

Impact of Peripheral Neuropathy and Peripheral Vascular Disease in Diabetic Foot Syndrome

Dr.C.Tharun Ganapathy¹, Dr.R.Jai Vinod Kumar², Dr.Shruthi Chandrasekar³.

¹Department of General Surgery, SRM Medical College and Research Institute, Kattankulathur, Tamil Nadu, India.

²Department of General Surgery, SRM Medical College and Research Institute, Kattankulathur, Tamil Nadu, India.

³Department of General Surgery, SRM Medical College and Research Institute, Kattankulathur, Tamil Nadu, India.

Abstract

Introduction: Diabetic foot syndrome is one of the major complications of Diabetes mellitus. In India, the prevalence of diabetic foot ulcers was estimated to be 3.6%. So this study was planned to estimate the influence of peripheral neuropathy and peripheral vascular disease in the outcome of diabetic foot management.

Objectives: To ascertain the risk of peripheral neuropathy and peripheral vascular disease in diabetic foot ulcers.

Methodology: A prospective study was conducted on 70 patients diagnosed with diabetic foot ulcers. All patients in the study group after thorough clinical examination and laboratory investigations were subjected to undergo Semmes Weinstein Monofilament test, Vibration Perception Threshold (VPT), and nerve conduction studies. Peripheral vascularity was assessed by Ankle brachial pressure under and Duplex Doppler study. The outcome of the patients was assessed by recording the healing time, requirement of surgery and the amputation rates.

Results: In our study, on Wagner's grading, the common grades were grades II to IV, 46% of them were on the toes and 40% on the plantar and metatarsal head of foot and heel. In the ulcer groups, neuropathic ulcer were more common (51.4%), compared to neuro-ischaemic ulcers (32.87%) and others (12.8%). The amputation rates were higher in neuroischaemic group (69.4%), when compared to other two groups and the healing rate were better in the neuropathic group (94%) compared to neuroischemic group (87%). This signifies that the presence of neuropathy increase the chance of foot ulceration and the presence of ischemia worsens the presentation which further affects the outcome of the ulcer.

Conclusion: From our study we confirm that peripheral neuropathy is the predominant factor for foot ulceration as the insensate foot is prone for undue trauma. The coexistence of peripheral vascular disease worsens the morbidity and mortality of the diabetic foot syndrome.

Key Words: Diabetic foot, diabetic ulcer, peripheral neuropathy, peripheral vascular disease, Wagner's grade

I. Introduction

The prevalence of diabetes is rapidly rising all over the globe at an alarming rate. Diabetes is accompanied by a progressive tissue damage secondary to micro and macrovascular complications.

Complications affecting diabetes are many with some of the most catastrophic ones affecting the lower extremities. 20% of all hospital admissions for diabetes were the result of foot problems.¹ 91.8% of amputations were performed secondary to gangrene, necrosis, ulcer, nearly one half of these patients were diabetics.²

The pathogenesis of diabetic foot are neuropathy, microvascular and macrovascular diseases.^{3 4 5}. Their process may occur exclusively or they may occur together in varying degrees placing patients at risk for morbidity such as ulceration, gangrene and infection. This is especially true if these pathological changes are combined with a foot deformity, making patients more vulnerable to foot problems.

Bauman et al.^{3 6} demonstrated that even slight pressure over a fixed bony deformity, such as a prominent metatarsal head or a hammer toe lead to ischemic necrosis and ulceration of skin. For this reason it is necessary to identify the patients at increased risk.

Apart from other diabetic complications, one long term complication of diabetes is neuropathy,⁶ which causes foot ulceration in diabetic patients. Despite considerable research, the pathogenesis of diabetic neuropathy remains undetermined.⁷ Current hypothesis regarding the etiology of diabetic neuropathy are centered on a combination of metabolic effects secondary to hyperglycemia and vascular changes that results in nerve hypoxia.⁸ Evidence for hypoxia as etiology is considerable and includes reduced endoneural blood flow, increased vascular resistance, and decreased endothelial production of nitric oxide.^{9 10}

Although microvascular dysfunction has been mainly implicated, the role of peripheral vascular disease remains considerable, as it appears likely that a decrease in total limb blood flow would potentiate nerve ischemia. Hence both peripheral neuropathy and peripheral vascular disease are one of the commonest etiology agents in diabetic foot ulcer, apart from other risk factors.

