A new method of measuring central arterial stiffness, arterial velocity pulse index (AVI) indicates relationship between early arterial sclerosis and DVT.

K. Hanzawa* (hanzawakazuhiko@gmail.com) , Y. Saito**, M. Ikura***, M. Tsuchida*, T. Nakajima***,
*Thoracic and Cardiovascular Surgery, Niigata Univ. Grad. Sch. Med. ,** Shisei Datum, ***Neurology, National Niigata Hospital, Japan

Background: We have reported that DVT increase and prolong after earthquake. And also not only pulmonary embolism but also cerebral infarction or myocardial infarction has increased in quake area residents with DVT (Table 1)(1). It has been reported that DVT is correlated with atherosclerosis. However, the mechanism of the correlation has been still unknown. A new method on measuring stiffness of central artery has been developed as arterial velocity pulse index (AVI). AVI is calculated by the ratio of speed changing of pressure (dp/dt) at brachial artery during systolic and diastolic periods (Fig. 1). The value of AVI increases by aging (Fig.2), carotid intima-media thickness (IMT) or plaque (Fig. 3), Aortic intima-media thickness or plaque by trans-esophageal echocardiography (Fig. 4) and cardio-ankle vascular index (CAVI) (Fig. 5).

Principle and definition of AVI (arterial velocity pulse index)

Pressure waveform of brachial artery relates with central arterial pressure (P1) and is modified by reflected pressure (P2) from peripheral artery (Fig. 1). P2 is affected by peripheral arterial resistance. As peripheral arterial stiffness increas by aging or atherosclerosis, P2 become high. In addition, stiffer central arterial wall tend to return fast during diastolic phase. Since pressure waveform during diastolic phase become more sharp angle in stiffer central artery. On the contrary, the pressure waveform is not affected by peripheral arterial resistanc or central arterial stiffness during systolic phase since left ventricle pressure is very high. Arterial velocity pulse index is calculated by the ratio of maximum pressure speed (dP/dt) at brachial artery during systolic period (Vf) and diastoli period (Vr).

AVI=20×Vr/Vf

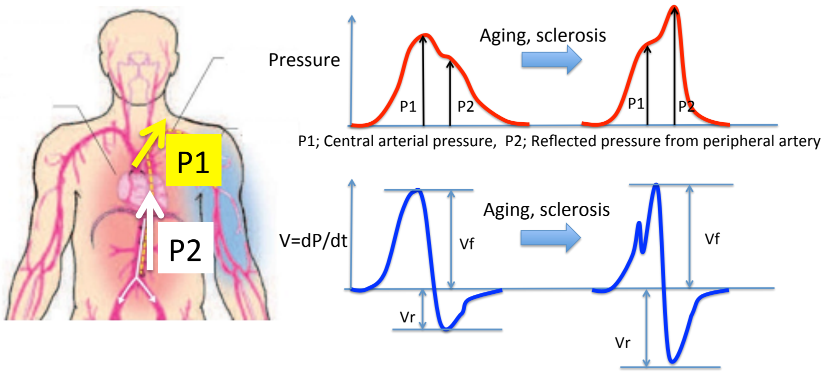
Therefore, AVI is thought to reflect central arterial stiffness or peripheral arteri resistance by aging, atherosclerosis and sclerotic change of central artery by other causes . AVI can be measured by PASESA (AVE-1500)(Shisei Datum) (Fig.2).

(Table 1) Relationship between DVT and cardiovascular events 8 years after Mid Niigata prefecture Earthquake

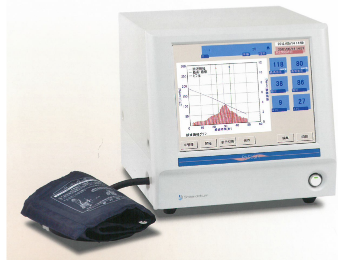
Brain and heart events after earthquake	DVT(+) after earthquake (n=237)	DVT (-) after earthquake (n=1175)
Pulmonary embolism (n=8)	7 (3.0%)	1 (0.08%)
Ischemic stroke (n=27)	16 (6.8%)	21 (n=1.8%)
Ischemic heart disease (n=51)	15 (6.3%)	36 (3.1%)

DVT after earthquake	Odds ratio	95% CI	P value
Pulmonary embolism	73.30	9.81-578.50	P<0.000001 *
Ischemic stroke	4.02	2.04-7.93	P<0.00001*
Ischemic heart disease	1.98	1.07-3.67	P<0.05*

(Fig. 1) Pressure waveform and velocity of pressure (dP/dt)

