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A Review of Foot pressure Measurement of Diabetic and Analysis Patients

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Abstract: Peripheral neuropathy, the main risk factor for diabetic foot ulcers (DFU), causes loss of protective feeling and is linked to very high plantar pressures. The goal of DFU preventive techniques is to lower these elevated plantar pressures. However, there are a number of limitations to the evidence that supports the connection between plantar pressure and DFUs, which could account for the poor prediction accuracy found in prospective studies. Most research measures the vertical, as opposed to the shear, barefoot plantar pressure in lab settings as opposed to in real-world activities. Previous DFU location-specific pressure was not well studied. Prior research has mostly concentrated on walking; however activity tracking studies indicate that more time is spent on other weight-bearing tasks, when a longer duration of lower "peak" plantar pressure may be applied. This suggests that a measure of the cumulative pressure applied over time might be more pertinent than peak pressure, however more investigation is required. Further research is needed, however studies have shown that delivering pressure feedback may lessen plantar pressures. This is an emerging potential use of smart technology. To increase our knowledge of the pressures that lead to DFUs and the efficacy of therapies, more pressure assessments pertaining to location-specific pressures pertaining to all weight-bearing activities are needed.

Keywords: Diabetic ulcer, peripheral neuropathy, plantar pressure, pressure feedback, pressure-time integral

INTRODUCTION

Globally, 425 million adults have diabetes mellitus at this time, but 629 million cases are predicted by 2045 due to the disease's increasing prevalence. Diabetes is the primary cause of non-traumatic lower limb amputations, with diabetic foot ulcers accounting for up to 85% of these cases (DFU). A significant number of diabetic foot ulcers result in infection or amputation, making them an expensive public health issue [1]. Diabetic foot ulcers are also linked to a lower quality of life. There is a 15–25% lifetime chance of having a DFU.6, 7 DFU recurrence rates, however, are 40% in the first year following ulceration and can reach 65% five years later.8,9 Trauma, diabetic peripheral neuropathy, and foot deformity are risk factors for diabetic foot ulcers (DFU), with diabetic peripheral neuropathy being the main risk factor[2].

This review aims to investigate the relationship between high plantar pressure, which can be used by several risk factors, and the prognosis and prevention of diabetic foot ulcers (DFU) in individuals with diabetes. This study is important because it may clarify if elevated plantar pressure is a useful measure for DFU prognosis and prevention. In order to achieve this, a thorough examination of the body of existing research will be carried out in an effort to compile the state of knowledge as it stands at the moment. The results of this review should add to the body of knowledge already available on DFU and offer suggestions for ways to reduce the risk of DFU in individuals with diabetes [3]. There view examines the relative benefits and drawbacks of earlier research, including how much the pressure encountered in "real-life" daily activities may have influenced earlier methodologies' poor forecasting performance.

Causing factors for elevated plantar pressure

Diabetes-related peripheral neuropathy impairs foot feeling, making it challenging to feel pressure. This frequently causes the weight-bearing plantar area of the foot to experience abnormally high and recurrent pressures. The issue is exacerbated by foot abnormalities including hammertoe and muscle atrophy, particularly at the metatarsal heads. Increased plantar pressure is also caused by other elements such as decreased ankle dorsiflexion and thicker plantar tissue [4]. Increased pressure on the soft tissue beneath the callus due to high plantar pressures might result in tissue deterioration and ulceration. Plantar pressure reduction is the main goal of current therapies for diabetic foot ulcers (DFU). In order to accommodate foot deformities and relieve pressure from high-risk regions, custom-made footwear and insoles are frequently suggested [5]. When worn, these measures have considerably decreased the rates of ulcerations. However, their efficacy is restricted by inadequate adherence. Prescription footwear tries to lower plantar pressure, but prior studies have identified several limitations about the relationship between high plantar pressure and the risk of DFU, which are covered in the sections that follow.

Barefoot Pressure Analysis

Numerous research works have examined plantar pressure analysis in individuals with diabetes. The majority of these researches have measured barefoot pressure using pressure platforms. Participants in the test follow a walkway, being sure to plant their feet correctly on the platform. The testing procedures and the types of patients used for the tests, however, differ throughout the literature [6]. The main method of measuring plantar pressure is vertically; some studies examine the foot as a whole, while others examine pressure at certain plantar areas, mainly the forefoot. Only a few studies look specifically at pressure in relation to ulcer site. The literature generally agrees that individuals with diabetes, particularly those who have a history of diabetic foot ulcers (DFU), have higher plantar pressures than people without the disease, notwithstanding considerable variation.