Upon considering these factors into account, a prospective study was conducted in diabetic patients with diabetic foot ulcers and assessment of peripheral neuropathy and peripheral vascular disease was done and the outcome of the patients was assessed.

II. Methodology

A prospective study was conducted on 70 patients diagnosed as diabetic and with foot ulcer attending the diabetic OPD and surgical units of SRM Medical College & Hospital over a period of 2 years.(Aug 2013 to July 2015). The patients included in this study were all above 30 years, previously not diagnosed to have peripheral neuropathy and peripheral vascular disease.

A detailed clinical history of their problem, and the foot ulcer was thoroughly examined for all patients included in the study population. All required laboratory investigations were done. Neuropathy testing was done using Semmes Weinstein Monofilament test(SWM), Vibration Perception Threshold(VPT) and Nerve conduction studies(NCS). Peripheral vascularity was assessed clinically with Ankle Brachial Pressure Index(ABPI) and B mode Duplex Doppler study. Grading of the ulcers were done using Wagner's grading.

All patient included in the study were treated as per the treating team. The outcome of the patients was assessed by recording the healing time, mode of surgery and the amputation rates. All the above data were analysed and formulated as tables and charts.

III. Results

In our study of 70 patients with diabetic foot ulcers, 6 (56.7%) were males and 24 (34.3%) were females. The mean age group was 55 + 5 years. The average duration of diabetes in the study population was 5.2 years. 48 (68.5%) patients had history of minor trauma due to bare foot walking and ill fitting foot wear, 3 (4.28%) patients had toenail infection, 13 (18.5%) patients had history of thorn prick.

In our study, ulcer grading was done according to Wagner's grading system. Grade 0 (1.4%), grade I (1.4%), grade II (34.3%), Grade III (24.3%), grade IV (37.2%), grade V (1.4%). Most of the ulcers were predominantly between grades II to IV.

Out of all diabetic ulcers, 46% of them were on the toes and 40% on the plantar aspect and metatarsal head of foot and heel. This signifies the importance of the need for patient education and frequent self evaluation of toes and pressure bearing areas of foot.

84% of the population from our study had peripheral neuropathy of which most of the patients had sensory motor neuropathy (89.8%). We also observed that motor neuropathy is also more common in patients with diabetic foot which lead to small muscle atrophy and deformities leading to foot ulcerations.

33% of the patients had presence of peripheral vascular disease which is one third of the study population. Out of which 18 (26%) had stenosis in peripheral arteries, 3 (4%) had complete occlusion and 2 (3%) had both stenosis and occlusion of peripheral arteries. 31.4% of patients had ABPI reading 0.9 to 0.6 and 1.42% had $ABPI \leq 0.45$.

In the ulcer groups, the neuropathic ulcer were more common (51.4%) compared to the neuro-ischaemic ulcer(32.87%) and others (12.8%)which indicates that substantial amount of population suffer both neuropathic and peripheral vascular problems.

In analyzing the outcome of these patients in the above three groups, the amputation rates were higher in neuro-ischaemic group (69.4%) when compared to other two groups which signifies that most of the patients undergoing amputation are predominantly due to combination of neuropathy, ischaemia and infection.

The outcome of the patients with diabetic foot ulcers, treated surgically were assessed depending on the wound healing time. The healing rate were better in the neuropathic group (94%) compared to neuro-ischaemic group (87%) which signifies that the presence of neuropathy increase the chance of foot ulceration and the presence of ischemia worsens the presentation and which further affects the outcome of the ulcer.

Hence both these factors play an important role in the prognosis of the disease apart from other associated risk factors like hyperglycemia, infection, osteomyelitis and deformity.

IV. Figures And Tables

Table 1. Duration Of Diabetes

Duration (in year)	Number of Patients	Percentage
0-2	15	21.4
2-4	14	20.0
4-6	24	34.3
6-8	8	11.4

