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Original Research Paper

General Surgery

PREDICTIVE VALUE OF ANKLE BRACHIAL INDEX IN OUTCOMES OF DIABETIC FOOT ULCERS

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ABSTRACT

Background: The study was conducted to determine the diagnostic accuracy of ankle brachial pressure index (ABPI) in predicting major amputation and duration of wound healing in diabetic foot ulcers. **Methods:** 100 participants (18-80 years) both out patients and inpatients with diabetic foot ulcers during 12 months were enrolled in the present prospective observational study. Institutional ethics committee approved the study and written informed consent was obtained from all study participants. **Results:** The mean ABPI of study participants was 0.7, with 24% participants having normal ABPI. Lower ABPI (<0.9) was associated with longer duration of ulcer healing. All participants with ABPI <0.3 required major amputation and had stay longer than 60 days. **Conclusions:** ABPI is a simple clinical tool that could be assessed even in a simple clinical setting, thus when used for screening and prediction of amputation and duration of stay in diabetic foot ulcers.

KEYWORDS :

INTRODUCTION

Reduced insulin secretion, its sensitivity or a combination of both results in the chronic metabolic disorder known as diabetes mellitus (DM).[1] In the last three decades, the global burden and prevalence in adults has increased fourfold and two fold respectively.[2] Though often referred to as the diabetic capital of the world, India has the second largest population of diabetics.[3] Among the complications of DM, foot ulcers are the most common yet preventable complication. The annual incidence of diabetic foot ulceration globally is 9.1 to 26.1 million and the Indian prevalence of diabetic foot ulcers is considerably lower than western population and is ~3%.[4] Almost 15-25% diabetic patients develop foot ulcers at least once in their life time and the prevalence is dependent on age and ethnicities.[5] Areas that encounter repetitive trauma and pressure sensations are the areas that develop ulceration.[6] Being the cause of the highest health-care burden among diabetics, the prevention and treatment of foot ulcers remain a considerable challenge.[7] Lower limb ischemia and vascularity determines healing in diabetic foot ulcers and plays as a major role in predicting lower limb amputations. Vascularity of the lower limb is assessed by clinical examination, hand held and color doppler or angiographic studies. Ankle branchial pressure index (ABPI) is calculated by dividing ankle systolic pressure with brachial systolic pressure using handheld or color doppler. The normal ABPI is >0.9 value <0.3 indicate active or impending gangrene. The decision of amputation in patients diabetic foot ulcers is usually delayed due to the time consuming first line management, surgical debridement. The decision of amputation is reached when there is no sign of healing after multiple debridement's or when angiography or doppler reveals reduction in lower limb vascularity. Angiography is considered the gold standard but due to the high cost and limited use in patients with renal failure, ABPI becomes a viable investigation in decision making in a resource poor setting. The present study aims at evaluating the diagnostic value of ABPI in aiding early decision making in diabetic foot ulcers.

METHODS

The present prospective observational study enrolled 100 participants aged 18-80 years admitted in general surgery department with diabetic foot ulcers (Wagner class 1-5) in a time period of 12 months between September 2021 to August 2022. Terminally ill, who received outpatient treatment and ulcers resultant of Hansen's disease, malignancy and filariasis were excluded.

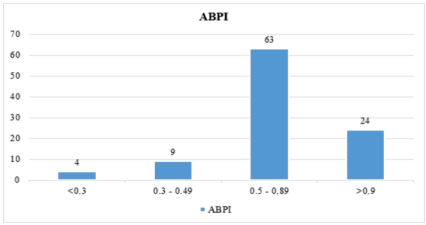
The study was approved by institutional ethics committee and written informed consent was obtained from all study participants. The total duration of ulcer was obtained from history (duration of lesion prior to hospital admission and duration of lesion from the time of admission to stage of healed ulcer or scar).

Ulcer completely covered by healthy granulation tissue and neo-epithelization in the peripheral regions of the ulcer either during hospital stay or during follow up visits was considered as healed ulcer. A completely healed stump or scar was considered as endpoint in participants who underwent amputation. All participants received standard of care with betadine, hydrogen peroxide or normal saline and appropriate antibiotics depending on the culture and sensitivity report. The outcomes measured were the healing of ulcer with different treatment modalities. ABPI of the affected limb was measured using hand held doppler and a value less than 0.9 was presumed to have PAD.

