



## Study of Associated Risk Factors Leading to Complication in Diabetic Foot Ulcer

**Dr. S.N. GOLE**

Assistant Professor, Department of Surgery, Pt. J.N.M. Medical College & Dr. B.R. Ambedkar Memorial Hospital, Raipur (C.G.).

**Dr. CHAKRADHAR BARIHA**

SR, Department of Surgery, Pt. J.N.M. Medical College & Dr. B.R. Ambedkar Memorial Hospital, Raipur (C.G.).

### ABSTRACT

*Introduction- A diabetic foot ulcer is a poorly healing ulcer, caused by a combination of diabetes induced foot neuropathy, and diabetes induced vascular disease. Diabetic foot-related problems occur frequently and may have serious consequences. Amputations at different anatomical levels are the most serious of them.*

*Methods and study design- A cross sectional study was carried out in patients presenting with diabetic foot, attending the surgical OPD and casualty of Dr. BRAM Hospital, Raipur (C.G.) and admitted consecutively to surgical wards were included. Study was done in these patients from, August 2014 to September 2015. Data were collected including particulars of the patient, detailed history and examination. Wound is graded according to Wagner's classification system. 96 Cases were selected according to mentioned inclusion and exclusion criteria and on the basis of the simple random sampling technique.*

*Result- diabetic foot complications were multifactorial. most common risk factors leading to diabetic foot complications was diabetes induced Ischemia of small and large blood vessels, (21.87%), followed by Diabetic neuropathy (16.66%), Poor glycemic control (15.62), Structural Deformities (14.58%), Cigarette smoking (11.45%), Non-compliance (8.33%), Hypertension (5.20%).*

*Conclusion- The finding of this study is quite promising & shows associated various risk factors leading to complication in diabetic foot ulcers. We also know that patients with diabetes who undergo amputations are subsequently more likely to die & suffer further amputation. It also provides a useful database for starting a preventive foot care program & separate wound clinic for reduction in diabetic foot related morbidity & mortality.*

**KEYWORDS : Poor glycemic control, distal symmetrical polyneuropathy, Structural Deformities, Raipur, Chhattisgarh.**

### INTRODUCTION

The world health organization (WHO) defines diabetic foot as the lower limb of a diabetic patient that has the potential risk of pathologic consequences, including infection, ulceration, and/or destruction of deep tissues associated with neurologic abnormalities, various degrees of peripheral vascular disease and/or metabolic complication of diabetes<sup>1</sup>.

Diabetes & foot problems are almost synchronous. Neuropathy, Infection, Deformity & Ischemia are major threat to diabetic foot & overall wellbeing of diabetic Pt. Amputations are perhaps the most feared & well recognized complication of diabetes & diabetes continues to be one of the most common underlying factors associated with lower extremity amputation even in developing countries. Foot ulceration and amputation affect the quality of life for patients and create an economic burden for both the patient and the health care system.

Diabetes is a lifelong problem & the incidence of diabetic foot ulcers complication increases with age & duration of disease. Diabetic patient at risk of foot lesion must be educated about risk factors & importance of foot care including need for self-inspection, & surveillance, monitoring foot temperature, appropriate daily foot hygiene, use of proper footwear, good diabetes control & prompt recognition & professional treatment of newly discovered lesions. Although the end results of diabetic foot ulceration may be devastating, the development of ulceration is preventable.

The present study assumes significance in the Indian context, especially in Chhattisgarh area where mostly peoples are poor and illiterate, thus disease is itself detected late, there is little awareness for foot care in patients and there is a significant delay in seeking the treatment. Further, a significant population is rural and work in the fields barefoot, thus increasing the chances of further infection.