Whole-foot bare foot analysis

The methods used in earlier barefoot pressure analysis research have been different. While some have employed a two-step approach to the platform, others have computed peak plantar pressure from mid-gait steps with the platform situated along a walkway.

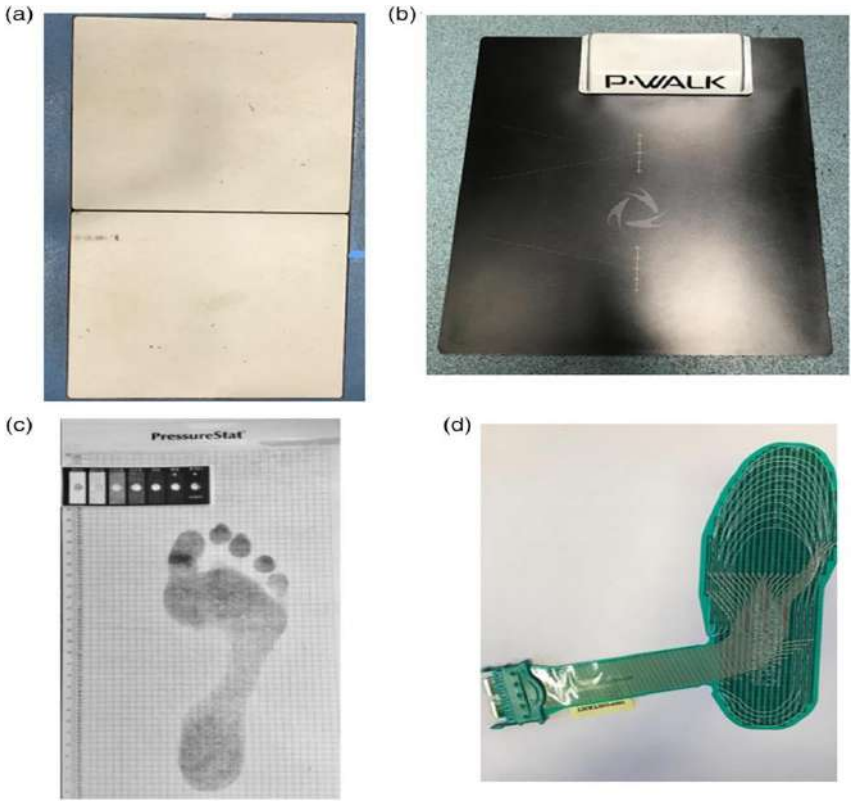

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Figure 1: Examples of equipment used to measure plantar pressure. A, AMTI force platform (Advanced Medical Technology, Inc. Watertown, MA). B, BTS P-walk pressure plate (MA). C, Pressure Stat (Medical Gait Technology BY, Emmen, the Netherlands). D, F-scan pressure assessment system insole (Tekscan, Inc., Boston, MA).The equipment A-Care typically used to collect bare foot pressure data, where as Displaced in-shoe [11]

The two-step method lowers the possibility of insensitive feet and makes complete touch easier. To guarantee the most natural gait possible, walking trials are still necessary, which carries some danger for the high-risk diabetic foot [7]. Research indicates that diabetics with foot ulcers had higher baseline peak plantar pressure. Such studies may produce diluted results and poorer sensitivity in predicting ulceration if they include patients without a history of diabetic foot ulcers. Conclusions regarding the causative link between high plantar pressure and DFU may be undermined by classifying patients with both active and previously healed DFUs together. DFU prediction could be enhanced by more thorough pressure evaluations that consider peak pressure location and its effects on DFU [8].Because vertical plantar pressure ignores shear plantar pressure; it may not be enough to predict diabetic foot ulcers (DFU). We may be able to learn more about foot mechanics and how they relate to DFU formation by looking into shear pressure. Few research, meanwhile, have looked into the connection between DFU and peak shear pressure.DFU is multifaceted and intricate. According to [9], the DFU group had increased peak shear and vertical plantar pressures, but only shear became statistically significant. Shear pressure exerted in shoes may not be the same as the shear pressure observed on bare feet in this study. To fully comprehend the part that's hear pressure plays in DFU, more studies with bigger cohorts are required. In addition to other risk factors, measuring both shear and vertical plantar pressure may aid in the prediction of DFU [10]. Nevertheless, more investigation is required before dismissing plantar pressure as the only factor that can predict DFU.

