



AN APPROACH TO DIAGNOSIS AND MANAGEMENT OF DIABETIC FOOT

General Surgery

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ABSTRACT

INTRODUCTION India has the dubious distinction of becoming the diabetic capital of the world within the next few years; with its attendant complications it is going to burden the resources of the country. In the past, the diabetics succumbed to the metabolic complications like ketoacidosis, but now they survive long enough to develop and succumb to the diabetic nephropathy and diabetic foot complications.

AIMS AND OBJECTIVES The various predisposing factors for diabetic foot with respect to North Bihar population. To analyse the different ways of clinical presentation of diabetic foot in our hospital. To evaluate the usefulness of surgical management available with special emphasis on strict glycemic control. To determine commonest microorganism/s infecting the diabetic foot patients in the North Bihar Population.

MATERIALS AND METHODS Department of General Surgery, DARBHANGA MEDICAL COLLEGE AND HOSPITAL, LAHERIASARAI.

Diabetic patients with foot ulcers admitted in this hospital, according to the WHO criteria, were selected for this study for 1 Year 8 month (April 2019 to December 2020).

RESULTS AND ANALYSIS We found peripheral Pulse of 37.9% of the patients was absent. Infection was present in 86.2% of the cases which was significantly higher ($Z=10.23; p<0.0001$). Ulcers were mostly at dorsum (22.4%) ($Z=1.58; p=0.11$) followed by fore foot (13.8%) and great toe (13.8%). Ulcers were mostly right sided (67.2%) followed by left sided (31.0%) ($Z=5.12; p<0.001$). Only 1(1.7%) patients had bilateral infection.

CONCLUSION The prevalence of risk factors for foot ulcer and infections, viz., neuropathy and vasculopathy, are different from the Western literature. Studies from India, suggest predominantly neuropathic ulcers unlike the West where neuroischemia is the most important predisposing factor. As compared to the West, which have predominant Gram-positive infections, centers throughout India have reported a consistent Gram-negative bacterial preponderance in DFI.

KEYWORDS

Approach To Diagnosis And Management Of Diabetic Foot

INTRODUCTION

India has the dubious distinction of becoming the diabetic capital of the world within the next few years; with its attendant complications it is going to burden the resources of the country. In the past, the diabetics succumbed to the metabolic complications like ketoacidosis, but now they survive long enough to develop and succumb to the diabetic nephropathy and diabetic foot complications.

The diabetic foot syndrome is defined as an array of foot abnormalities, resulting from peripheral neuropathy, micro and macroangiopathy and other consequences of metabolic disturbances. A clinical important manifestation of the diabetic foot syndrome is the diabetic foot ulcer.

Diabetic patients are at higher risk for lower limb ulceration. Foot complications secondary to diabetes mellitus are the most common reason for hospital admission for these patients and frequently results in amputation.

The reasons for diabetic foot are -

Foot is the most vulnerable part of body for injury and infection, often neglected by patient.

Neuropathy, ischemia and soft tissue infection are the causative factors for diabetic foot problem. The site of preference for neuropathy and ischemia is also the foot. Most commonly an ulcer will result from sensory neuropathy which typically occurs on pressure bearing areas of foot, which may be initially unrecognized due to absence of pain resulting in continued trauma and ultimately infection. Infection is often polymicrobial and can be destructive involving deeper space, muscle, joints and bones.

In 2020, according to the International Diabetes Federation (IDF), 463 million people have diabetes in the world and 88 million people in the Southeast Asia region. Of this 88 million people, 77 million belong to India.¹ The prevalence of diabetes in Bihar is approximately 43%.²

Among diabetes mellitus related complications, foot ulceration is the most common, affecting approximately 15% of diabetic patients during their lifetime.³ This can be attributed to several social and cultural practices such as barefoot walking, inadequate facilities for diabetes care and education, and poor socioeconomic conditions.

It is important to note the increased prevalence of type two DM in children and adolescences, which by itself is a worldwide health problem. As a result, we unfortunately should expect the higher rate of micro and macro vascular complications of diabetes and increase rate of diabetic foot ulcer in younger ages.⁴

This leads to a major burden both on the patient and the health care system. The risk of amputation is a life-long threat to the diabetic patient, and the costs due to diabetic ulcers and amputation are high. Frequent assessment of risk factors is necessary for early detection of patients at risk, followed by strict diabetes regulation, patient education about foot care and appropriate footwear.

