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Insole modification as a plantar pressure distributor in diabetic polyneuropathy: A case report

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Abstract--73 years old, male, referred from Internal Medicine department with diagnose Diabetic Polyneuropathy. The patient felt numbness at both feet since about 8 years ago and also complain about shortened walking distance because of fatigue. From the physical examination we found that has muscle weakness at left leg. From the foot examination there were decreased vibration and light touch sensation, anhidrosis, hyperkeratosis at his feet. There were also charcot arthropathy and decreased of foot fat pad. Foot pressure examination was high. The treatment goal for this patient is to wear comfortable footwear, improving walking endurance, and preventing future ulceration. The insole was needed to decrease plantar pressure during ambulation. Recommended rehabilitation treatment involves interaction between the health care team and the patient to achieve rehabilitation goals.

Keywords---diabetic foot, footwear, insoles, offloading, prevention

Introduction

In general, the worldwide incidence of type 2 diabetes occurs at a young age. In Japan, 80% of newly diagnosed diabetes cases in adolescents are type 2 diabetes. In Mexico City, 25% of the population of type 2 diabetes is classified as "early onset". In Bangladesh, the median age at diagnosis in 2005 was significantly lower than in 1995. This shift towards a younger age of onset is important because evidence suggests that early-onset type 2 diabetes may be more aggressive. Health behaviors contribute to the adverse clinical profile observed in young diabetes. (Zaccardi, 2015).

The role of physical medicine and rehabilitation experts is very important in preventing disability in concordance of the functional level of patients with diabetes. Diabetes selectively damages cells, such as endothelial cells and mesangial cells, whose glucose transport rates do not decrease rapidly as a result of hyperglycemia, leading to high levels of glucose in the cells. This explains the causes of complications that occur in the cell. Complications of diabetes in cells are explained through 4 mechanisms, namely the polyol pathway, production of intracellular AGE precursors, PKC activation and increased activity of the hexosamine pathway (Brownlee 2005).

The most common complication of diabetes is diabetic polyneuropathy. This disorder is caused by changes in metabolism and microvascular structure caused by hyperglycemia and covariates of cardiovascular risk that occur simultaneously. The prevalence of diabetic polyneuropathy can be as high as 50% depending on age and onset of diabetes. Symptomatic pain in diabetic polyneuropathy occurs in 30% of patients with neuropathy (Alam, et al., 2017).

Signs and symptoms of diabetic neuropathy may present as somatic, autonomic, motor or sensory symptoms. The most common somatic symptom is sensory polyneuropathy in both arms and legs in the form of a glove and stocking pattern. A tingling feeling, a feeling of attachment to the legs, balance disturbances and a burning feeling that increases at night are other symptoms that can appear. The prevalence of autonomic neuropathy in diabetic patients is around 50-60%. In patients with long-onset diabetes, 6% of deaths are due to cardiac autonomic neuropathy. Gastroparesis, cystopathy, gustatory sweating, and erectile dysfunction are hidden autonomic symptoms; sometimes does not appear during the anamnesis. Autonomic disorders appear, among others, in the form of weakness in several muscle groups, loss of deep tendon reflexes, and muscle atrophy (Kapoor, 2017).

Insole is the basic part inside the shoe that covers the connection between the upper and the outsole. It maintains the shape of the shoe and its unity with the related parts (Postema, et al, 2018). The main function of the insole is the redistribution of pressure. This can be achieved on the principle of increasing the contact area between the foot and the insole and its additional corrective area. The material used to make the insole should be shock-absorbing, soft and quite elastic, and not slippery. Shoes for diabetes generally feature an insole that is tailored to the shoe and measured specifically for the patient. The insole must be adapted to the anatomy of the foot so that it can distribute the load evenly on a wider surface than a flat surface. The pressure drop function on the insole can be optimized by using a rocker profile on the outsole (Hochlenert, et al, 2018).