Location-specific bare foot pressure analysis

Several studies have shown that particular foot regions have higher peak vertical plantar pressures than others. Because of the high incidence of ulceration at the forefoot, research has made it a particularly interesting area to measure region-specific pressures. Studies that have only looked at forefoot pressures in bare feet have revealed that the ulcerated cohort exhibits noticeably higher peak plantar pressure [11]. Nevertheless, these studies'" ulcerated" cohorts comprised both ongoing and healed DFUs, which would make it difficult to pinpoint patients who are susceptible to ulceration. Conversely, it has been demonstrated that the ratio of forefoot to rear foot pressure, as well as the forefoot peak pressure, properly predict ulceration. Instead of taking into account their history of DFU, patients were categorized based only on the degree of neuropathy. Moderate to severe cases of neuropathy, which are mostly at high risk of ulceration, showed significantly increased pressure in the forefoot and rear foot[12]. By dividing barefoot pressure into more locations, a limited number of studies have added further information. The foot has been divided into the rear foot, mid foot, and forefoot in these investigations. Patients with diabetic neuropathy were shown to have significantly higher pressures in the mid foot and forefoot during push-off, but the rear foot revealed pressures that were comparable to those of non-diabetic controls. To validate these findings and emphasize the need of location-specific pressure analysis as opposed to foot-wide analysis, more study is required.

Bare foot pressure analysis specific to ulcer location

The magnitude of pressure at the site of a previous ulceration is correlated with its location, according to the findings of the two studies that have assessed barefoot pressure there. An investigation of a recent study that discovered a site-specific connection at the hallux may be arbitrary. It will take further research with less subjective analysis to validate site-specific correlations between DFUs and plantar pressure [11]. For those with diabetic neuropathy, wearing shoes is necessary for most daily activities. Consequently, a more ecologically sound method, according to some research, would be to examine plantar pressure under shod situations throughout daily life.

In-shoe pressure analysis in relation to DFU risk

According to studies, those with ulcers have higher in-shoe pressures than people without them, yet vertical plantar pressures in shoes are still lower than when one is barefoot. To determine who is at risk of DFU, a vertical plantar pressure threshold of 200 kPa has been proposed [13]. On the other hand, some people whose pressures were over the threshold and other people whose pressures were below it suffered from ulcers. Because pressure analysis is sometimes location-specific, the ulcerated metatarsals had a higher peak plantar pressure than the non-ulcerated group, whereas the hallux and heel had a lower peak plantar pressure. Only in the metatarsals was a higher baseline peak plantar pressure substantially linked to a higher incidence of DFU. Only five mid-gait steps per foot were examined in the study [5], and more research is necessary to confirm a relationship between pressure and ulceration that is location-specific.

Influence of daily activity on DFU development

Repetitive loading and plantar pressure are associated with DFU formation. Those with diabetic neuropathy who are highly active have higher cumulative pressure and an increased risk of ulcers. That being said, those with a history of DFU take fewer steps than people in good health. Accelerometers detect activity, however they might not accurately record levels. [14] Recorded activity levels—including all weight-bearing activities using questionnaires. The individuals who developed ulcers and the non-developers did not significantly differ in their weight-bearing exercise, according to the results. Triaxial accelerometers can distinguish between different types of activities, therefore it is important to compare high-risk patients to controls [15].Every weight-bearing activity increases the risk of DFU by applying cumulative loading to the plantar foot.

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CONCLUSION

Due to their high recurrence rates and potential for limb amputation, diabetic foot ulcers (DFU) represent a serious public health hazard. One of the main risk factors for DFU is high plantar pressure. Studies have also documented shear pressures, which are frequently exclusively measured when the subject is barefoot, even if vertical plantar pressure is more frequently measured. According to research, evaluating pressure cumulatively over time may be more meaningful than the widely used peak pressure metric. While insoles and customized shoes work well to relieve excessive plantar pressures, plantar pressure feedback is a viable substitute. Continuous monitoring and feedback are made possible by smart technology, but further study is required to fully comprehend the long-term impacts. At the end of the day, knowing what causes plantar pressure and DFU will aid in the creation of successful interventions.

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