This study aims to enumerate the different risk factors which lead to the formation of diabetic foot ulcers in India, focusing in North Bihar and hopes to shed light on the modifiable ones which will lead to a lesser prevalence of diabetic foot ulcers.

The study also focuses on the commonest microorganisms infecting the diabetic foot patients in the Indian setting. According to western data, diabetic foot patients initially are infected with Gram positive flora. However, in Indian setting it is generally seen that patients have polymicrobial infections at the time of presentation.

The treatment of diabetic foot ulcers done in this study is the following, debridement, wound cover with flap, minor and major amputations.

Direct arterial anastomoses was not part of the study as the means and methods were not available at this hospital.

1. To determine the various predisposing factors for diabetic foot with respect to North Bihar population.
2. To analyse the different ways of clinical presentation of diabetic foot in our hospital.
3. To evaluate the usefulness of surgical management available with special emphasis on strict glycemic control.
4. To determine commonest microorganism/s infecting the diabetic foot patients in the North Bihar Population.

MATERIALS AND METHODS

Department of General Surgery, DARBHANGA MEDICAL COLLEGE AND HOSPITAL, LAHERIASARAI for 1 Year 8 month (April 2019 to December 2020).

58 Diabetic patients with foot ulcers admitted in this hospital, according to the WHO criteria, were selected for this study.

INCLUSION CRITERIA

All the patients with Diabetes Mellitus presenting with foot ulcers, infection of foot and gangrene of foot.

EXCLUSION CRITERIA

- 1) Patients with foot infections without Diabetes.
- 2) Patients with ulcer and Gangrene of foot other than Diabetic etiology.
- 3) Patients not agreeing to be part of study.
- 4) Miscellaneous:
 - Patient on steroids,
 - Malignancy,
 - HIV.

RESULTS AND ANALYSIS

Our study showed that most (70.7%) of the patients were with below primary and primary level of education ($Z=5.79$; $p<0.0001$). Patients were mostly from below average economic background (63.8%) which was significantly higher ($Z=3.90$; $p<0.0001$). 63.8% of the patients had habit of smoking which was significantly higher ($Z=3.90$; $p<0.0001$). 62.1% of the patients did not use footwear which was significantly higher ($Z=3.42$; $p=0.0006$). 75.9% of the patients had HTN which was significantly higher ($Z=7.32$; $p<0.001$). The mean duration of diabetes (mean $\pm$ s.d.) of the patients was 11.96 ± 4.06 years with range 7 - 25 years and the median was 10 years. Most of the patients (86.2%) had duration of diabetes ≥ 10 years which was significantly higher ($Z=10.23$; $p<0.0001$). Only 13.8% had duration of diabetes <10 years. The mean level of HbA1c (mean $\pm$ s.d.) of the patients was $8.11 \pm 1.42\%$ with range 5.80 - 11.20 % and the median was 7.95%. 72.4% of the patients had level of HbA1c $>7.0\%$ which was significantly higher ($Z=6.33$; $p<0.0001$). Most (46.6%) of the ulcers were in the Grade-II followed by Grade-III (20.7%) and Grade-I (19.0%). Proportion of patients with Grade-II was significantly higher ($Z=3.87$; $p<0.0001$). Sensory Abnormality was present in 63.8% of the patients which was significantly higher ($Z=3.90$; $p<0.0001$).

We found peripheral Pulse of 37.9% of the patients was absent. Infection was present in 86.2% of the cases which was significantly higher ($Z=10.23$; $p<0.0001$). Ulcers were mostly at dorsum (22.4%) ($Z=1.58$; $p=0.11$) followed by fore foot (13.8%) and great toe (13.8%). Ulcers were mostly right sided (67.2%) followed by left sided (31.0%) ($Z=5.12$; $p<0.001$). Only 1 (1.7%) patients had bilateral infection. In most of the cases microbes polymicrobial (58.6%) were found. *Escherichia coli* (62.0%) was most common among the microorganisms. Both debridement along with flap and debridement along with skin graft were undergone in 29.3% of the patients. In 15 (25.8%) of the cases amputation was done. The risk of sensory abnormality was 1.89 times more among the patients with age >55 years in comparison with the patients with age ≤ 55 years but the risk was not significant [OR-1.89 (0.62, 5.76); $p=0.25$]. Chi-square () test showed that there was significant association between sensory abnormality and Wagner grade of ulcers of the patients ($p<0.0001$). Significantly higher proportion of sensory abnormalities was found among the patients with higher Wagner grade. The risk of sensory abnormality was 1.38 times more among the patients with bare foot in comparison with the patients without bare foot but the risk was not significant [OR-1.38 (0.46, 4.14); $p=0.56$]. The risk of sensory abnormality was 9.79 times more among the patients with duration of diabetes >10 years in comparison with the patients with duration of diabetes ≤ 10 years and the risk was significant [OR-9.79 (1.95, 19.15); $p<0.0001$]. The risk of sensory abnormality was 11.00 times more among the patients with level of HbA1c $>7.0\%$ in comparison with the patients with level of HbA1c $\leq 7.0\%$ and the risk was significant [OR-11.00 (2.85, 42.45); $p=0.0001$].

