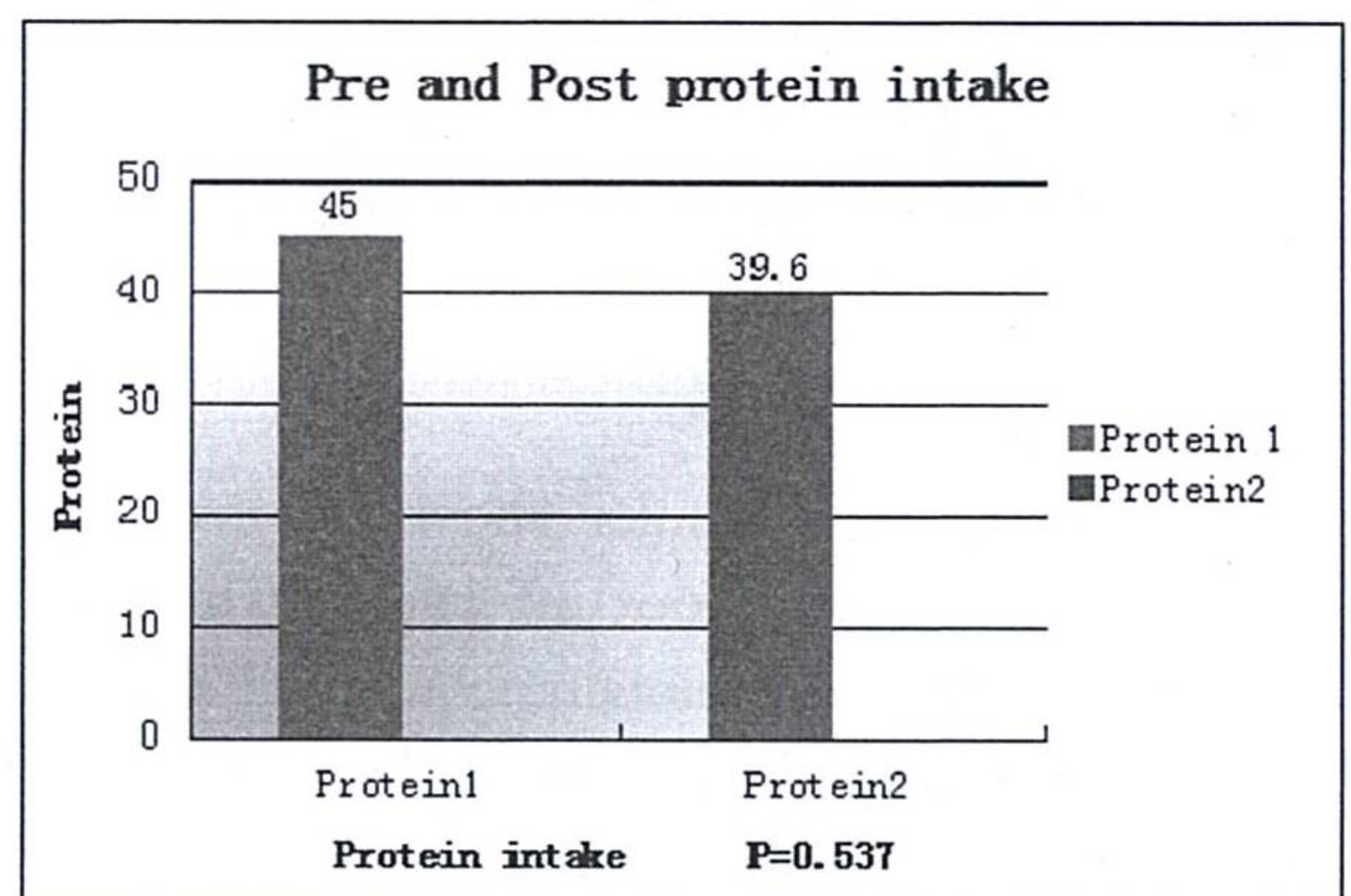
In this study Mini nutritional assessment (MNA) is used to assess the nutritional status of the 29 patients with foot infection who had undergone debridement. The findings conclude that 3.5% patients were malnourished, 31% were at risk of malnutrition and other 65.5% were seemed to be normal as shown in Table 5.

Figure:1 Calorie intake Pre and Post Debridement



Pre debridement calorie intake was sufficient according to RDA. Research has shown that obesity is a predisposing factor for foot infection due to change in gait and unequal distribution of weight on the pressure points of the leg<sup>30</sup>. Therefore, intense diet counselling was given to all 29 subjects to reduce calorie intake in daily diet to reduce weight. Dietary recall was taken after a year to evaluate the calorie content of the diet. The intake of calories has reduced from 1239 kcal to 1113 kcal. This reduction in calorie intake was highly significant with a p value of 0.001. (Fig 1)