8-10	5	7.4
10-12	1	1.4
12-14	2	2.8
14-16	1	1.4

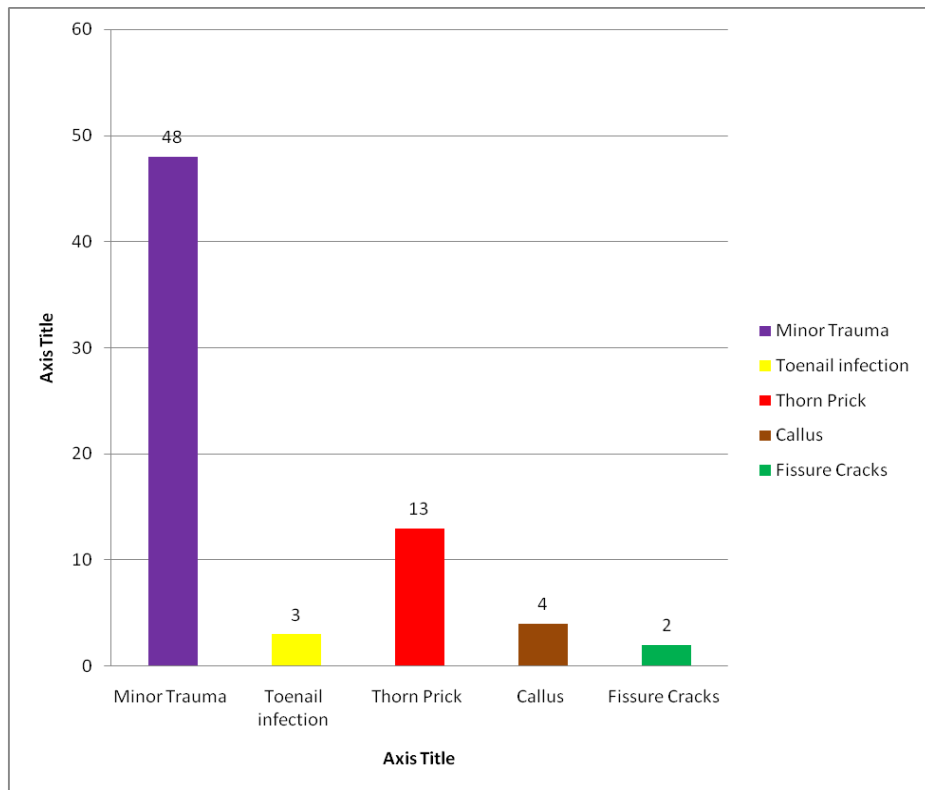


Figure 1. Predisposing external risk factors

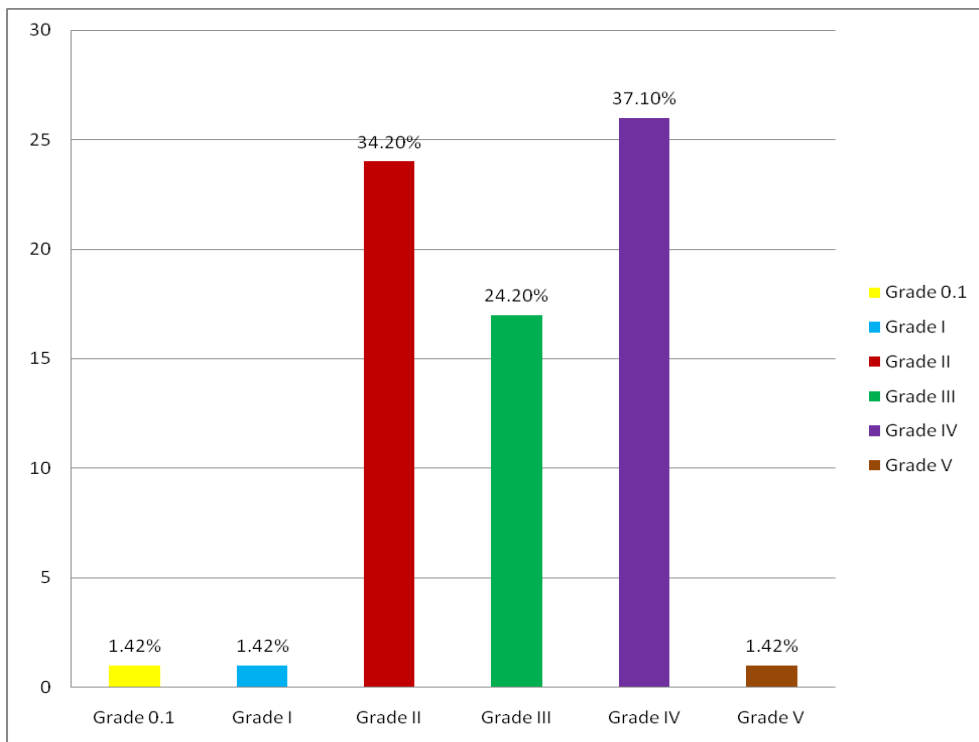


Figure -2 Distribution of grades of diabetic foot ulcers

Table -2 Distribution Of Foot Lesions

Foot lesions	Number of patients	Percentage
Toe	32	45.7
Plantar, Metatarsal Head, Mid Foot, Heel	28	40
Dorsum of Foot	10	14.3
Multiple Ulcers	0	0