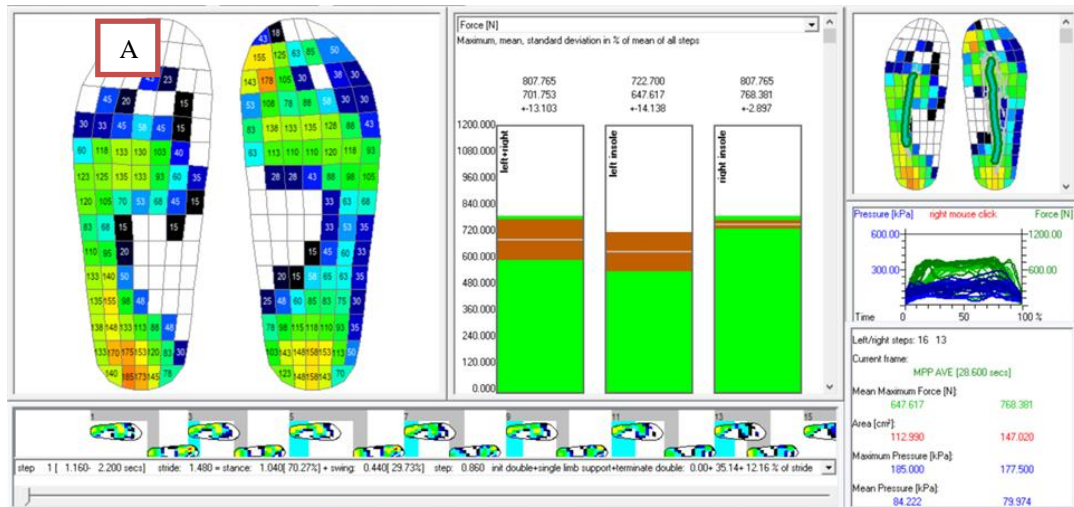
Case Description

A 73 years old male referred from Internal Medicine outpatient clinic with Diabetic Polyneuropathy with chief complaint was numbness at both foot since 8 years ago. He also complained about shortened walking distance because of fatigue and need to take a rest after approximately 300m walking because of muscle cramp. His feet were dry and cracking but never had wound or amputation at his foot. He

has hypertension for 10 years, diabetes mellitus for 15 years and Benign Prostate Hyperplasia. He routinely consumed insulin injection 3x/day, Clopidogrel 1x75mg, Adalat oros 1x30mg and Tamsulosin 1x0,4mg. He wasn't joint social event as much because of the pandemic and do most of daily activity at home. He joined religious gathering once a week. The Barthel index was 100 of 100.

The vital sign was as follows: BP 160/90 mmHg; HR 86 x/min (regular); RR 18 x/min; Sat 99%. The gait was steppage gait. Range of motion was full but muscle strength for left hip extensor, abductor, adductor internal rotator, external rotator, knee flexor, ankle plantarflexor, evertor, invertor, toes and big toes was 4; Hip flexor, knee extensor and ankle dorsiflexor was 3. Sensory deficit felt on the both feet from the ankle to distal about 20% which indicate peripheral polyneuropathy.

For specific foot examination we evaluate for neurological, vascular, dermatologic and musculoskeletal examination. Neurologic examination of monofilament test was 6/10 both site, tuning fork vibration was decrease, but pinprick sensation was still felt both side and reflex achilles was normal. Vascular examination shown that Ankle Brachial Index Score was 1,2 and adequate arterial pulse. Dermatologic examination shown anhidrosis at both feet, hyperkeratosis at MTP 1 and achilles area of both feet, but skin tenting was good. Musculoskeletal examination shown Charcot arthropathy deformity and decreased of fat pad. Foot Pressure Examination without insole Max pressure R 185 L 177,5, mean pressure R 84,22 L 79,97 (Figure 1).



