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Research Brief

Clinical implication of the brachial-ankle pulse wave velocity for endovascular treatment

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ABSTRACT

This study aimed to evaluate the clinical implication of the brachial-ankle pulse wave velocity (baPWV) for endovascular treatment (EVT). Eighty-four patients who underwent EVT for aortoiliac and femoropopliteal artery were included. In these patients, 36 (43 %) had an ABI improvement above 0.9 a day after EVT. The baPWV in patients who received re-EVT afterwards was significantly higher than that of patients who did not. The area under the receiver operating characteristic curve for the baPWV for predicting re-EVT was 0.788. The optimal cut-off values of the baPWV for re-EVT, specificity, and sensitivity were 2220 cm/s, 93.1 %, and 57.1 %, respectively.

1. Introduction

The brachial-ankle pulse wave velocity (baPWV), **which has a relatively large number of published papers in Asia**, is an indicator for the assessment of arterial stiffness.[1–5] The baPWV is also known to be a significant predictor of cardiovascular events.[6,7] The baPWV is an index affected by age and blood pressure, but the standard value is 1800 cm/s.[8–10] **However, the baPWV measurement becomes unreliable if an ankle-brachial index (ABI) less than or equal to 0.9. Therefore, the baPWV should be evaluated in the setting of ABI greater than 0.9.[11] Atherosclerosis obliterans is one of the typical diseases caused by the development of arteriosclerosis. However, the clinical implications of baPWV for endovascular treatment (EVT) remain unclear. In this study, we examined the usefulness of baPWV for EVT, especially for restenosis.**

2. Methods

A total of **eighty-four** consecutive patients who underwent successful EVT for aortoiliac and femoropopliteal artery disease at our hospital between January 2017 and May 2019 were included in this study. Patients who did not show post-EVT improvements in the ABI and/or angiographic stenosis were excluded. The ABI and baPWV data were obtained using an automated oscillometric device (VP-1000; Omron Healthcare Co.). The study was approved by the institutional review board of our hospital and was conducted in compliance with the Helsinki Declaration.

3. Results

Of the **eighty-four** patients, 36 (43 %) had an ABI improvement above 0.9 **a** day after EVT. Since the baPWV value is unreliable below ABI 0.9, subsequent analyses were performed on these 36 patients. The patient and lesion characteristics are summarized in Tables 1 and 2. In brief, the comorbidities were hypertension in 81 %, diabetes in 58 %, dyslipidemiain 75 %, ischemic heart disease in 42 %, hemodialysis in 25 %, and atrial fibrillationin 11 % of the 36 patients; current smokers accounted for 56 %. Rutherford category 2/3/4/5/6 was observed in 17 (47 %)/8 (22 %)/1 (3 %)/6 (17 %)/4 (11 %) patients, respectively. The mean ABI before EVT was 0.70 ± 0.14. The target lesions were the common iliac artery in 25 %, external iliac arteryin 8 %, and superficial femoral artery in 67 % of the patients. Plain old balloon angioplasty was performed in 28 %, drug-coated balloon in 22 %, and stent implantation in 50 % of the patients.

There were significant correlations between the baPWV and age, **a** day after EVT ($r = 0.414$, $p = 0.0122$). baPWV in patients who received re-EVT afterwards (an average of 11 months after initial EVT) was significantly higher than that of patients who did not (2131 ± 356.6 vs. 1784 ± 298.5 cm/s, $p = 0.0118$) (Fig. 1, left panel).

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Table 1
Patient characteristics ($n = 36$).

Demographic	
Age, years	72.5 ± 7.8
Male/female	27 (75 %)/9 (25 %)
Height, m	1.62 ± 0.09
Weight, kg	59.4 ± 11.1
BMI, kg/m^2	22.7 ± 3.9
Medical history	
HT	29 (81 %)
DM	21 (58 %)
DL	27 (75 %)
IHD	15 (42 %)
HD	9 (25 %)
AF	4 (11 %)
Current/Past Smoking	20 (56 %)/5 (14 %)
Laboratory characteristics	
Hb, g/dL	12.4 ± 2.1
TC, mg/dL	173 ± 44
HDL-C, mg/dL	53 ± 16
LDL-C, mg/dL	100 ± 30
TG, mg/dL	140 ± 79
HbA1c, %	6.4 ± 0.9
BG, mg/dL	138 ± 40
UA, mg/dL	5.4 ± 1.3
CRP, mg/dL	0.96 ± 1.70
Clinical presentation	
Fontaine stage	
2/3/4	25 (69 %)/1 (3 %)/10 (28 %)
Rutherford category	
2/3/4/5/6	17 (47 %)/8 (22 %)/1 (3 %)/6 (17 %)/4 (11 %)
ABI	0.70 ± 0.14
%MAP, %	49 ± 5
UT, ms	218 ± 56

Data are expressed as the mean ± SD or number (%).
BMI, body mass index; HT, hypertension; DM, diabetes mellitus; DL, dyslipidemia; IHD, ischemic heart disease; HD, hemodialysis; AF, atrial fibrillation; Hb, hemoglobin; TC, total cholesterol; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TG, triglyceride; HbA1c, glycated hemoglobin; BG, blood glucose; UA, urinary acid; CRP, C-reactive protein; ABI, ankle-brachial index; %MAP, percentage of mean arterial pressure; UT, upstroke time.

