

Lower limb complications

Confusion!



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In the 1990s, I had the great pleasure of working with Peter Cavanagh.

We took X-rays of feet and discovered a number of things. One of these was that medial arterial calcification (MAC)

affected people with diabetes with neuropathy and renal disease even when the ankle-brachial index (ABI) was low (<0.9; Young et al, 1993). This quarter's Digest articles are all about ABI and MAC with interesting, but some conflicting, research about their impact on mortality rates and arterial disease.

First, there is confusion about how best to measure ankle pressure indices. Ena et al (2011; summary over page) report that automated blood pressure machines do not give accurate results and tend to overestimate ABI, whereas Kollias et al (2011; summary over page) found them to be accurate.

Sheikh et al (2011; summary over page) add to the methodological confusion by stating that it is post-exercise ABI values that are most prognostically accurate. They studied two groups, those with ABI ≥ 0.85 pre- and post-exercise and those with ABI ≥ 0.85 pre- and <0.85 post-exercise. An abnormal ABI post-exercise was associated with a significant, independent rise in mortality rate. These data add further weight to the argument that

peripheral arterial disease (PAD) predicts cardiac and cerebrovascular death, but does MAC?

Aboyans et al (2011) and Adragao et al (2011; summarised below and alongside) present studies with differing results. Aboyans et al state that when all else is controlled, MAC is not an independent predictor of mortality, whereas Doppler analysis and an ABI of <0.9 are. In a population of people on dialysis, Adragao et al found that MAC does increase mortality rates, which certainly sits better with my view of arterial compliance, systolic hypertension and the associated factors that lead to MAC formation, including possibly renal hyperparathyroidism – all known to increase mortality rates.

Although these studies were not conducted in people with diabetes only, they provide clues as to what to expect in our patients. Finally, Aerden et al (2011; summary over page) report on the age-old problem of MAC impacting the interpreting of ABI values. They found that 34% of arteries in participants with diabetes were not compressible, and that there was a poor correlation between ABI and PAD in those with radiological evidence of MAC. They also found that participants with MAC had lower average ABI values and more vascular disease.

And so the circle is complete ... ouroboros.

Young MJ, Adams JE, Anderson GF et al (1993) Medial arterial calcification in the feet of diabetic patients and matched non-diabetic control subjects. *Diabetologia* 36: 615–21

NEPHROLOGY DIALYSIS TRANSPLANTATION

ABI can be used to identify people at high CV risk

Readability	✓✓✓✓
Applicability to practice	✓✓✓
WOW! factor	✓✓✓

1 In people who undergo haemodialysis, vascular calcification (VC) may play a role in the development of peripheral artery disease (PAD), which may be identified using the ankle-brachial index (ABI).

2 An ABI <0.9 indicates PAD, whereas ABI >1.3 indicates stiff, non-compressible distal arteries, which could be related to distal artery calcification.

3 In this study, the authors aimed to determine the association of ABI with VC and with mortality rates.

4 Baseline ABI was measured using a Doppler machine in 219 participants undergoing haemodialysis.

5 VC was assessed in plain X-rays using the simple VC score (SVCS) and the abdominal aorta CS (AACS).

6 AACS ≥ 6 and iliac-femoral CS ≥ 2 were associated with ABI <0.9 (odds ratios [ORs], 2.52 [$P=0.007$]; and 4.45 [$P=0.001$], respectively); pelvic and hand CS ≥ 2 were associated with ABI >1.3 (ORs, 4.21 [$P=0.003$]; and 3.74 [$P=0.006$], respectively).

7 Over an observational period of 28.9 months, ABI <0.9 and >1.3 were associated with all-cause mortality (hazard ratios [HRs], 3.9 [$P<0.001$]; and 2.7 [$P=0.038$], respectively) and with cardiovascular mortality (HRs, 7.2 [$P=0.002$]; and 5.1 [$P=0.028$], respectively).

8 The authors found that low (<0.9) and high (>1.3) ABI were associated with mortality; VC in large arteries were associated with low ABI and VC in peripheral and distal arteries with high ABI.

Adragao T, Pires A, Branco P et al (2011) Ankle-brachial index, vascular calcifications and mortality in dialysis patients. *Nephrol Dial Transplant* [Epub ahead of print]

JOURNAL OF VASCULAR SURGERY

Poor CVD prognosis with high ABI

Readability	✓✓✓✓
Applicability to practice	✓✓✓
WOW! factor	✓✓✓

1 The authors studied the prognosis of high ankle-brachial index (ABI; ≥ 1.40) and coexistent occlusive peripheral artery disease (O-PAD).

2 Data were reviewed for 403 people with diabetes who underwent Doppler assessment: those with ABI

≤ 0.90 had O-PAD; 0.91–1.39 were normal; ≥ 1.40 with normal Doppler patterns had isolated medial calcinosis (IMC); and ≥ 1.40 with abnormal Doppler patterns had mixed disease.

3 After 6.5 years of follow-up, the presence of occlusive disease, but not IMC, was significantly associated with cardiovascular disease (CVD) events (hazard ratio, 2.21; $P=0.016$).

