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An investigation for early stage diagnosis of diabetic foot

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ABSTRACT

Diabetic foot ulcers are responsible for more hospitalizations than any other complication of diabetes. Many patients needlessly undergo amputations because of improper diagnostic and therapeutic approaches. Even though many of the body systems are effected by diabetes, prominent symptoms of diabetic foot is not visible in the initial stages. It is also difficult to generalize the results present diagnostic techniques to estimate foot ulcer incidence. The most important factors related to the development of ulcers are peripheral neuropathy, foot deformities, minor foot trauma, infection and peripheral vascular disease. A new methodology is proposed for integrating present techniques of evaluation for early stage diagnosis.

Keywords: Diabetic foot; early detection; peripheral neuropathy, vascular disease, path physiology

1. INTRODUCTION

Diabetes is a growing global epidemic of the current century. The most recent estimate of International Diabetes Federation indicates that 387 million people, have diabetes and this may rise to 592 million within the next twenty years [1]. A further 316 million with impaired glucose tolerance are at high risk from the disease, with projections indicating that over 1 billion people will be living with or at high risk of diabetes in 2035. The World Health Organization (WHO) estimated that 9% among adults aged 18+ years are suffering from diabetes. In 2012, an estimated 1.5 million deaths were directly caused by diabetes and more than 80% of diabetes deaths occur in low and middle-income countries. WHO also projects that diabetes will be the 7th leading cause of death in 2030 [3]. According to the statistics of the International Diabetes Federation, there are nearly 65 million diabetics in India [2]. As the incidence of diabetes is on the rise, there is a proportionate rise in the complications associated with diabetes.

Diabetic Foot is one of the most threatening complications of Diabetes. This is a state that a foot exhibits any pathology that results directly from diabetes mellitus or any long-term complication of diabetes mellitus.

2. DIABETIC FOOT INFECTION

Different types of foot problems may develop in the diabetic cases as a result of damage to nerves and blood vessels. These problems can easily lead to infection and ulceration, which increase a person's risk of amputation.

The maximum number of hospital admissions in diabetics is due to foot problems. It occurs in 15-25% of all patients with diabetes and precedes 85% of all lower leg amputations. People with diabetes are 25 times more likely to lose a leg than people without the condition.

Throughout the world, up to 70% of all leg amputations happen to people with diabetes [5]. More than one million people with diabetes lose a leg every year as a consequence of their condition. Diabetic foot problems are a common occurrence throughout the world, resulting in major economic consequences for patients, their families and society. An estimate of International Working Group on the Diabetic Foot reveals that every twenty seconds a lower limb is lost to diabetes somewhere in the world [4].

3. PATHOPHYSIOLOGY

Foot ulceration invariably occurs as a consequence of an interaction between environmental hazards and specific pathologies in the lower extremities of these patients [5]. The most important factors related to the development of these ulcers are peripheral neuropathy, foot deformities, minor foot trauma, infection and peripheral vascular disease [6].

Peripheral neuropathies and peripheral arterial disease commonly coexist in patients with diabetes and foot ulcers. There is a connection between diabetes duration and development of foot ulcer.

Acute arterial occlusion is said to present with the pain, pallor, pulselessness, par aesthesia and paralysis. This, however, is not always the case, and the severity and number of symptoms will vary with the level of ischaemia [28]. Chronic arterial insufficiency of the lower extremity causes two classic symptoms-intermittent claudication and rest pain. Claudication is usually described as a cramp-like tightening in the calf, thigh or buttock and occasionally in the foot, brought on by walking a certain distance and relieved by resting, often for several minutes.

Rest pain is a different and far more significant symptom. The pain is usually felt in the foot or the toe, often the great toe, and comes on soon after elevating the leg, occurring classically on going to bed. It is usually relieved by hanging the foot out of the bed, and the patient is often forced to sleep in a chair. Other conditions, such as spinal stenos is, can mimic the symptoms of rest pain and intermittent claudication.

Elevated levels of glycosylated haemoglobin (HbA1C) were significantly associated with development of foot ulcers. Hyperglycemia is important in the pathogenesis both of the specific complications of diabetes mellitus, microangiopathy and neuropathy. These denotes retinopathy, nephropathy and the development of macro vascular disease [8].

Diabetic peripheral neuropathy, the presence of symptoms, and signs of peripheral nerve dysfunction in people with diabetes. This has to be diagnosed in the early stages, a major opportunity to ameliorate symptoms and prevent the development of the major clinical neuropathic endpoints of the lower limb: the chronic painful foot, the insensate foot, the Charcot foot, and the neuropathic ulcer. It is important that diabetic neuropathy can occur with no pain or with an insensate foot or may present with pain in the form of dysesthesias and paresthesias.

Examination of tissues from patients with diabetes reveals capillary damage, neovascularization, and occlusion in the vasa nervorum. Reduced blood supply to the neural tissue results in impairments in neurotransmission that affect both sensory and motor conduction. Tissue oxygen level; transcutaneous oxygen tension (TcPO2) is also very much related with the occurrence of ulcer.