Our study showed that the risk of absence of peripheral pulse was 1.57 times more among the patients with age >55 years in comparison with the patients with age ≤ 55 years but the risk was not significant [OR-1.57 (0.53, 4.58); $p=0.40$]. Chi-square () test showed that there was significant association between Peripheral Pulse and Wagner grade of ulcers of the patients ($p<0.0001$). The risk of absence of peripheral pulse was 1.90 times more among the patients with habit of smoking in comparison with the patients without habit of smoking but the risk was not significant [OR-1.90 (0.60, 6.01); $p=0.26$]. The risk of absence of peripheral pulse was 13.50 times more among the patients with duration of diabetes >10 years in comparison with the patients with duration of diabetes ≤ 10 years and the risk was significant [OR-13.50 (3.60, 50.54); $p<0.0001$].

Table-: Distribution of Footwear, Level of HbA1c and Site

		Number	%
Footwear	Barefoot	36	62.1%
	Normal	22	37.9%
	Total	58	100.0%
Level of HbA1c	>7.0	42	72.4%
	≤ 7.0	16	27.6%
	Total	58	100.0%
Site	Dorsum	13	22.4%
	Fore Foot	8	13.8%
	Great Toe	8	13.8%
	Heel	4	6.9%
	Planter Great Toe	4	6.9%
	Planter Mid Foot	3	5.2%
	Planter 1 st MT Head	2	3.4%
	Toe	2	3.4%
	2 nd & 5 th Toe	1	1.7%
	B/W 2 nd & 3 rd Toe	1	1.7%
	Dorsum and Planter	1	1.7%
	Foot Planter	1	1.7%
	Great Toe & 3 rd Toe	1	1.7%
	Leg and Foot	1	1.7%
	MT Head	1	1.7%
	Planter	1	1.7%
	Planter & Dorsum	1	1.7%
	Planter 3 rd MT Head	1	1.7%
	Planter Heel	1	1.7%
	Planter Mid Toe	1	1.7%
	Posterior Ankle	1	1.7%
	Sole Foot	1	1.7%
	Total	58	100.0%

DISCUSSION

Revealed that the mean (mean $\pm$ S.D.) age of the patients was 56.51 ± 7.14 years with range 42-75 years and the median age was 55 years. Most of the patients were with age between 50-69 years (86.3%) which was significantly higher ($Z=10.26$; $p<0.0001$).

As per the study that took place at National University Hospital, Singapore, in 2007, A Nather et al reported, an average age of 59.8 years.⁵

Vishwanathan et al⁶ conducted study on total of 1319 type 2 diabetic patients, according to the WHO criteria, were selected from four different centres across India. The centres were Diabetes Research Centre (DRC) Chennai, Government Rajaji Hospital (GRH) Madurai, Christian Medical College (CMC) Vellore and All India Institute of Medical Sciences (AIIMS) Delhi. The authors found a mean age of 53.7 ± 9.9 years in the AIIMS subset, 53 ± 11.8 years in the CMC, Vellore subset, 53.9 ± 11.3 years in the GRH, Madurai subset, and 52.9 ± 9.3 years in the DRC, Chennai subset.

In a Norwegian study, Iverson et al⁷, reported an average age of 67.2 ± 14 years.

Mehra et al, from Kasturba Gandhi Institute of Medical Sciences, Sevagram, conducted a study in 2002 - 03, which reported that the most common age group is 41 - 60 years (48.1%) and the mean age was 55.6 ± 12 years.⁸

Thus in this study the age of presentation of the patients was more or less comparable with other studies.

Proportion of males 41 (70.7%) was significantly higher than that of females 17 (29.3%) ($Z=5.85$; $p<0.0001$). The sex ratio was 2.4:1 (Male:Female).

A Nather et al⁵, from Singapore reported, 66 males (54.1%) and 56 females (45.9%) with a male to female sex ratio of 1.18:1.