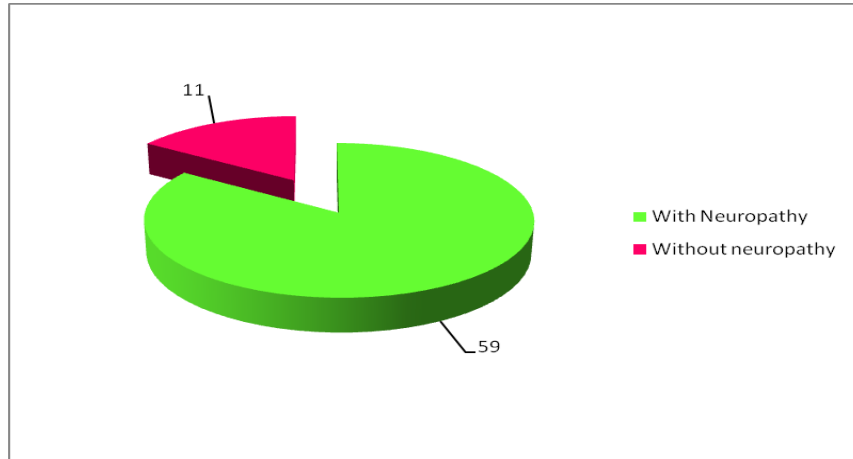


Figure -3 Distribution score with and without neuropathy

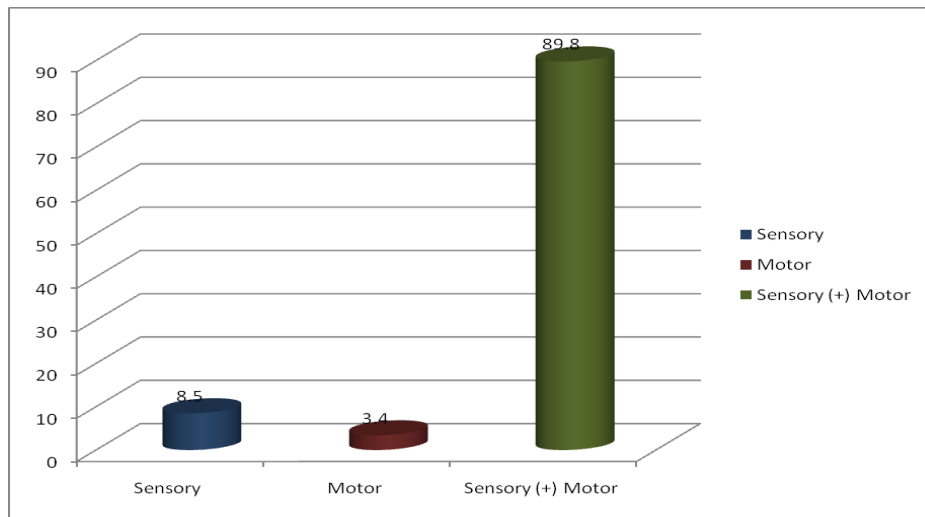


Figure -4 Distribution score following nerve conduction study

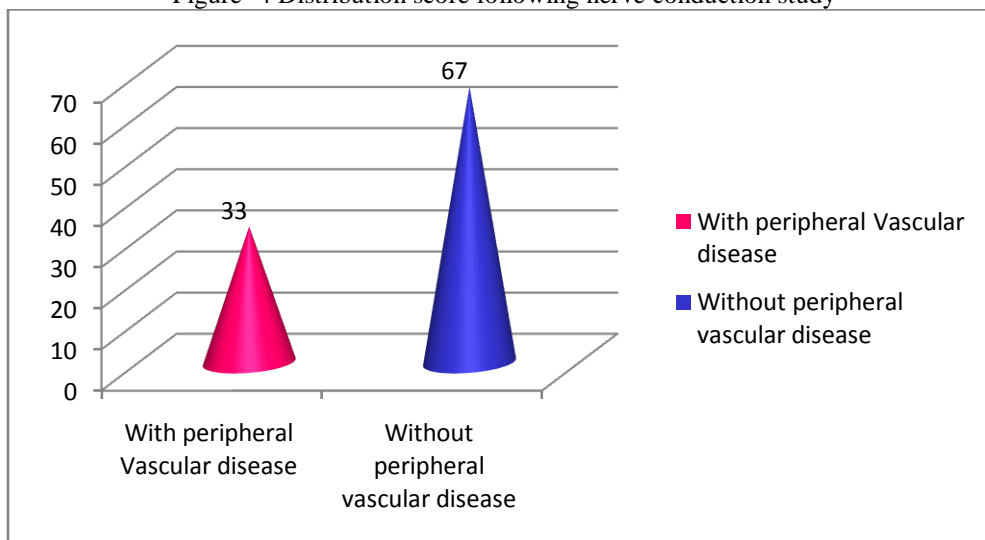


Figure -5 Distribution score according to the Peripheral vascular status

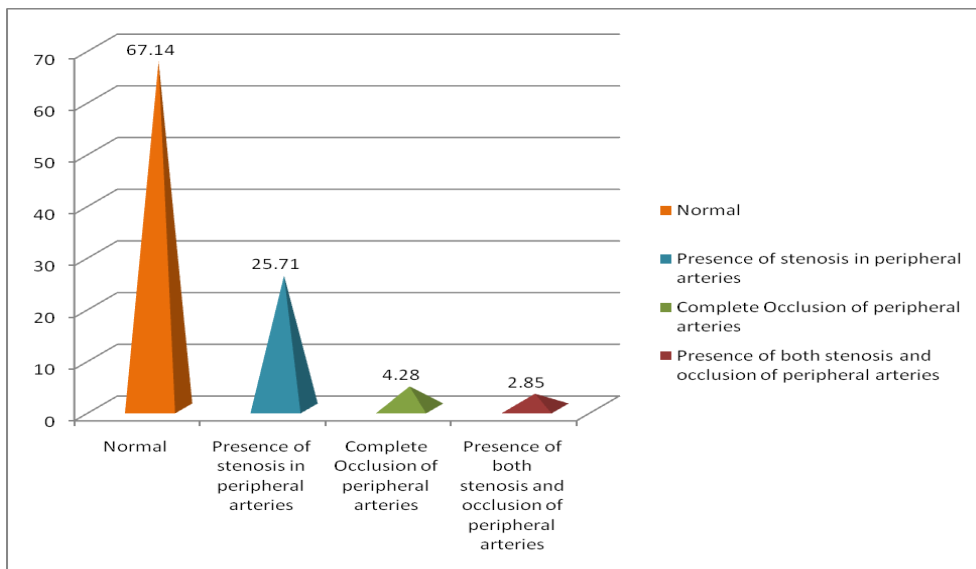


Figure -6 Distribution of score related to doppler study

Table -3 Distribution of Score According To Ankle Brachial Pressure Index (Abpi)

ABPI	Number of patients	Percentage
1.1-1	47	67.14
0.9 to 0.6	22	31.4
≤0.45	1	1.42

Table -4 Distribution Of Score Categorized In Ulcer Groups

Categories	Number of patients	Percentage
Neuropathic	36	51.4
Neuro- Ischaemic	23	32.8
Infective(Nonischaemic/Neuropathy)	11	12.8

Table -5 Distribution Of Patients Undergone Amputation

Categories	Minor amputation *	Major amputation **	Total amputation
Neuropathic (n=36)	4(11.1%)	-	11.11
Neuro-ischaemic(n=23)	12 (52.17%)	4 (17.3%)	69.4
Infection (Nonischaemic/Neuropathic)(n=9)	4 (44.4%)	1 (11.1%)	66.5

*Toe amputation

** Forefoot, BK AK amputation

Table -6 Distribution Of Outcome Of The Patients

Categories	Healed *	Unhealed**	Mortality ***
Neuropathic(n=36)	34 (94.%)	2(6%)	-
Neuro-ischaemic(n=23)	20 (87%)	2 (9%)	1 (4.3)
Infection (Non ischaemic/Neuropathic)(n=9)	9(82%)	2 (18%)	-

*with in a period of 6 months either by full primary healing or by SSG

**healing time ore than 6 months period going for further surgeries

***patient dead due to complication of the wounds

V. Conclusion

From our study we confirm that peripheral neuropathy is the predominant factor for foot ulceration as the insensate foot is prone for undue trauma. The coexistence of peripheral vascular disease worsens the morbidity and mortality of the diabetic foot syndrome. Peripheral vascular disease further increases the amputation rates and reduces the healing time.

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