4. IDENTIFICATION METHODOLOGIES

Early stage identification of the foot at high risk of diabetes complication is key to prevent amputations. A variety of measures was used to quantify peripheral neuropathy associated with amputation risk. These included insensitivity to monofilament, motor nerve conduction velocity of the deep peroneal nerve, sensory nerve conduction velocity of the sural nerve, vibration perception threshold (VPT), absent or diminished bilateral vibration sensation, and absent Achilles tendon and patellar reflexes.

Peripheral neuropathies and peripheral arterial disease commonly coexist in patients with diabetes and foot ulcers. The different measures of peripheral arterial disease are ankle-arm index (AAI), transcutaneous oxygen tension (TcPO2) and pulses. This peripheral arterial function, as measured by low TcPO2, low AAI, and absent or diminished dorsalis pedis and posterior tibialis pulses as well as medial arterial calcification and its relationship to amputation[7]. Peripheral vascular status was assessed by palpation of the dorsalis pedis and posterior tibial pulses on both feet. Presence of two or less of the four pedal pulses, either with or without the presence of oedema, indicated Peripheral Vascular Disease.

The major symptoms of lower-limb arterial disease include intermittent claudication, absent peripheral pulses, and rest pain. The presence of medial arterial calcification was based on radiographic examination of the feet obtained during biennial examinations.

One of the most popular technique used for initial diagnosis is the ankle brachial pressure index (ABPI). This is the ratio of highest pressure recorded at the ankle for that leg to the highest brachial pressure obtained for both arms. ABPI normally > 1.0. ABPI < 0.92 indicates arterial disease. ABPI > 0.5 and < 0.9 can be associated with claudication and if symptoms warrant a patient should be referred for further assessment. ABPI <0.5 indicates severe arterial disease and may be associated with gangrene, ischemic ulceration or rest pain and warrants urgent referral for a vascular opinion.

Examination of the legs can give valuable information on the state of the peripheral circulation. There are a lot of indications for peripheral arterial ultrasound examination related to diabetic foot. The detection of hemodynamic ally significant stenoses or occlusions in specified segments of the peripheral arteries in symptomatic patients with suspected arterial occlusive disease. These patients could present with recognized clinical indicators, including claudication, rest pain, ischemic tissue loss, and suspected arterial embolizations. The monitoring of sites of various percutaneous interventions, including angioplasty, thrombolysis/ thrombectomy, atherectomy, and stent placements. The evaluation of suspected vascular and perivascular abnormalities, including such entities as masses, aneurysms, pseudoaneurysms, and arteriovenous fistulas. Clarifying or confirming the presence of significant arterial abnormalities identified by other imaging modalities.

Palpation and auscultation of the proximal lower limb pulses can give an indication of the condition of the under-lying vessels. Once the state of the proximal vessels has been assessed, attention should be directed to the ankle and foot pulses. The simple presence or absence of ankle pulses to palpation should not be used alone as an indicator of arterial disease whether assessing the diabetic foot or a patient with a presumed venous leg ulcer. Distal perfusion can only be accurately assessed by the correct application of Doppler or other investigation methods such as photophlethysmography.

The indications for peripheral venous ultrasound examinations include the evaluation of possible venous thromboembolic disease or venous obstruction in symptomatic or high-risk asymptomatic individuals. Assessment of venous insufficiency, reflux, and varicosities. Evaluation of veins before venous access. Follow-up for patients with known venous thrombosis near the anticipated end of anticoagulation to determine if residual venous thrombosis is present.

Concentration in the blood is the so-called oxygen saturation, SO2. It indicates the rate of oxygen delivery to and consumption by the tissues. The optical extinction coefficient of oxyhemoglobin differs significantly from that of deoxyhemoglobin. Thus, the spectral absorption coefficient of tissue depends on the concentration and oxygen saturation of hemoglobin within the tissue. It also established that hyperspectral tissue oximetry has the ability to identify ischemic and inflammatory complications before they are visible during a clinical examination. Retrospective analysis of hyperspectral tissue oximetry from preulcerative locations showed that diabetic foot ulcer formation can be predicted with high sensitivity and specificity [29].

5. PROPOSED TECHNIQUE

It is very difficult to generalize the results from experiments to estimate foot ulcer incidence in the general population of people with diabetes. The pathology of diabetic foot is associated with many factors and a variety of measures was used to quantify the body parameters associated with diabetic foot.

It is proposed to find out a methodology integrating most of the prime factors of diabetic foot such as absent pulses in dorsalis pedis and posterior tibial arteries, ankle-arm index, peripheral vascular status, Neuropathy, transcutaneous oxygen tension etc.

CONCLUSION

While analysing the present diagnostic methods of diabetic foot detection, pulse detection and ankle brachial pressure index measurement are the easiest methods. Ultrasound is the most useful tool for pressure related measurements. But the analysis of transcutaneous oxygen tension gives better results. The research has to be extended for integrating two or more methods.

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