### RISK FACTORS

Risk factors implicated in the development of diabetic foot ulcers are- Diabetic neuropathy, Ischemia of small and large blood vessels, Hypertension, Cigarette smoking, Poor glycemic control, Non-compliance, Poor vision, Obesity, Previous foot ulcerations, Trauma, Re-

petitive shear stresses and structural Deformities -joint contractures, clawing of toes, spurs, extrusions of bones (as in Charcot neuroarthropathy), malunited fractures, and arthritides

### COMPLICATIONS OF DIABETIC FOOT ULCER

**1. Infection-** By the time the patient reports to a specialized Centre, infection is already deep seated. Infection of the planter accounts for majority of diabetic foot lesions. Continued ambulation in absence of pain due to neuropathy leads to further necrosis and spread of infection<sup>2</sup>

Such infected foot lead to toxic thrombosis of the vessels leading to ischemia thus aggravating the existing problem. The foot is often massively swollen, foul smelling and patient is toxic with sign of septicemia. Such an infected foot is often limb threatening requiring urgent amputation and is at times even life threatening.

**2. Gangrene -** Gangrene is defined as focal or extensive necrosis of the skin and underlying tissue. In the diabetic foot, however, smaller unnamed arteries may function as 'end - arteries' due to multiple complete blockade and/or partial constrictive atherosclerotic lesions. Therefore local edema and thrombosis due to toxins produced by some bacteria (mainly staphylococci and streptococci) may cause ischemic necrosis of the tip of a toe or a part of its surface or of one or more toes, even when pulses are present in the foot arteries. Gangrene of the fifth toe or the hallux is due to more extended atherosclerotic disease and will probably lead to toe amputation or disarticulation<sup>3</sup>.

**3. Septicemia-** Patients with diabetes mellitus who have sepsis limited to the forefoot requiring acute hospitalization and undergoing primary digit amputations have a high incidence of intermediate-term, persistent, and recurrent infection, leading to a modest rate of limb loss, despite having apparently salvageable lesions and non-invasive evidence of presumed adequate forefoot perfusion. Systemic spread of infection which include leukocytosis, fever, which can lead to ARDS /Renal failure<sup>4</sup>.

**4. Loss of foot or toes-** Peripheral arterial disease (PAD), infec-

tion, chronic hyperglycemia, and history of previous diabetic foot ulcers or amputation are significant risk factors for amputation. Ischemia is a contributory if not the major factor determining the need for a lower extremity amputation (LEA). In a study 59% of patients who had LEAs over a 5 year follow-up period had PAD and 5 year amputation rates were higher and times to amputation were shorter in this group<sup>5</sup>.

**5. Osteomyelitis-** the majority of diabetic foot ulcers have an underlying osteomyelitis that is clinically unsuspected. Leukocyte scans are highly sensitive for diagnosing osteomyelitis in diabetic foot ulcers and may be useful for monitoring the efficacy of antibiotic treatment. We recommend that diabetic patients with foot ulcers that expose bone should be treated for osteomyelitis<sup>6</sup>.

MEGGITT-WAGNER CLASSIFICATION

Meggitt-Wagner classification system assessed ulcer depth without co-morbidities such as ischemia or pressure load<sup>7</sup>.

Grade 0	No ulcer
Grade 1	Superficial skin ulcer
Grade 2	Deep ulcer extension in to ligament, tendon, joint capsule, fascia. Bone may be exposed No abscess or osteomyelitis
Grade 3	Deep ulcer with abscess or osteomyelitis or joint sepsis
Grade 4	Gangrene to portion of forefoot or heel
Grade 5	Extensive gangrene of foot

AIMS AND OBJECTIVE

1. To identify the risk factors presenting with diabetic foot ulcer.
2. To evaluate association of identified risk factors with the complication of diabetic foot ulcer.

MATERIALS AND METHODS

A cross sectional study was carried out in patients presenting with diabetic foot, attending the surgical OPD and casualty of Dr. BRAM Hospital, Raipur (C.G.) and admitted consecutively to surgical wards were included. Study was done in these patients from, September 2014 to August 2015. Data were collected including particulars of the patient, detailed history and examination. Wound is graded according to Wagner's classification system. 96 Cases were selected on the basis of the simple random sampling technique.

