

Original Article

THE PLANTAR PRESSURE STUDY IN DIABETIC PATIENTS AND ITS USE TO PROGNOSTICATE DIABETIC FOOT ULCERS.

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ABSTRACT

The aim of the study was to study the distribution of plantar pressure in patients with diabetes of more than 5 years duration with or without neuropathy and to prognosticate the occurrence of foot ulcers. The study was conducted at Era's Lucknow Medical College and Hospital, Lucknow and Jai Clinic and diabetes care centre, Lucknow. The subjects included in the study were 40 patients with type-II diabetes in age group of 55-65 years and 10 non-diabetic controls in the same age group. The diabetic subjects were divided into two categories – with neuropathy and without neuropathy using biothesiometry. The plantar pressure distribution was seen in these subjects using PRADIPAD. The plantar pressure was increased in the anterior part of foot in more cases usually on the medial side (head of first metatarsal). No significant difference was seen in the high pressure zone in the patients with or without neuropathy in the current study.

Key Words: plantar, neuropathy, diabetes, biothesiometry, metatarsal head, heel

INTRODUCTION

The foot is an extremely complex and flexible structure. It is composed of network of bones, joints, ligaments and numerous muscles that work together to provide the body with support, forward propulsion, adaptation to uneven surfaces and absorption of shock. The complex interaction of foot bones and joints allows the wide range of movement exhibited by foot during walking. The body weight is transmitted from the femur and tibia through the talus and calcaneus and head of metatarsals to the ground.

In the recent years, the plantar pressure has been widely accepted as a vital biomechanical parameter. In diabetic individuals, neuropathy hinders the redistribution of plantar pressure points thus leading to susceptible areas where there is constant capillary blanching which may develop into trophic ulcers.

Diabetes leads to neurovascular complications that alter the normal biomechanics of foot, producing high pressure areas at the metatarsal heads, heel and toe regions. For this reason it is of vital

importance to identify these areas using pressure measurements in order to prevent foot injuries. The identification of the risk factors, preventive foot maintenance and regular foot examinations are essential to prevent foot ulcers in patients with diabetes.

The various structural and functional factors of foot function have been associated with high plantar pressures and this may be responsible for plantar ulceration in patients with diabetes. Risk assessment of diabetic foot would be made easier if elevated plantar pressure could be indicated. The rising incidence of diabetes and its complications are going to pose a great health problem in our country. Timely and effective intervention and screening tests for complications could help in controlling the disease.

We hypothesized that the patient with diabetes would show an altered distribution pattern of plantar pressure when compared with non-diabetic controls.

In the recent years, the plantar pressure has widely been accepted as a vital biomechanical parameter to evaluate the relationship between

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excessive localized pressure and ulceration in the foot of diabetic patients.⁽¹⁾

The development of diabetic foot ulcers is associated with high amount of pressure exerted on certain regions of foot.

The patients of diabetes mellitus with neuropathy are at risk of recurrent ulceration and impaired pain because of increased pressure under metatarsal head. The redistribution of pressure points may be essential in the prevention of trophic ulcers in susceptible individuals.⁽²⁾

A number of factors like the peripheral vascular disease, changes in the foot architecture, peripheral sensory neuropathy and plantar pressure are considered to be the prime etiological factors for the development of ulcers.^(3,4) The plantar pressure analyses have been described for understanding the diabetic foot function as well as for the possibilities of therapeutic intervention.

The long term sequel of diabetic foot includes motor neuropathy that leads to the clawing of toes and prominent metatarsal heads.⁽⁵⁾ Motor neuropathy is perhaps the most important etiopathogenic factor in the production of high foot pressures. Motor neuropathy causes intrinsic muscle atrophy that promotes foot deformity and decreased joint mobility.⁽⁶⁾ The final result of these changes is the development of high foot pressures under metatarsal heads and loss of toe function especially the great toe.^(7,8)

Because of sensory neuropathy high pressure may lead to tissue breakdown and development of ulceration. The combination of peripheral vascular disease and neuropathy makes the diabetic patients susceptible to foot ulceration and infection.⁽⁹⁾ The plantar pressure are higher in diabetic patients following partial foot amputation as well further increasing the risk of tissue breakdown and re amputation.⁽¹⁰⁾

Abnormal mechanical loading of foot result in repetitive pressure applied to the plantar aspect of foot during walking has a important role in development of diabetic foot diseases. Diabetes leads to neurovascular complications that alter the normal biomechanics of foot, producing high pressure areas at the metatarsal heads, heel and toe regions. So it is important to identify these areas using pressure measurements in order to prevent foot injuries.

