REVIEW ARTICLE

Early Detection of Diabetic Macrovascular Disease

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Diabetic macrovascular disease, a significant contributor to the morbidity and mortality of individuals, is an occult problem which is frequently only identified after the occurrence of an ischemic event. Evaluating arterial pulsations of the foot using a hand held Doppler can suggest the presence or absence of peripheral vascular disease, therefore allowing more specific studies to be performed and appropriate interventions taken.

BACKGROUND

Diabetes mellitus is associated with the development of both microvascular and macrovascular complications. Macrovascular complications are occult and frequently present clinically only after the occurrence of an ischemic event. This study investigates the use of a hand held Doppler as an aid in the prediction of macrovascular disease.

METHODS

During the annual diabetic foot examination a hand held Doppler was employed to determine the quality of the arterial circulation and to determine the presence of triphasic, biphasic, and monophasic pulses. Those patients with monophasic pulses, which are considered abnormal, were referred for further and more specific vascular studies.

RESULTS

A total of 218 patients were examined and of these 19 were found to have monophasic pulses. Sequential non-invasive vascular studies confirmed peripheral vascular disease in all 19 patients. Of these 19 patients, 3 required vascular intervention and 11 remain under yearly observation. Carotid occlusive disease was identified in 12 of the 19, however no intervention other than yearly follow-up was needed in these cases. Occult coronary artery disease was identified in 4 of the 19 and, of these, 3 required intervention with a drug-eluting stent.

CONCLUSION

The employment of a hand held Doppler during the diabetic foot examination allows the osteopathic family physician to assess and predict macrovascular disease with a great degree of certainty, refer the patient for more specialized testing, and take steps to prevent the occurrence of ischemic cardiovascular events in the diabetic population.

Diabetes mellitus is a disease with rapidly growing incidence in the United States and is the cause of significant morbidity and mortality. The Center for Disease Control and Prevention lists diabetes as the seventh leading cause of death in this country. Current estimates indicate that there are 25.8 million children and adults with diabetes. Of this estimated population the risk for heart disease or stroke is 2-4 times greater than that for the non-diabetic population, with retinopathy present in 25.8%, kidney failure in 44%, hypertension in 67%, neuropathy in 60-70%, and non-traumatic lower limb amputations occurring in more than 60%. The estimated total cost of treating diabetes and its complications in the United States in 2007 was 218 billion dollars.[1]

There is little doubt that these serious complications of diabetes mellitus are due to its direct action on the vascular system. Micro- and macrovascular disease account for the complications listed above, and should be searched for early into the course of treatment and followed closely to prevent the occurrence or progression of disease.

Microvascular disease is routinely tested for during the comprehensive dilated eye exam and retinal photography, urine microalbumin screening, and during the foot examination done with a 10 gram monofilament and 128 Hz tuning fork. It can also be suspected by observing structural damage caused by neuropathic disease and tendon damage in the diabetic foot, as occurs in claw toes or Charcot arthropathy.[2]

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Macrovascular disease comprises carotid occlusional disease (COD), coronary artery disease (CAD), renal artery stenosis, mesenteric artery stenosis, abdominal aortic aneurysm, and peripheral vascular disease. It has no simple easily administered office study which would allow the clinician to pursue further more specific testing. Patient complaints referable to vascular disease or the presence of an abnormal physical finding mean referral for specialized testing can and should be carried out. These complaints or physical findings usually occur only after significant vascular disease or end organ damage has occurred. Searching for macrovascular disease using screening codes could be carried out, but the enormous volume of patients requiring testing would certainly overwhelm the system and would not be economically practical.

Diabetes, smoking, and advanced age are three major risk factors for peripheral vascular disease (PVD).[3] The incidence of PVD in diabetic patients is estimated to range from 30% to 50% depending on the reference reviewed.[4,5] There is a strong correlation between the duration of diabetes and the development or progression of PVD, which is caused by atherosclerotic narrowing of the lumen, intimal plaque, endothelial dysfunction from oxidative stress, and smooth muscle denervation of the tunica media leading to increased permeability.[6] As PVD has been noted in the Reduction of Atherothrombosis for Continual Health (REACH) registry to have the highest rate of cardiovascular death and major cardiovascular events, it is incumbent upon the primary care physician to identify those at risk, diagnose the extent of their disease, and apply risk factor modifying treatments such as education, lifestyle modification, pharmacologic agents, or surgical intervention.[7,8]