Inclusion criteria

1. All adult above 18 year old patient having diabetic foot ulcer.
2. Patient having neuropathic and ischemic foot ulcer secondary to diabetes mellitus.

Exclusion criteria

1. Foot ulcer secondary to venous disorders and arterial disorders other than diabetes mellitus.
2. Foot ulcer secondary to other causes of peripheral neuropathy like syringomyelia etc.

OBSERVATION

TABLE NO.1

DISTRIBUTION OF CASES ACCORDING TO AGE GROUP

AGE GROUP	No. of cases	%
18-30yr	8	8.33
30-45yr	25	26.04
45-60yr	41	42.70
>60yr	22	22.91

In our study majority of cases presented in the age group 45-60 years(42.70%),30-45 years(26.04) &>60 years (22.91%). The mean age of patients was 51.9 years

TABLE NO.2

DISTRIBUTION OF CASES ACCORDING TO SEX

WAGNER'S GRADE	MALE	FEMALE	P value
	no	no	
1	9	3	<0.005

2	20	7	<0.005
3	19	14	>0.005
4	10	6	<0.005
5	6	2	<0.005
TOTAL	64	32	

Present study includes 66.66% male & 33.33% female with male, female Ratio of 2:1. There is strong statistical association of diabetic foot with gender seen in grade 1, 2, 4 & 5 but not in grade 3. maximum number of cases presented in grade 3 & 2 (34.37% & 28.12% respectively) & only 8.33% presented in grade 5.

TABLE-3  
BACTERIOLOGY IN DIFFERENT DIABETIC FOOT

BACTERIOLOGY	No of cases	%
E. coli	33	34.34
Pseudomonas	17	17.70
Proteus	10	10.41
Mixed	10	10.41
Klebsiella	9	9.37
Staphylococcus aureus	8	8.33
No Growth	9	9.37

The table shows the common positive organism distributed in diabetic foot

The most common organism isolated in study is E.coli 33 (34.37%) with other being pseudomonas (17.70%), Staphylococcus aureus (8.33%), proteus (10.41%), klebsilla (9.37%) & no growth ((9.37%) , (10.41%) of wound showed mixed culture.

TABLE-4  
NEED FOR AMPUTATION IN DIFFERENT GRADES

WAGNER'S GRADE	NOT NEED AMPUTATION	NEEDED AMPUTATION			P value
		Total	Major	Minor	
1	12	0	0	0	--
2	26	1	0	1	<0.05
3	27	6	2	4	<0.05
4	2	14	0	14	<0.05
5	0	8	8	0	--
Total	67	29	10	19	--

The table shows distribution of cases according to of amputation in different grades.

Table reveals, total 30.20% patients required amputation, no patients in grade 1 required amputation, while all patients of grade 5(100%) required amputation.

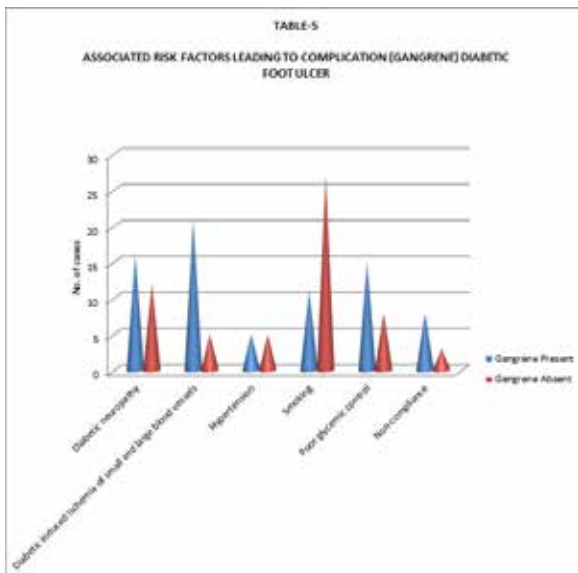
Statistical analysis reveals significant association in grade 2, 3 & 4 while in grade 5 all 100% patients required amputation.