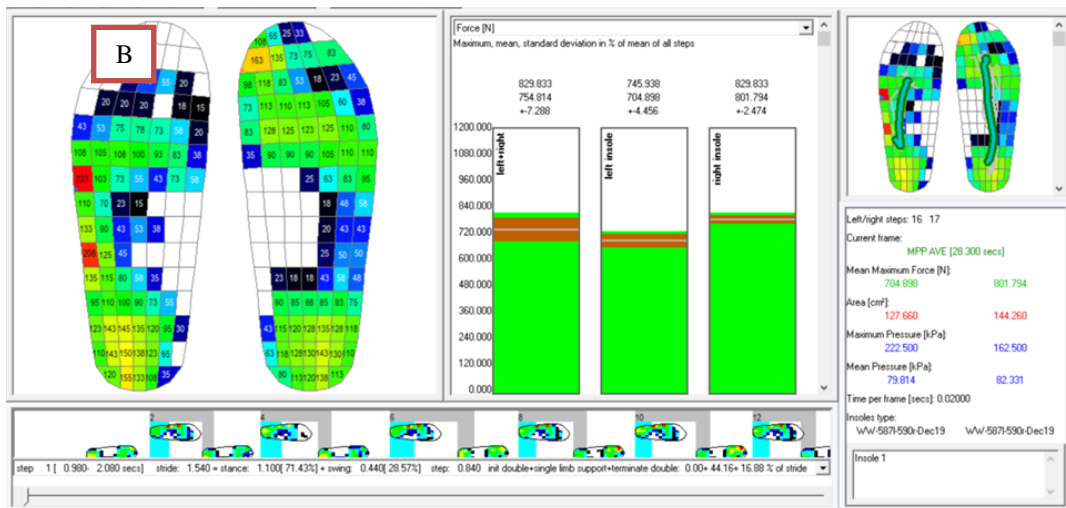


Figure 1. Foot pressure examination using Pedar® in-shoe system (A) before insole; (B) after insole

Patient received modification insole based on the pressure examination. To measure foot pressure we used Pedar® in-shoe system. With the use of modified insole, the pressure changed as Max pressure R 222,5 L 162,5 Mean Pressure R 79,8 L 82,3. We can see that the maximum pressure is higher with insole and the mean pressure is lower compared to without insole. The foot pressure picture at figure 1 shows us that the high pressure on achilles (orange square) distributed better after the use of insole. There is a possibility that red spots on left foot a sensor disturbance.

Discussion

Rehabilitation in diabetic neuropathy in preventing ulcers is always challenging due to its complications damage various parts of the nervous system and can have diverse clinical manifestations. Chronic distal sensorimotor polyneuropathy and autonomic neuropathy are the most common types of neuropathy. Both of these disorders play an important role in the pathogenesis of ulcers (Boulton 2016).

From a kinematic point of view, individuals with diabetic polyneuropathy have limited range of joint motion in the metatarsal head, ankle dorsiflexion and plantarflexion and in the knee in flexion and extension. Impaired movement and joint mobility in the ankle related to changes in plantar pressure. In the metatarsal head, joint movement disorders mostly occur in the first metatarsophalangeal joint, which is very common in diabetic patients with a history of ulcers. Recent study stated that patients with diabetes had an increase in the moment of hip flexion when push off and a decrease in the moment of extensor during initial contact compared to normal people. The peak moment of plantar flexion is decreased in patients with diabetic polyneuropathy. The abnormal pattern in plantar pressure is related to the redistribution of joint movement so that it will reduce the ability to control the speed to advance when heel-strike (Alam, 2017).

Achieving proper gait function requires the ability to maintain a safe gait when directing steps in complex and volatile situations. The quality of gait in humans is closely related to their general health condition. For example, walking speed is directly proportional to the ability to live independently, perform daily activities such as crossing the road safely, and the risk of falling (Wrobel, 2010).

Insole maintains the shape of the shoe and its unity with the related parts (Postema, et al, 2018). The main function of the insole is the redistribution of pressure. This can be achieved on the principle of increasing the contact area between the foot and the insole and its additional corrective area. The material used to make the insole should be shock-absorbing, soft and quite elastic, and not slippery. Shoes for diabetes generally feature an insole that is tailored to the shoe and measured specifically for the patient. The insole must be adapted to the anatomy of the foot so that it can distribute the load evenly on a wider surface than a flat surface. The pressure drop function on the insole can be optimized by using a rocker profile on the outsole (Hochlenert, et al, 2018).

Conclusion

The role of physical medicine and rehabilitation experts is very important to prevent ambulation disturbance. Insole modification is needed to decrease plantar pressure during ambulation. Adherence of the patient is an extremely important to be evaluated before prescribing any treatment to the patient. Comprehensive rehabilitation team role should be involved interaction between the health care provider, care giver, and the patient to achieve to achieve mutually agreed goals.

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