MATERIAL AND METHODS

50 subjects were included in the study. 40 subjects were diabetic patients in the age group of 55-65 years with diabetes of 8-15 years duration and 10 subjects were non-diabetic controls in the same age group.

The subjects underwent neuropathy assessment using biothesiometer and the 40 diabetic subjects were divided into two groups, one with neuropathy and other without neuropathy. Subsequently the plantar pressure assessment was done using thermal scanner on PRADIP PAD.

Each subject was asked to walk few steps with one step on PRADIP PAD . The plantar impressions taken on standardized paper are scanned and plantar pressure analysis was done using high resolution image calibrated with primary standards. The subjects were categorized as follows after analysis:

- 1) Subjects with increased plantar pressure under first metatarsal head (medial)
- 2) Subjects with increased plantar pressure under second & third metatarsal head (central)
- 3) Subjects with increased plantar pressure under fourth & fifth metatarsal head (lateral)
- 4) Subjects with increased plantar pressure under heel
- 5) Subjects with equal distribution of plantar pressure (equal distribution)

OBSERVATIONS & RESULTS

On application of Chi- square test , it was seen that at 5% level of significance there is no association between incidence of increased plantar pressure & neuropathy in the two groups of study diabetic subjects with and without polyneuropathy.

Table No. 01. Patient characteristics

	PNP (-) (Polyneuropathy negative)	PNP (+) (Polyneuropathy positive)	CONTROL
No. of patients	20	20	10
Gender (Male/ Female)	12/8	10/10	4/6

Table No. 2(a). Patient characteristics

	PNP(-) (Polyneuropathy negative)						PNP(+) (Polyneuropathy positive)						CONTROL					
	Male / Female			Male / Female			Male / Female			Male / Female			Male / Female					
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range			
Age (years)	59.2	6.8	9	58.0	7.1	10	61.2	8.3	10	57.9	8.1	8	62.0	6.2	6	58.4	7.6	9
Duration of diabetes (yrs)	11.9	6.3	6	10.8	7.2	7	12.3	7.8	5	10.9	5.7	6	-	-	-	-	-	-
HBA1c (%)	9.8	1.3	4.2	7.9	1.5	4.6	8.2	0.9	3.9	8.8	1.7	4.4	5.3	0.5	1.1	5.4	0.7	1.3
BMI(Kg/m)	29.6	3.9	8.6	30.1	4.2	8.3	28.7	4.9	9.2	29.7	3.5	7.2	27.1	4.8	8.0	30.1	5.3	9.0