TABLE NO.5  
ASSOCIATED RISK FACTORS LEADING TO COMPLICATION (GANGRENE) DIABETIC FOOT ULCER

Risk factors	Total No of cases	Gangrene	No of cases	%
Diabetic neuropathy	29	Gangrene Present	16	16.66
		Gangrene Absent	12	12.5
Diabetic induced Ischemia of small and large blood vessels	26	Present	21	21.87
		Absent	5	5.20

Hypertension	10	Present	5	5.20
		Absent	5	5.20
Smoking	38	Present	11	11.45
		Absent	27	28.12
Poor glycemic control	23	Present	15	15.62
		Absent	8	8.33
Non-compliance	11	Present	8	8.33
		Absent	3	3.12
Structural Deformities	45	Present	14	14.58
		Absent	31	32.29

The table shows associated risk factors leading to complication diabetic foot ulcers (gangrene). In our study most common risk factors leading to diabetic foot complications were diabetes induced Ischemia of small and large blood vessels, (21.87%), followed by Diabetic neuropathy (16.66%), Poor glycemic control (15.62), Structural Deformities (14.58%), Smoking(11.45%),Non- compliance(8.33%), Hypertension(5.20%).



## DISCUSSION

Total of 96 diabetic foot patients were enrolled for the study

### Age distribution

In our study most (42.70%) of the patients enrolled were in the age group 45- 60 years. while minimum were in the age group 18-30 years (8.33%)(Table-1).These findings endorse the findings of **Pecoraro RE et al**<sup>8</sup>, who showed that among hospital discharges for foot ulcer in US during 1983-90, the highest percentage were presents in 45 to 64 years of age while the lowest percentage was among persons <40 years of age.

### Sex distribution

Present study includes 64(66.66%) male & 32(33.33%) female with male to female ratio of 2:1(Table-2). There is strong statistical association of diabetic foot with gender seen in grade 1, 2, 4 & 5 but not in grade 3. Maximum number of cases presented in grade 3 & 2 (34.37%& 28.12% respectively) & only 8.33% presented in grade 5.

In a retrospective study conducted at Carillon Roanoke Community Hospital in Virginia, USA by **Stepha L et al**<sup>9</sup>. The incidence was found to be 53% amongst males and 47% amongst females (1.27:1).

In our study the proportion of males to females was much greater than the above study which could be attributed to the social circumstances prevailing in our country. In our country females are relegated the secondary place in society. Majority of smokers were males. There is much discrepancy in the actual incidence of disease and their report to the hospital. Another contributing factor may be the difference in nature of jobs being performed by males and females. In our social structure, the female are mostly restricted to household work, where the control over sanitation is more as compared to outdoor

jobs were males are more involved.

### Wagner's grading

In our study we classify wound according to **Wagner system**<sup>10</sup>. In our study maximum proportion of cases (34.37%) were graded as grade 3 and grade 2 (28.12%) according to Wagner's grading criteria and rest of cases were graded as 1 (12.5%), grade 4 (16.66%) & grade 5 (8.33%) (Table-2).

Similar study in India by **Bhupendra et al**<sup>11</sup>, at wardha, (2008), showed grade 2 lesions to be most common (30.8%) followed by grade 3, grade 4 & grade 1.

The different would be attributed to the low educational status of rural population which leads to delayed presentation. Thus, although in our study grade 3 is more common, the percentage wise difference between this study & others study in India in past is insignificant.

### Bacteriology & patients needed treatment in different bacterial infection

In our study E-Coli is most common bacteria isolated followed by Pseudomonas. Poor outcomes were seen with pseudomonas, Klebsiella microorganisms. Good outcomes were seen with Staphylococcus aureus, proteus & others. Antibacterial agents given to patient, depending upon cultured and sensitivity report (Table-3).