The clinical suspicion and diagnosis of PVD, however, is fraught with inconclusive findings and frequently goes unrecognized in clinical practice.[9] PVD is reported to be asymptomatic in 20 to 50% of the population.[10] The asymptomatic nature of PVD can allow occult progression, particularly in the neuropathic patient, and result in progressive vascular blockage without patient complaints until critical limb ischemia, either with activity or at rest, has been reached. Critical limb ischemia is associated with a very high increased risk of cardiovascular ischemic events, morbidity, and mortality. Moreover, those individuals who do not develop symptoms have greater functional impairment and more adverse pathophysiological findings than those who are symptomatic.[11] Utilizing patient questioners such as the World Health Organization, Rose, and Edinburgh in studies have only uncovered 10% to 12% of individuals who actually had PVD.[12,13] Physician - patient interviews, even when conducted to target PVD, were also unhelpful as many individuals have already gradually modified their lifestyles without realization.[14]

The clinical examination of the foot is likewise inconclusive as "no clinical examination feature helped to reduce the likelihood of PVD".[15] Relying on color, capillary fill time, absence of hair growth, and atrophic skin are weak predictors of PVD.[16] Indeed, as diabetic vascular disease of the lower extremities particularly affects the femoropopliteal and smaller vessels below the knee and spares the pedal vessels, palpation of the dorsalis pedis and posterior tibial arteries may bring about a false sense of diagnostic security.[17]

The American Diabetes Association and diabetic/vascular specialists have recommended the use of the Ankle Brachial Index (ABI) as a screening tool for PVD in patients over 50 years of age, and those under 50 who have PVD risk factors such as diabetes >10 years, smoking, hypertension, and dyslipidemia.[18] The United States Preventive Services Task Force (USPSTF), however, recommends against the routine use of the ABI as a screening tool for PVD and suggests smoking cessation, lipid lowering agents, and physical activity training in its place.[19] The recommendations of the USPSTF have been challenged in an excellent special report which points out the adverse public health consequences of not providing screening. This report discusses the strong relationship between decreasing ABI and death, stating that a low ABI more than doubled the risk of stroke and quintupled the risk of cardiovascular death.[20]

The ABI is a ratio of the highest systolic ankle blood pressure divided by the highest systolic brachial blood pressure as measured using a properly sized blood pressure cuff and a Doppler probe. A value greater than 1.30 is considered abnormal, and reflects non-compressible arteries from intimal calcification. Patients returning these values should have a toe brachial index done for a more precise diagnosis. Values of 0.91 to 1.30 are considered normal, values of 0.41 to 0.90 represents mild to moderate PVD, and values below 0.40 represent severe PVD.[21] The ABI has been shown to have a sensitivity of 95% and a specificity approaching 100% for identifying PVD when compared to angiography.[22] A caveat, however, remains regarding the sensitivity, as partially or fully non- compressible arteries due to intimal calcification can give false negative results. Should the ABI be >1.30, normal (0.91 – 1.30) in the presence of symptoms, or a strong degree of clinical suspicion is present, an exercise study should be performed. This study could be either a repeat ABI or a sequential study, both done with and without exercise. Should the exercise findings decrease by 20% or more PVD is present.[23]

The routine use of the ABI in office practice would seemingly be effective in identifying patients with vascular disease and allow appropriate referrals to be made. The equipment is

relatively inexpensive and easy to operate, however extensive staff training is needed. In order to do a proper ABI assessment the patient must be supine for 15 minutes before testing can be done. This effectively ties up an examination room and office personnel who have multiple other tasks to perform. Moreover without a device which produces a physical recording of the ABI, reimbursement for this test will be denied. The American Heart Association has stated that routine screening of adults with ABI equipment is beyond the scope of clinical practice.[24]

The hand held Doppler evaluation of arterial foot pulsations brings a different perspective to the examination of the diabetic foot. Arterial pulsations as are either heard or recorded from a continuous wave Doppler exist in three waveforms which reflect the absence or extent of arterial disease. Normally the pulse waveform is triphasic following systole, early diastole, and late diastole although not all waveforms, particularly late diastole, can be distinguished at times. The lack of a third waveform, known as a biphasic pulsation, is therefore considered to be a normal finding. As PVD ensues, the diastolic flow becomes less predominant to the point where it is obliterated, and in this case a single monophasic sound is either heard or recorded.[25] Since we realize that pedal vessels are frequently spared in the diabetic foot, monophasic Doppler signals are abnormal and are therefore associated with a degree of proximal arterial stenosis.