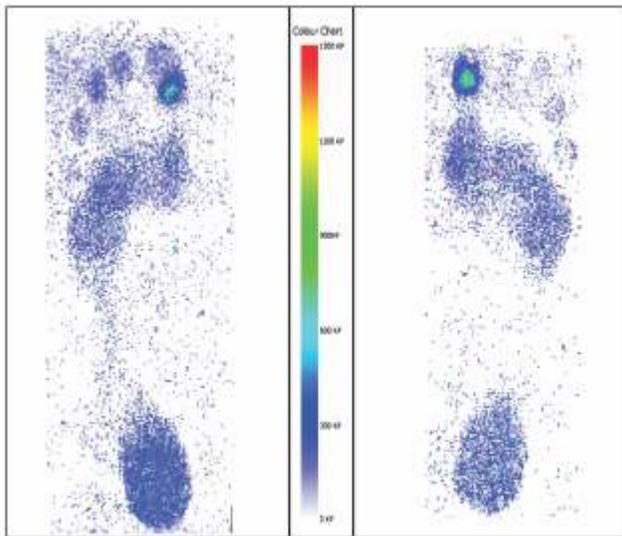


Fig. 01. Plantar pressure scan

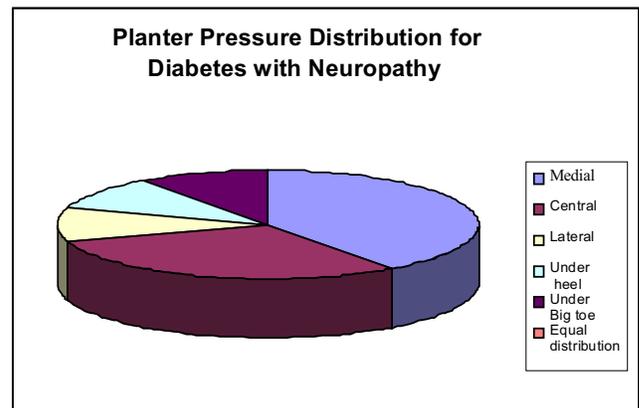


Fig. 02. Pie chart showing the Planter Pressure Distribution for diabetes with Neuropathy

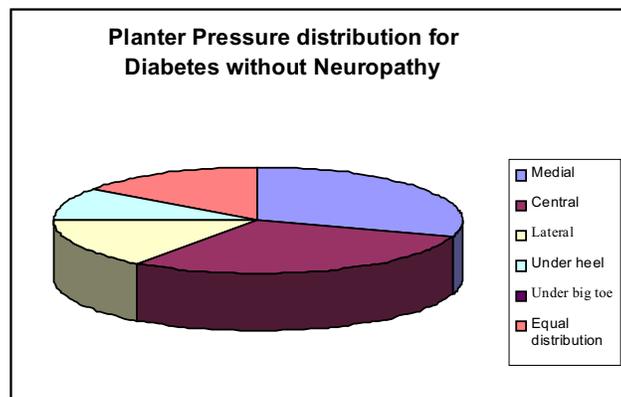


Fig. 03. Pie chart showing the Planter Pressure Distribution for diabetes without Neuropathy

Table No. 3. Plantar Pressure distribution

Increased pressure	DIABETES WITH NEUROPATHY(20)	DIABETES WITHOUT NEUROPATHY(20)	CONTROL (10)
Medial	8	6	-
Central	6	6	-
Lateral	2	3	-
Under heel	2	2	-
Under big toe	2	-	-
Equal distribution	-	3	10

DISCUSSION

India is emerging as the global capital of diabetes. It is the major cause of non-traumatic amputation of foot in the world. This study model can go a long way in dealing with this calamity. This study has wide ranging clinical and social ramifications for we can prognosticate the occurrence of diabetic foot ulcers and prevent it by primary intervention. India is emerging as the global capital of diabetic complications. The scourge of diabetic foot has a bearing on all aspects of individual's life be it social, financial or occupational. The cost of managing diabetic foot is very high, beyond the reach of the most of our diabetic population, leading to the unfortunate event of limb loss and loss of livelihood. Thermal scan is a cheaper method of assessing high pressure areas in the foot and beautifully illustrated pictures derived from the software using scanner help in educating patient regarding the high pressure zones in the foot in comparison to a plane Harris mat.

The plantar pressure was maximum under the first metatarsal head (medial) followed by the second and third metatarsal head (central) followed by fourth and fifth metatarsal head (lateral), heel and big toe. This was in variance with the study conducted by Z. Pataky et al⁵ who concluded significant increase in peak plantar pressure at the level of big toe and fifth metatarsal head and peak plantar pressure was lowest under the heel in diabetic group. Our study showed that there is no statistically significant difference in planter pressure in two groups with and without diabetic polyneuropathy ,this collaborates the findings of a previous study by Xiao H S et al² who studied the plantar pressure changes in a large number of Chinese diabetic patients and concluded that the mean plantar pressure in diabetics with peripheral neuropathy was higher than that of normal subjects, but it was not statistically significant .

This study model can go a long way in dealing with this calamity. This study has wide ranging clinical and social ramifications, for we can prognosticate the occurrence of diabetic foot ulcers and prevent it by primary intervention.

CONCLUSION

There is impaired redistribution of plantar pressure in subjects with diabetes. Increased plantar pressure makes the diabetic subjects prone to foot ulcers which is attributable to various anatomical factors like changes in foot architecture, loss of arch, muscle atrophy etc. Thermal scanners can identify the hotspots for the occurrence of ulcer Abnormal foot pressure can be reduced by using special footwear, off-loading modalities such as accomodative dressing, walking splint etc. This can be advised to the patient to provide them protection against the formation of pressure ulcers.

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