Similar study by another Indian worker **C. Anandi et al**<sup>13</sup>, showed E. coli to be most common among aerobes & clostridium perfringens in anaerobes. Other aerobes include Klebsiella. Pseudomonas, proteus and Staphylococcus aureus.

### Need for amputation in different grades

In our study total 30.20% patients required amputation, no patients in grade 1 required amputation, while all patients of grade 5(100%) required amputation. Statistical analysis reveals significant association in grade 2, 3 & 4 while in grade 5 all 100% patients required amputation. Study by **Edouard Ghanassia et al**<sup>12</sup> showed 43.8% patients, required amputation during a follow up of 6.5 years (Table-5).

### Associated risk factors leading to complication in diabetic foot ulcers

In our study diabetic foot complications were multifactorial. Most common risk factors leading to diabetic foot complications were diabetes induced Ischemia of small and large blood vessels, (21.87%), followed by Diabetic neuropathy (16.66%), Poor glycemic control (15.62), Structural Deformities (14.58%), Smoking(11.45%),Non- compliance(8.33%), Hypertension(5.20%)(Table-5).

In a study by **Abott A et al**<sup>13</sup>, 21.9% European subjects had absent distal pulsations below popliteal. Similarly the present study shows Sensory involvement in up to 39.16% of subjects which is much higher than some standard studies in west which shows, only 11-20% cases had neurological involvement.

The reason probably is due to delayed diagnosis of both diabetes and foot lesions. Diagnosed diabetics mostly are uncontrolled either due to inadequate treatment or they are defaulters. Thus neuropathy vasculopathy gets accelerated in these poor patients.

Poor control of diabetic status at the time of presentation was also observed by **Young P.J. et al**<sup>14</sup>.

Studies in the United States of America have reported that foot deformities contribute as much as 78% to foot ulceration (**Ronald et al**<sup>15</sup>). In this study, foot deformity was however, present in 46.87% of the subjects with the foot lesion. The mechanical abnormalities found in this study included prominent metatarsals, callus formation, claw toes, hallux valgus, hammer toes, & high arching of the feet. Among patients who have lost protective sensation, the most common mechanism of injury appears to be unperceived, excessive and repetitive pressure on sites of foot deformities. This leads to elevated focal pressure making ulceration even more likely. Some cases also presents as metallic foreign body in wound.

**Forrest (1997)**<sup>16</sup> Showed that hypertension, and smoking were all independent predictors of the incidence of distal symmetrical pol-

neuropathy. The results indicate that in addition to good glycemic control, avoidance of smoking and good blood pressure control may be helpful in preventing or delaying the onset of distal symmetrical polyneuropathy in IDDM patients.

## CONCLUSION

On the basis of observation made & their analysis, the following conclusions were drawn:-

In our study maximum (42.70%) of the patients enrolled were in the age group 45- 60 years.

Male to female ratio of 2:1 was seen in the present study. The study found that genders do play a role in presentation of foot lesion in early & late stages in hospitals.

Most of cases presented in Wagner's grade 3 (34.37%).

Gram-Negative bacteria are most common pathogens in this area (E-Coli in 34.37%, Pseudomonas in 17.70%, Proteus in 10.41% & Klebsiella in 9.37%). Staphylococcus aureus is present in only 8.33% of cultures. 10% culture shows mixed growth & 9% were sterile (i.e. No growth) at presentation.

In our study 30.20% diabetic foot patients presenting in this hospital requires amputation either major or minor. Whereas aggressive debridement & dressing is needed in all of them.

In our study diabetic foot complications were multifactorial. Most common risk factors leading to diabetic foot complications was diabetes induced Ischemia of small and large blood vessels, (21.87%), followed by Diabetic neuropathy (16.66%), Poor glycemic control (15.62), Structural Deformities(14.58%),Smoking(11.45%), Noncompliance(8.33%),Hypertension(5.20%).