MATERALS AND METHODS:

Figure 1: Doppler Waveforms

For the past twenty months, all patients who presented for a routine diabetic examination (N=218) have had a bilateral Doppler examination of their dorsalis pedis and posterior tibial arteries performed. This examination extended their office time between 3 and 7 minutes depending upon the Doppler findings.

Following an explanation by the RN or office assistant this examination was well received with a 0% rejection rate. A 5mg Hz Doppler (Nicolet imex Elite model 100, Nicolet Vascular Inc., 6355 Joyce Drive, Golden CO 80403) was employed and the patients were examined supine in their usual blinded foot examination position. All patients with presumptive evidence of PVD, as evidenced by monophasic pulses, were questioned about claudication, walking speed, and walking distance by the physician and none, despite extensive questioning, returned a positive response. Those patients, now considered to have PVD, were then referred to a large urban medical center for outpatient sequential non-invasive vascular studies with and without exercise, to be interpreted by a vascular specialist.

Early on in the course of the study it became apparent that reliance on a monophasic dorsalis pedis pulse was not predictive of PVD. This is consistent with the findings as reported by Khan, et. al., and therefore patients with a single monophasic dorsalis pedis pulse were excluded from further testing.[26] These patients who had been tested, four in number, were then considered as control subjects for the remainder of the study.

Patients who tested positive using sequential NIVS with and without exercise were referred for more specific vascular studies, which progressively included exercise coronary isotopic studies, cardiac CT angiography, cardiac catheterization, lower extremity angiography, cardiovascular and peripheral vascular procedures, and carotid Doppler examinations. These patients numbered 19/218 or 8.7% of the current diabetic population.

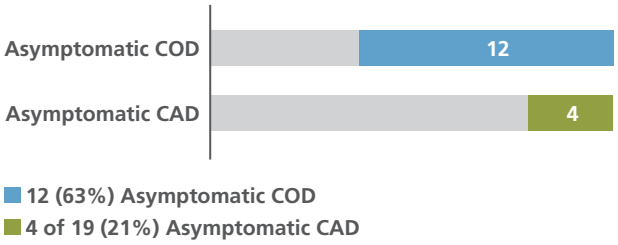
FINDINGS:

Of the nineteen patients identified by an in-office Doppler examination as having suspect PVD, all, or 100%, were confirmed as having the condition by more specialized testing. Moreover the Doppler findings in unilateral disease were also confirmed with near 100% accuracy. Three patients required immediate intervention and eleven continue to be followed on a yearly basis. One of the three requiring intervention was already an amputee from a previous traumatic accident. The limb which required intervention was referred to as his "good" leg.

Of the nineteen patients 63% (twelve) were found to have asymptomatic COD with an absolute absence of physical findings. Carotid stenosis by Doppler was estimated to be mild in five individuals and moderate in seven. These individuals are being followed on a yearly basis.

21% (four) were found to have asymptomatic CAD. Of the four CAD patients, whose ages ranged from 64 to 77 years, 75% (3) required cardiovascular intervention. One had severely calcified vessels with trivial blockage, two required stenting of a single coronary artery, and the third had a total occlusion of one coronary artery and required stenting of the two remaining coronary arteries.

Figure 2: Specialized Testing Findings



From the entire diabetic population 8.7% have been identified as having PVD, 5.5% with asymptomatic COD, 1.8% with asymptomatic CAD, and 1.4% with obstructive albeit asymptomatic CAD requiring intervention.

CONCLUSION:

Although this is a small study on diabetic patients from a single practice, the results strongly suggest that the Doppler foot examination, properly performed, is an inexpensive and reliable in-office test for screening and prediction of PVD. Using further diagnostic testing, once PVD has been confirmed, can uncover occult macrovascular disease and lead to life and limb saving interventions.

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