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Change over time of the ankle brachial index

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ABSTRACT

Objective: this study was designed to better understand the evolution of the ankle brachial Index (ABI) over time, so as to better inform clinical decision-making.
Methods: patient selection included consecutive patients with at least two documented ABI Indexes obtained at Emory Healthcare between April 2005 and April 2013. Retrospective chart reviews were conducted on consecutive patients to assess ABI Index values, time between ABIs and whether revascularization had occurred between the two ABI measures. Qualifying patients included 76 patients with two ABIs and without a surgical intervention between the two measures.
Results: the primary study outcome measure was the change in ABI per day. The average change in ABI per year was calculated as -0.012045. Extrapolating from these data, the estimated time in which meaningful deterioration (0.1) was found to be 8.3 years.
Conclusion: these data demonstrate a change in ABI that is minimal and thus suggest that without intervening medical treatments that would change the ABI, routinely repeating this test is not warranted.

1. Introduction

Peripheral vascular disease (PVD), more specifically peripheral arterial disease (PAD) has a prevalence rate of 8–12% of the adult population of the United States, with an estimated 8.5 million individuals with this condition. Some have estimated the prevalence of PAD as high as 29% among those aged over 50 years who have a history of diabetes mellitus (DM) [1,2].

PAD is a risk marker for cardiovascular and cerebrovascular disease, associated with an increased risk of mortality from these conditions by four to six fold [3]. As such, the early diagnosis and follow up of PVD/PAD are important for patient care.

The detection of PAD is an important function in wound care in individuals with venous insufficiency. In 2014, the Society for Vascular Surgery and the American Venous Forum published guidelines for the management of venous leg ulcers which included the use of compression therapy for the management of venous legs ulcers as well as to prevent their recurrence. These guidelines also recommended the measurement of the ABI on all patients with venous leg ulcers [4]. Within these recommendations the society notes that a change of 0.15 in ABI is required to be considered clinically relevant, or greater than 0.10 if it is associated with a change in clinical status. They also note that the typical cutoff point for a diagnosis of peripheral artery disease is an ABI of 0.90 or less at rest, with an ABI of 0.50 or less corresponding to critical limb ischemia. This suggests that pressure dressings should not be applied in those with an ABI of 0.50 or less. It is of clinical importance to be able to gauge whether, and in what time frame, a repeat ABI is needed before applying therapeutic pressure dressings. To know the expected rate of deterioration of PAD as measured by the ABI is a missing formula in the calculus of clinical wound care.

The ankle-brachial Index (ABI) is a simple, easy to perform, objective means of assessing for the presence of PAD. Several professional organizations, including the American College of Cardiology/American Heart Association (ACC/A HA), Society of Interventional Radiology, Association for Vascular Surgery, Society for Vascular Surgery, and Society for Vascular Medicine and Biology endorse the use of the resting ABI to establish the diagnosis of PAD and venous insufficiency [4–7]. No consensus has been reached however as to the rate of change in ABI over time, and thus the frequency with which to repeat the ABI. This study was designed to understand the progression of the ABI over time, by reviewing a cohort of patients with significant risk factors for PAD, and who had at least two measures of PAD.

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2. Materials and methods

Upon receiving approval from the Institutional Review Board (IRB) data was obtained from Emory Healthcare patient records. Patient selection included consecutive patients with least two documented ABI Indexes obtained at Emory Healthcare between April 2005 and April 2013. Retrospective chart reviews were conducted on randomly selected patients to assess ABI Index values. Patient data collected included: time between ABIs and whether revascularization had occurred between the two ABI measures. Qualifying patients included 76 patients with two ABIs and without a surgical intervention between the two measures. Selected study participants included 76 patients without a surgical intervention between the two measures. Patients experiencing revascularization between the two Indexes were excluded from the study.

The ABI was calculated using the highest systolic ankle pressure for each leg, measured at the dorsalis pedis and posterior tibial arteries. The highest measure of either the dorsalis pedis or posterior tibial measurement was used for the left and right ankle, divided by the highest brachial pressure [8]. The pooled ABI was the average of the right and left ankle ABI measurements. The daily change in ABIs was determined by the difference between the most recent ABI and the baseline ABI, divided by the number of days between the two measurements.

Medical information gathered from patient charts included age, sex, ethnicity, height, weight, history of diabetes, medications, hypertension, dyslipidemia, prior or current tobacco use, coronary artery disease, chronic kidney disease, timing of revascularization procedures and reason for visit leading up to ABI. Information on the following prescriptions were gathered from medical records: aspirin, abciximab, cangrelor, cilostazol, clopidogrel, dipyridamole, eptifibatide, prasugrel, ticagrelor, ticlopidine, tirofiban, vorapaxar, and warfarin.

The primary outcome measure was the daily change in ABI. Secondary outcomes included daily change in ABI for the left and right extremities by gender, diabetes diagnosis, medication prescription, and comorbid condition. Estimated rates of change in ABI were calculated for 12 and 18-month time periods.