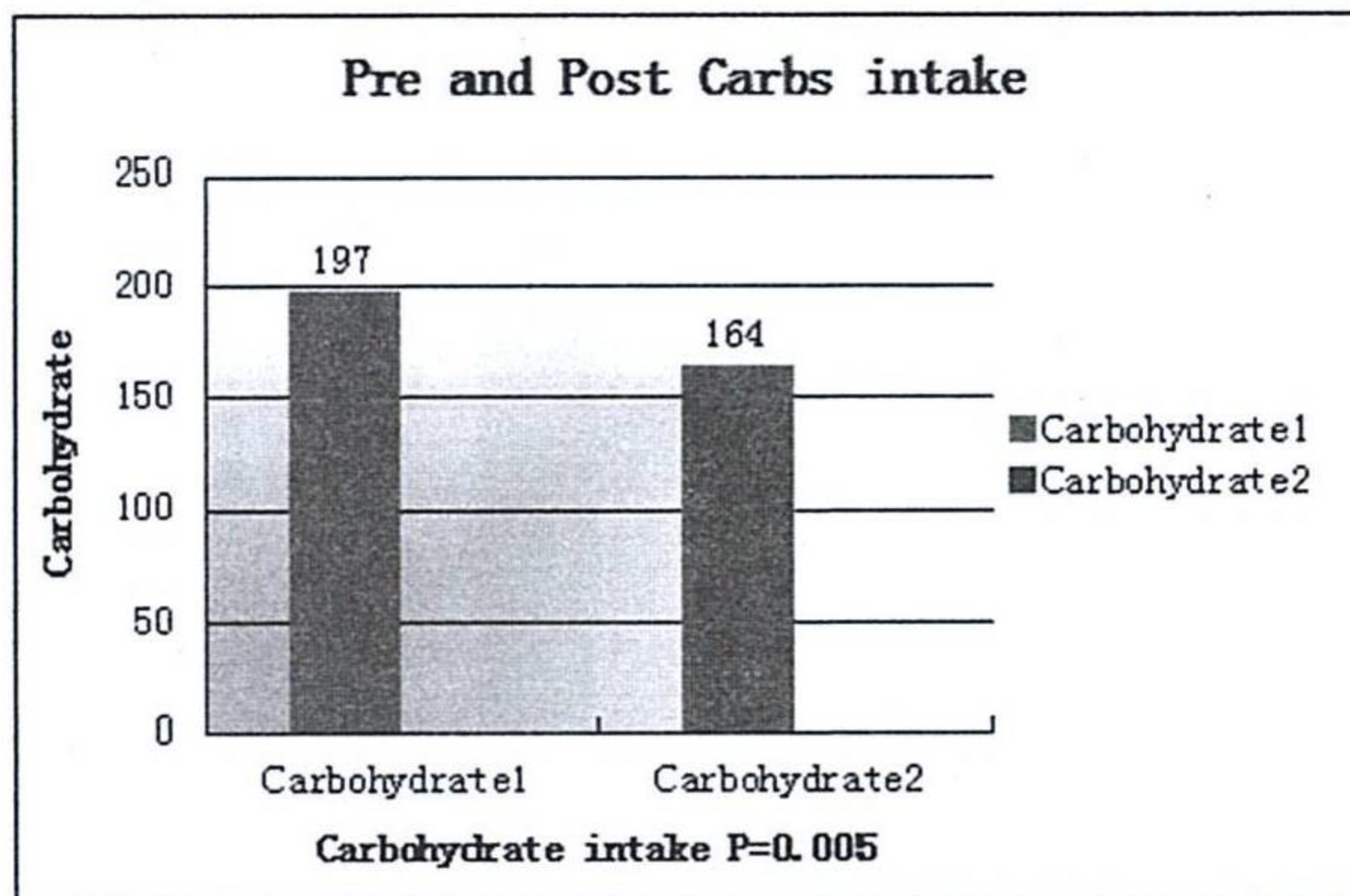
Figure:2 Protein intake pre and post Debridement



It can be seen from Fig 2 that along with the calorie intake the protein intake has also reduced one year after debridement which was not statistically significant (p value=0.537). However, emphasis was given during the counselling session with the patient to include biologically high quality proteins. It was found that all the patients were taking 2-3 egg whites per day if non vegetarian and protein supplements for vegetarian.



Figure:3 Carbohydrate intake pre and post Debridement



Research has shown that poor glycemic control with consistently high HbA1c values results in poor wound healing. Research has reported<sup>31</sup>. HbA1c was significantly associated with ulcer area healing rate. It was observed that for every 1% increase in HbA1c levels, the rate of ulcer healing decreased by 0.028cm<sup>2</sup>/day<sup>32</sup>.

All subjects were advised to reduce carbohydrate intake. The patients' carbohydrate intake met the RDA during the pre debridement period. In this diet 60-65% of calorie was from a carbohydrate source. However, the carbohydrate content of the diet was reduced such that 50-55% of the calorie was from carbohydrate sources. The intake of carbohydrate in this study was seen to reduce from 197g pre debridement period to 164 g post debridement. This difference was highly significant (p=0.005).

### Conclusion:

Our study results show an association between obesity and foot infection. It highlights the importance of maintaining a good glycemic control and maintaining HbA1c less than 7%. It also emphasizes that a low carbohydrate diet is important for diabetic patients.

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