4 Participants with ABI ≥ 1.40 and concomitant O-PAD were found to have a poor CVD prognosis.

Aboyans V, Lacroix P, Tran M-H et al (2011) The prognosis of diabetic patients with high ankle-brachial index depends on the coexistence of occlusive peripheral artery disease. *J Vasc Surg* 53: 984–91

ANNALS OF VASCULAR SURGERY

Calcification causes unreliable ABI estimation of PAD

Readability	✓✓✓✓
Applicability to practice	✓✓✓
WOW! factor	✓✓✓

- The authors assessed whether the ankle-brachial index (ABI) is not a good predictor of peripheral artery disease (PAD) in people with diabetes, and if arterial calcifications or the distribution of atherosclerotic lesions contribute to this unreliability.
- Study participants comprised 187 people with diabetic foot and a suspicion of PAD.
- The extent and distribution of atherosclerosis was determined by angiography from the aorta to the foot and the extent of calcification was measured by X-ray.
- To assess the reliability of the ABI in detecting atherosclerosis below the knee, the authors compared standard ABI (which uses the highest distal pressure) with an ABI using the lowest pressure and an ABI using the average of both pressures.
- ABI was only detectable in 123 participants (66%); the mean ABI was 0.92.
- There were increased numbers of atherosclerotic lesions showed in the distal compared with proximal regions.
- A total of 108 participants (58%) had calcified arteries; these individuals had lower ABI ($P < 0.013$) and more advanced PAD ($P < 0.001$).
- The correlation between ABI and PAD was weak ($r = -0.487$); the ABIs using both distal pressures correlated best with PAD ($r = -0.554$).
- It was concluded that ABI underestimated PAD, and both calcification and the distribution of atherosclerotic lesions have a role in the unreliability of ABI.

Aerden D, Massaad D, von Kemp K et al (2011) The ankle-brachial index and the diabetic foot: a troublesome marriage. *Ann Vasc Surg* [Epub ahead of print]

HYPERTENSION RESEARCH

Automated ABI: An alternative to Doppler

Readability	✓✓✓✓
Applicability to practice	✓✓✓
WOW! factor	✓✓✓

- The aim of this study was to compare the use of Doppler (manual) and automated ankle-brachial index (ABI) measuring to diagnose peripheral artery disease (PAD).
- The study cohort was made up of 93 people with cardiovascular (CV) risk factors.
- Agreement in diagnosing PAD was found between automated

and Doppler ABI in 95% of the cohort (κ , 0.79), and in 94% of those with diabetes (κ , 0.79).

- There was no significant difference in the CV risk factors that predicted PAD when either measurement was used.
- The mean time required for ABI measurement was shorter with the automated method (5.8 min vs 9.3 min for Doppler; $P < 0.001$).
- The authors concluded that automated ABI measurement is as reliable as, and faster than, the Doppler method in diagnosing PAD.

Kollias A, Xilomenos A, Protogerou A et al (2011) Automated determination of the ankle-brachial index using an oscillometric blood pressure monitor: validation vs. Doppler measurement and cardiovascular risk factor profile. *Hypertens Res* **34**: 825–30

AMERICAN JOURNAL OF CARDIOLOGY

Post-exercise ABI: A strong predictor of all-cause mortality

Readability	✓✓✓✓
Applicability to practice	✓✓✓
WOW! factor	✓✓✓

- The authors investigated whether post-exercise ankle-brachial index (ABI) could be used to predict all-cause mortality risk.
- A total of 6292 people who had ABI measurements taken before and after a fixed-grade treadmill or

symptom-limited exercise protocol were included in the study.

- Participants were divided into Group 1: ABI ≥ 0.85 before and after exercise; and Group 2: ABI normal at rest and < 0.85 post-exercise.
- The 10-year mortality rates were 32.7% and 41.2% for Groups 1 and 2, respectively. After exclusion of people with a history of cardiovascular events, ABI < 0.85 post-exercise was associated with all-cause mortality (hazard ratio 1.67; $P < 0.0001$).
- The authors concluded that in this cohort post-exercise ABI was an independent predictor of mortality.

Sheikh MA, Bhatt DL, Li J et al (2011) Usefulness of postexercise ankle-brachial index to predict all-cause mortality. *Am J Cardiol* **107**: 778–82

DIABETES RESEARCH AND CLINICAL PRACTICE

ABI is best estimated with Doppler

Readability	✓✓✓✓
Applicability to practice	✓✓✓
WOW! factor	✓✓✓

- In this study, the authors assessed the accuracy of an upper-arm automated blood pressure-measuring device to estimate ankle-brachial index (ABI) by comparing it with the handheld Doppler machine measurements as a standard method.

- The study included 110 people with diabetes aged > 50 years.
- The prevalence of peripheral arterial disease, as defined by ABI < 0.91 , was 32% with the Doppler method and 29% with the automated device.
- The mean ABI value was lower with the automated device (0.97 vs 1.02; $P = 0.023$), with 26.7% false positive and 13.7% false negative results.
- The authors concluded that the automated device was not as accurate as the Doppler method in estimating ABI.

Ena J, Lozano T, Verdú G et al (2011) Accuracy of ankle-brachial index obtained by automated blood pressure measuring devices in patients with diabetes mellitus. *Diabetes Res Clin Pract* **92**: 329–36

“The ankle-brachial index (ABI) underestimated peripheral artery disease, and both calcification and the distribution of atherosclerotic lesions have a role in the unreliability of ABI.”