3. Results

Daily change in ABI values were calculated by subtracting the value of the first ABI from the second ABI and dividing by the days separating the two tests. Multivariable regression analysis of daily change in ABI was performed with variables adjusting for baseline ABI, age, gender, prescription of aspirin and diabetes diagnosis. All statistical tests were 2-sided. $P \leq 0.05$ were considered statistically significant. The summaries are in Table 1.

The initial ABI for left (0.885, 95% CI [0.804, 0.966]) and right (0.877, 95% CI [0.803, 0.952]) are not significantly different (p = 0.868) and hence where pooled to give a value of 0.881, 95% CI [0.818, 0.944]. Also, the final ABI for left and right are not significantly different (p = 0.877). These are also pooled to give final ABI of 0.885, 95% CI [0.825, 0.946]. There was no significant difference between the pooled initial ABI and the final ABI (p = 0.860). Of the 76 patients, the mean daily change in ABI, was -0.000, 033, 95% CI [-0.000, 185, 0.000, 120]. The mean time between any two ABIs was 539 days, 95% CI [436.5, 642.6].

Baseline ABI values were considered to examine whether the value of the first ABI had an effect upon the progression of change in the ABI over time. Controlling for baseline ABI and other variables, the value of the baseline ABI was significantly associated with daily change in ABI (p = 0.002). Subjects with baseline ABIs < .82 had greater increases (0.000, 0410, 95% CI [-0.000224, 0.000, 306]) in daily change, as compared to those with ABIs of 0.82 and greater who show a decrease (-0.000, 086, 95% CI [-0.000274, 0.000, 102]).

Patients with diabetes (N = 33) had a mean of 616 days between ABI studies, while those without had a mean of 481 days. The daily change in ABI for those with a diagnosis of diabetes was -0.000, 047, 95% CI [-0.000, 263, 0.000, 169], and for those without a diagnosis of diabetes -0.000, 022, 95% CI [-0.000, 243, 0.000, 199]. Daily change in ABI in males (-0.000, 093) with diabetes was similar to that of males (-0.000095) without diabetes. The difference in daily change when comparing females with and without diabetes was similar (p = 0.808).

Male patients (N = 48) averaged 571, 95% CI [430, 712] days between ABIs, while female patients (N = 28) averaged 486, 95% CI [336, 636]. The mean daily change in ABI for males was -0.000, 094, (95% [CI -0.000, 293, +0.000, 106], and for females + 0.000072, 95% CI [-0.000, 174, +0.000, 317]. There is no significant difference between those who use tobacco and those who do not (p = 0.103). Similarly, there was no significant difference in the daily change in ABI for those with or without coronary artery disease (p = 0.601). Patient age at the time of the first ABI was between 33–91 years. Age made no significant contribution to change in ABI over time (p = .165). Patient demographics are shown in Table 2.

The estimated change in ABI for a 12-month period is -0.012, 045, and for an 18-month period -0.018, 067. Extrapolating from these data, the estimated time in which meaningful deterioration (0.1) will occur is 8.3 years (Fig. 1).

4. Discussion

In 1652, a surgeon to King Charles II Richard Wiseman reported of the importance of compression to heal a venous ulcer. In his book Severall Chirugical Treatises, Wiseman described a laced leather

Table 1
Summary of Key Variables.

	N	Mean	Std. Deviation	95% Confidence Interval		P-value
				Lower	Upper	
Age as of 1st ABI	76	68.0	11.0	65.4	70.5	
Time difference in days	76	539.6	450.8	436.5	642.6	
Right Initial	76	0.877	0.327	0.803	0.952	0.726
Right Final	76	0.888	0.307	0.818	0.958	
Right Change	76	0.021	0.259	−0.038	0.080	
Left Initial	76	0.885	0.354	0.804	0.966	0.936
eft Final	76	0.883	0.299	0.814	0.951	
Left Change	76	−0.019	0.273	−0.081	0.043	
Left Daily change	76	−0.000014	0.000,886	−0.000217	0.000188	0.793
Right Daily Change	76	−0.000051	0.000,928	−0.000263	0.000,161	
Pooled Initial	76	0.881	0.276	0.818	0.944	0.860
Pooled Final	76	0.885	0.265	0.825	0.946	
Pooled difference	76	0.004	0.202	−0.042	0.050	
Pooled daily Change	76	−0.000033	0.000,669	−0.000185	0.000,120	

Table 2
Summary of Daily Ankle Brachial Index (ABI), against initial ABI.