Table 2
Lesion characteristics ($n = 36$).

Lesions	
CIA	9 (25 %)
EIA	3 (8 %)
TASCII A/B/C/D	6/5/1/0
CFA	0 (0 %)
SFA	24 (67 %)
POP	0 (0 %)
TASCII A/B/C/D	6/11/5/2
Lesion length	
Focal, ≤1 cm	5 (14 %)
Short, >1 and < 5 cm	19 (53 %)
Intermediate, ≥5 and < 15 cm	9 (25 %)
Long, ≥15 cm	3 (8 %)
PACSS grade	
0	6 (17 %)
1	14 (39 %)
2	6 (17 %)
3	9 (25 %)
4	1 (3 %)
Stenosis	
75 %	2 (6 %)
90 %	19 (53 %)
99 %	6 (17 %)
100 %	9 (25 %)
Procedure	
POBA	10 (28 %)
DCB	8 (22 %)
Stent	16 (44 %)
Viabahn® stent graft	2 (6 %)

CIA, common iliac artery; EIA, external iliac artery; CFA, common femoral artery; SFA, superficial femoral artery; POP, popliteal artery; TASCII, Trans-Atlantic Inter-Society Consensus II; PACSS, peripheral arterial calcium scoring system; POBA, plain old balloon angioplasty; DCB, drug-coated balloon.

The area under the receiver operating characteristic curve for the baPWV for predicting re-EVT was 0.788 (95 % CI, 0.581–0.995) (Fig. 1, right panel). The optimal cut-off values of the baPWV for re-EVT, specificity, and sensitivity were 2220 cm/s, 93.1 %, and 57.1 %, respectively. At the time of before EVT,C-reactive protein (CRP) levels in patients requiring re-EVT afterwards were significantly higher (2.6 ± 2.8 vs. 0.4 ± 0.5 mg/dL, $p = 0.00188$) and hemoglobin (Hb) was significantly lower (10.7 ± 1.4 vs. 12.8 ± 2.0 g/dL, $p = 0.0159$) than in patients not requiring re-EVT.

4. Discussion

These results indicated that the baPWV is useful for predicting re-EVT in patients with ABI improvement of 0.9 or more after EVT. Conversely, even if EVT is successful and the ABI improves to 0.9 or more, if the baPWV is quite high, restenosis of the target lesion will eventually occur. We also observed that inflammation and anemia may affect re-EVT. Several limitations of this study must be acknowledged, such as a selection bias because of the retrospective nature of the study, the small number of patients in a single hospital, and the limited follow-up period. Further research is required to validate these results. In conclusion, patients who needed re-EVT afterwards were characterized by high baPWV one day after EVT, high CRP, and low Hb levels before EVT.

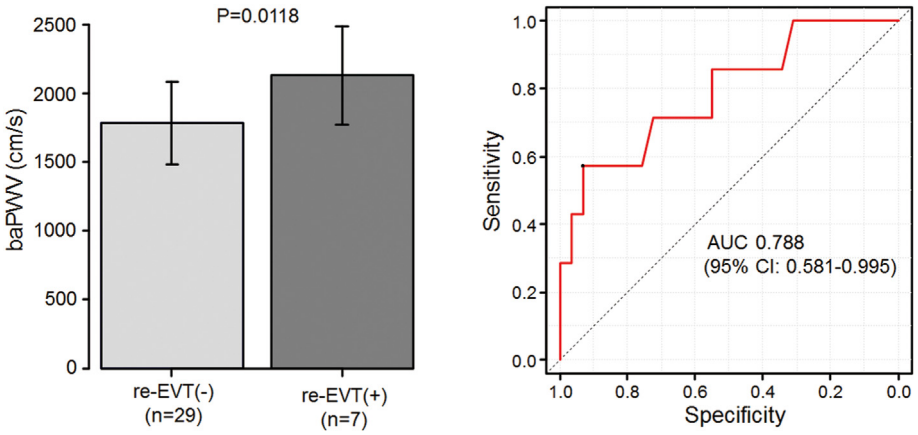

Fig. 1. The brachial-ankle pulse wave velocity (baPWV) as a predictor of restenosis. Left panel: The baPWV in patients who received re-endovascular treatment (EVT) afterwards was significantly higher than that in patients who did not. Right panel: The area under the receiver operating characteristic curve of baPWV for predicting re-EVT was 0.788.

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Declaration of competing interest

All authors have no relationships relevant to the contents of this paper to disclose.

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