Vishwanathan et al⁶, from India, reported, AIIMS Delhi, 131 males (62.7%) and 86 (37.3%) females, with a sex ratio of 1.36:1, CMC, Vellore, 169 males (66.8%) and 84 females (33.2%) with a sex ratio of 2.01:1. GRH Madurai showed 188 males (48.5%) and 199 females (51.5%) with a sex ratio of 0.95:1 and DRC Chennai shows, 313 males (67.7%) and 149 females (32.3%), with a sex ratio of 2.1:1.

Iverson et al ⁷, from Norway, reported, 56.8% male and 43.2% female with a sex ratio of 1.32:1.

Mehra et al ⁸, showed 84.6 % males and 15.4% females, with a sex ratio of 5.5:1.

Frykberg et al ⁹ found that male was indentured as a risk factor in a cross-sectional study with 251 patients, where 70% of the subjects with ulceration were males.

A. Nather et al ⁵, did not find smoking to be a predictive factor to diabetic foot ulcers ($p = 0.224$) on multivariate analysis. Smoking had been identified as a long-term risk factor for DFPs in several studies. It causes damage to blood vessels leading to poor circulation which increases the risk of foot lesions.

A number of studies had shown that smoking did not appear to be a direct risk factor for diabetic foot ulcers. However, Smoking to be a risk factor for ulceration. However, smoking is a strong risk factor for peripheral vascular disease, which is associated with diabetic foot ulcers.

However, smoking is a strong risk factor for peripheral vascular disease, which is associated with diabetic foot ulcers.

Vishwanathan et al ⁶, found a smoking history amongst 9% in AIIMS Delhi subset, 17% in CMC Vellore, 7% in GRH Madurai, and 13% in DRC Chennai. Iverson et al ⁷, noted 49.7% of people with diabetes mellitus, suffer foot ulcers.

There was a strongly significant association between smoking >10 cigarettes/day and amputation compared with those who smoked <10 cigarettes/day.

In this study patients found to be hypertensive was 75.9% ($p < 0.001$). (Table-8).

Vishwanathan et al ⁶, noted figures of 56% in AIIMS Delhi, 22%, in CMC Vellore, 44%, in GRH Madurai and 21% in DRC Chennai.

Adler et al ¹⁰ reported that individuals with co-existing hypertension had a five-fold increased risk of developing peripheral vascular disease (PVD) and thus the patients were at increased risk for amputation, compared to normotensive individuals with diabetes.

As in Table-7, 62.1% of the patients did not use footwear which was significantly higher ($Z = 3.42; p = 0.0006$).

In this study, as the results of Table-14, infection was present in 86.2% of the cases which was significantly higher ($Z = 10.23; p < 0.0001$). *Escherichia coli* (62.0%) was most common among the microorganisms (table-19).

In a study by Matthews and Lipsky ¹¹ (2007), it was found that *Staphylococcus aureus* was the most common pathogen isolated from diabetic foot ulcers (70%).

Gadepalli et al ¹² (2006), found almost 2.3 species per patient, most of which were aerobes (65%); anaerobes (1.3%) and mixed aerobes and anaerobes (33.7%). The ratio of gram-negative to gram-positive in the aerobic category was 1.5:1.0 (60.6 vs. 39.4%). Of the total, 51.4 and 33.3% were aerobic gram-negative and -positive bacteria, respectively.

Shankar et al ¹³ observed that the distribution of gram-negative bacteria (57.6%) is more common than that of gram-positive ones (42.3%) and it is contrary to the viewpoint that diabetic foot infections are frequently monomicrobial.

CONCLUSION

The socio-epidemiology of diabetic foot and its complications in India is entirely different from the West. Diabetic foot infections in India are often a consequence of wounds caused by the person wearing footwear that is not sufficiently protective (e.g., sandals) or poor fit, or wearing none at all. Poor hygiene may be associated with risk of rat bites and increases the risk of ulcer infection and may enable maggot infestation. There is a considerable delay by the patients in approaching the physician for foot problems. The delay in seeking proper health care is also because of lack of health-related education, nearby health care services, or financial resources. The prevalence of risk factors for foot

ulcer and infections, viz., neuropathy and vasculopathy, are different from the Western literature. Studies from India, suggest predominantly neuropathic ulcers unlike the West where neuroischemia is the most important predisposing factor. As compared to the West, which have predominant Gram-positive infections, centers throughout India have reported a consistent Gram-negative bacterial preponderance in DFI.

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