The finding of this study is quite promising & shows associated various risk factors leading to complication in diabetic foot ulcers. We also know that patients with diabetes who undergo amputations are subsequently more likely to die & suffer further amputation. It also provides a useful database for starting a preventive foot care program & separate wound clinic for reduction in diabetic foot related morbidity & mortality.

## REFERENCE

1. WHO/IDF. Definitions and diagnosis of Diabetes and Intermediate Hyper glycaemia. 2006, 71/2. Word Health Organization.
2. S Pendsey, K Bakker,ZG Abbas. Step by Step, improving diabetic foot care in the developing world, M Med 2006 Volume 23 Issue 8, Pages 365 – 369.
3. Jude Rodrigues and Nivedita Mitta- Diabetic Foot and Gangrene Department of Surgery, Goa Medical College, India 2011.
4. Mark R. Nehler, MD, Presented at the Thirteenth Annual Meeting of the Western Vascular Society, Whistler, British Columbia, Sep 10–13, 1998.
5. Diabetic Foot Ulceration and Amputation Stephanie Burns<sup>1</sup> and Yih-Kuen Jan<sup>2</sup> <sup>1</sup>Veterans Affairs Medical Center, Department of Physical Therapy, <sup>2</sup>University of Oklahoma Health Sciences Center, Department of Rehabilitation Sciences, Oklahoma City, Oklahoma, USA.
6. Lisa G. Newman, MD Unsuspected Osteomyelitis in Diabetic Foot Ulcers. Diagnosis and Monitoring by Leukocyte Scanning With Indium In 111 Oxyquinoline JAMA. 1991;266(9):1246-1251.
7. Treece KA, Macfarlane RM, Pound N, Game FL, Jeffcoate WJ: Validation of a system of foot ulcer classification in diabetes mellitus. Diabet Med 21:987-991, 2004.
8. Pecoraro RE, Reiber GE. Classification of wounds in diabetic amputees. Wounds 1990; 2:65-73.
9. Stephen L. Hill MD, a, Golde I. Holtzman PhD and Roxanne Buse MDa : The effects of peripheral vascular disease with osteomyelitis in the diabetic foot. Department of Surgery (SLH, RE), Carilion Medical Center, Roanoke, Virginia, USA The American Journal of Surgery Volume 177, Issue 4, April 1999, Pages 282-286.
10. Wagner FW: Supplement: algorithms of foot care. In The Diabetic Foot. 3 rd ed. Levin ME, O'Neal LW, Eds. St. Louis, MO, CV. Mosby, 1983, p. 291-302.
11. Bhupendra R. Mehral , Anald P. Thawaitl, Sou S. Karancililr „t al. Evaluation of foot problems (imong diabetics in rural population; 2008 August, Indian Journal of Surgery ISSN 0972-2068 Volume 70.
12. Kajetan M, Konkoly TM, Jermendy G. Experience with microbiological studies of the diabetic foot. Orv Hetil 136: 2161-2164.
13. Abbott JD, Huang y, Liu D, Hickey R, Krause DS, Giordano FJ. Stromal cell -derived factor- lalpha plays a critical role in stem cell recruitment. Circulation 2004;110:3300-

3305.

14. Young MJ, Vet% es A, Walker MG, Boulton MM. Correlations between nerve function and tissue oxygenation in diabetic patients: further clues to the aetiology of diabetic neuropathy? Diabetologia 1992;35:1146-1150.
15. Ronald A. Sage, DPM\*, Julie Kate Webster, DPM and Susan Gross Fisher :Outpatient Care and Morbidity Reduction in Diabetic Foot Ulcers Associated gwith Chronic Pressure Callus, Journal of the American Podiatric Medical Association Volume 91 Number 6 275-279 2001.
16. By:Forrest, KYZ (Forrest, KYZ); Maser, RE (Maser, RE); Pambianco, G (Pambianco, G); Becker, DJ (Becker, DJ); Orchard, TJ (Orchard, TJ) DIABETES Volume: 46 Issue: 4,Pages: 665-670Published: APR 1997.