	Less than 0.82			0.82 and greater			Total				
	N	Mean	Std.	N	Mean	Std.	N	Mean	Std.	95% Lower	95% Upper
Female	12	.000,219	0.000643	16	−.000039	0.000624	28	.000,072	.000,634	−.000174	.000,317
Male	20	−.000066	0.000782	28	−.000113	0.000625	48	−.000094	.000,687	−.000293	.000,106
No Diabetes	21	.000,087	0.000838	22	−.000126	0.000581	43	−.000022	.000,718	−.000243	.000,199
Diabetes	11	−.000047	0.000508	22	−.000047	0.000665	33	−.000047	.000,609	−.000263	.000,169
in 12 months	19	−.000008	0.000904	19	−.000139	0.000764	38	−.000074	.000,828	−.000346	0.000198
13 to 18 months	3	.000,364	0.000694	8	−.000174	0.000821	11	−.000028	.000,794	−.000561	.000,506
Over 18 months	10	.000,038	0.000287	17	.000,014	0.000242	27	.000,023	.000,254	−.000078	.000,124
No Tobacco	17	.000,210	0.000697	23	−.000002	0.000681	40	.000,088	.000,687	−.000132	.000,308
Tobacco	14	−.000147	0.000783	21	−.000179	0.000544	35	−.000166	.000,639	−.000386	.000,053
No Coronary	19	.000,082	0.000805	18	−.000015	0.000602	37	.000,035	.000,706	−.000201	.000,270
Coronary	13	−.000018	0.000646	26	−.000136	0.000637	39	−.000097	.000,634	−.000302	.000,109
Total	32	.000,041	0.000735	44	−.000086	0.000619	76	−.000033	.000,669	−.001850	.000,120

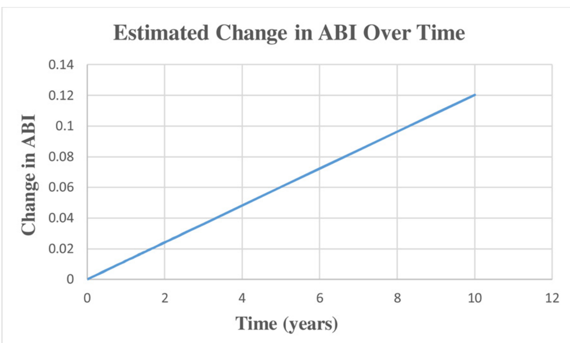

Fig. 1. Ankle brachial Index (ABI).

stocking to achieve this compression. This was refined by Paul Gerson Unna in 1854 who developed a paste noncompliant bandage to advance the practice of therapeutic compression (Villavicencio). As current recommendations for wound assessment prior to the placement of compression bandages includes an evaluation of vascular status, typically a screening ABI, we sought to understand how this measure might change among those who may need recurrent treatment.

This retrospective study included all patients seen in a vascular clinic with two ABIs and no intervening medical procedure involving the vasculature of the lower extremities. Our data demonstrated that once determined, the rate of ABI change over time is too slow to warrant a follow up ABI in the absence of an intervening medical circumstance.

Our data demonstrate that the change in ABI is dependent upon the baseline measure, as progression of disease may occur more rapidly in those with an ABI < 0.82. Follow up measures may also be dependent on the laterality of the limb, gender, diabetes diagnosis, tobacco use and coronary artery disease.

The ABI is often used as an indicator of the potential for a wound to heal as well as an assessment of peripheral artery disease [4]. The ABI is relevant when using compression garments, particularly Unna boot, as compression is contraindicated with peripheral artery disease, as indicated by an ABI .50 or less [4,7]. Patients with abnormal ABIs or symptomatic peripheral artery disease should undergo further evaluation regarding wound care as compression stockings/devices may lead to complications [4,7,9].

Males with diabetes had significant progression of disease compared to females with diabetes. Additionally, changes in ABI values in diabetics over time can be confounded by increased rates of calcification in diabetics [10]. Potential interaction between gender and diabetes can be investigated in future research.

This study is limited by the retrospective nature of the analysis. As our data reviewed only those patients who had received two ABIs over time we must assume that this group was at risk of PAD and thus may have had a different clinical course than those who had only one ABI, or those who had none. There may be two groups among those with only one ABI. As the ABI is thought to be a screening tool, the results of the first examination may have either assuaged concern and resulted in no further ABI orders, or ignited a concern and thus led to more definitive testing.

This study is also limited by the sample size, as there were very few Indexes with no intervening intervention. The sample size limitation also had an effect upon the ability to examine the effects of medications and comorbidities. Medications may affect the vasculature and in fact are intended to reduce the deterioration of the vasculature. Our sample size was insufficient however to calculate the efficacy of these in changing the trajectory of the change in ABI over time. Thus, further research is needed to investigate the effects of these medications on change in ABI. The sample size was also insufficient to effectively calculate the change in ABI over time as effected by diabetes, diabetic control (HgA1c), hypertension, and hyperlipidemia. Further study will be needed to answer these questions.

5. Conclusions

This pilot study of patients referred to a university health system vascular clinic for assessment of the Ankle Brachial Index found that over time, these values do not change sufficiently as to warrant a repeat examination. These data do not support the common practice of repeating ABIs, in the absence of an intervening intervention. Further prospective studies are warranted.

Author contributions

Study conception: DB
Data collection: TM
Analysis: DB, DA, TM, SA
Investigation: DB, DA, TM
Writing: DB, DA, TM
Funding acquisition: N/A
Critical review and revision: DB, DA, TM, SA
Final approval of the article: DB, DA, TM, SA
Accountability for all aspects of the article: DB, DA, TM

Conflict of Interest

None.

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