RESULTS

64% (n=64) participants were males and 46% (n=46) were females. The mean ABPI was 0.7 and only 24% (n=24) had normal ABPI (Table 1) and the association between duration of healing and ABPI is demonstrated in (Table 2). The duration of ulcer healing was longer as ABPI reduced.

Table 1



Significant association was observed between ABPI and method of treatment required. Significant association was observed between groups probably indicating the higher proportion of participants with ABPI <0.3 who underwent above knee amputation or the higher proportion of participants with normal ABPI who required dressing and debridement alone for ulcer healing. Significantly higher proportion of participants with ABPI ≤0.9 required ≥30 days for wound healing and significantly higher proportion of participants with ABPI <0.67 required >90 days of wound healing.

Table 2

ABPI	Dressing and Debridement	Dressing and Debridement and SSG	Toe Amputation	Fore foot Amputation	BK Amputation	AK Amputation
<0.3	0	0	0	0	0	4
0.3 - 0.49	1	0	0	0	8	0
0.5 - 0.89	22	9	26	6	0	0
>0.9	24	0	0	0	0	0

DISCUSSION

Foot ulceration is one of the leading causes of hospital admission in DM and is the most common non-traumatic cause of lower limb amputation. Preservation of the maximal length of the viable extremity and minimizing the morbidity and mortality is very significant in lower limb amputation since overly distal amputation can result in lower rates of healing due to inadequate blood supply which might require further surgical procedures. Overly proximal amputation can result in lower rates of ambulation without appropriate prosthesis and in an ethical point of view it is incorrect.[8] Owing to these factors, selection of a proper amputation level is crucial in diabetic foot ulcers. The clinical diagnosis of the most important predictor in diabetic foot ulcers, ischemia is difficult since autonomic neuropathy can give a perception of warmth in the extremity. Lack of autonomic tone in capillaries results in shunting of blood from arteries to veins leading to warmth, bounding pulses and dilated veins.

This could be misinterpreted and the absence of ischemia. The lack of claudication pain due to autonomic neuropathy delays the clinical diagnosis often. The usual scenario in patients with diabetic foot ulcers with PAD is an initial phase of multiple debridement's with poor wound healing eventually leading to the only option, amputation. The initial stage of multiple debridement's require prolonged hospitalization and associated complications and economic burden which would suggest early institution of amputation.[9] Males accounted to 64% of participants which could be due to the higher prevalence of DM among males in our setting.[10] This can also be attributed to the higher risk of diabetic foot ulcers among males which has been previously reported.[11] High prevalence of diabetic foot ulcers was observed in the ages between 50-69 years. ABPI among study participants was significantly low (0.7) which is considered moderate PAD.[12] Only 24% participants had normal ABPI, while 76% participants had lower than normal ABPI. Increased production of endothelin-1, angiotensin II, and prostanoids lead to vasoconstriction and platelet dysfunction, enhanced uptake of glucose increases oxidative stress and decrease NO production, upregulation of P-selectin, glycoproteins (Ib, IIb/IIIa) promote platelet adhesion and aggregation. Calcium dysregulation increase platelet aggregation and hypercoagulability while increase in levels of tissue factor and factor VII production enhances coagulability. Decreased antithrombin and protein C synthesis, rheology, elevation in blood viscosity, increase in fibrinogen production increases the coagulability of blood. Other pathogenic processes include impairment in arteriogenesis, inhibition of shear stress sensing mechanisms and decrease in monocyte and growth factor signaling.

All these pathogenic mechanisms contribute to increase in atherothrombosis causing reduced plaque stability, increased chances of plaque rupture and restenosis.[13] All participants with ABPI less than 0.3 required more than 120 days for ulcer healing while all participants with ABPI of more than or equal to 0.9 required less than 30 days for ulcer healing.

The outcome of coexistent PAD in patients with diabetic foot ulcers is dependent on various other factors such as comorbidities, infection, neuropathy, immunological factors and poor glycemic control.[14,15] Hence, we recommend a careful history, physical examination with ABPI in the poor socioeconomic strata or angiography in affording patients. ABPI is a valuable tool for predicting the outcomes and duration of wound healing in patients with diabetic foot ulcers.

CONCLUSION

We recommend the use of ABPI as a routine tool in all patients with diabetic foot ulcers for screening PAD and angiography in those with lower ABPI so that the decision for amputation can be made early which would save a considerable amount in health-care expenditure towards hospital admission, surgical debridement and dressing and eventual amputation.

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Conflict of interest: None declared.

Ethical approval: The study was approved by the Institutional Ethics Committee.

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