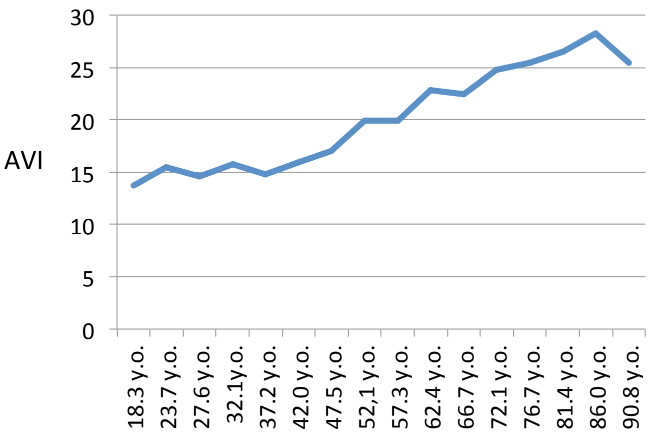


(Fig.2) Device for measuring AVI

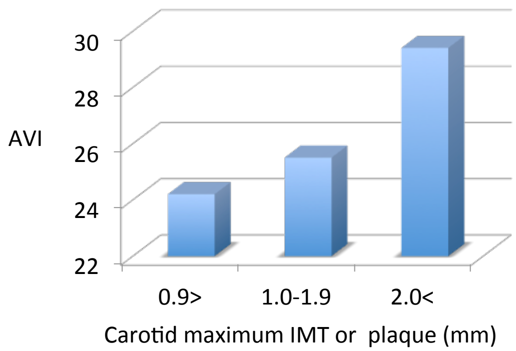


PASESA (AVE-1500)

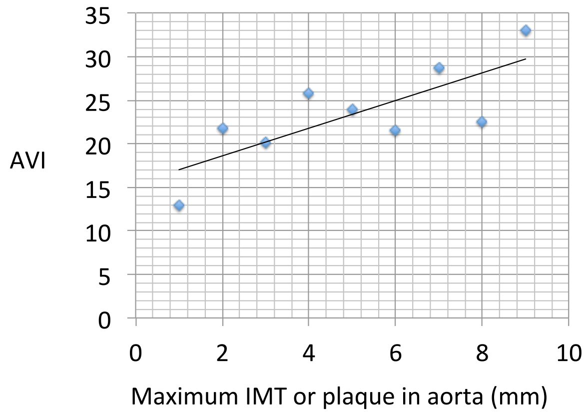
(Fig. 3) Relationship between AVI and age in residents in Nagaoka city, Ojiya city and Tokamachi city (n=1596)



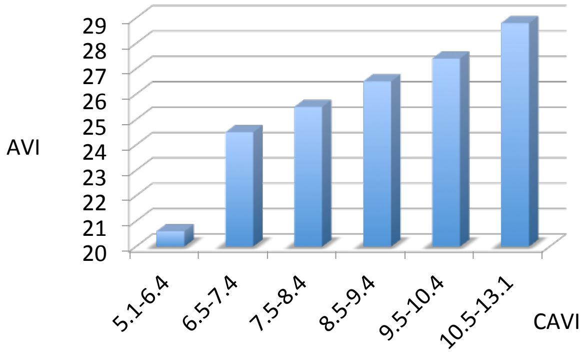
(Fig.4) Relationship between carotid maximum IMT or plaque and AVI in residents in Kashiwazaki city without any disease (n=92)

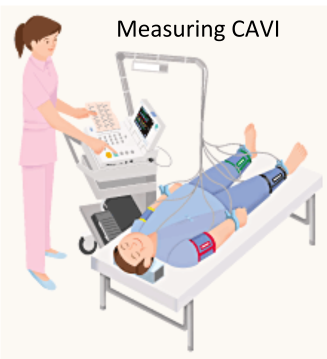


(Fig. 5) Relationship between AVI and maximum IMT or plaque in aorta by TEE in patients with cerebrovascular or cardiovascular disease (n=83)



(Fig. 6) Relationship between cardio-ankle vascular index (CAVI) and AVI In residents in Ohtsuchi town, Ohfunato city, Miyako city and Yamada town (n=272)





TEE; trans-esophageal echocardiography

Aortic plaque

AVI correlated with age (Fig.3), carotid IMT or plaque by carotid ultrasonography (Fig. 4), aortic IMT or plaque by TEE (Fig. 5) and CAVI by VaSera (VS-1500®,Fukuda Denshi) (Fig. 6). Since AVI indicates both peripheral and central arterial atherosclerotic change.

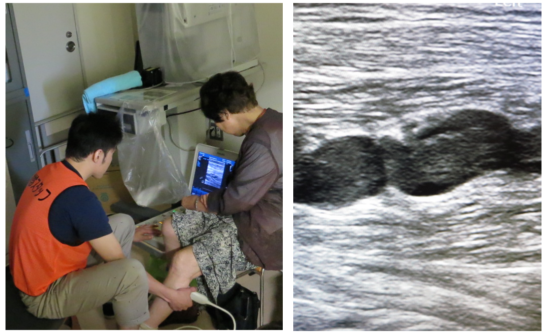
Purpose: We attempted to screen DVT and measure AVI in Kashiwazaki city where many DVT were recognized after Niigata prefecture Chu-etsu-Oki earthquake 2007.

Subjects and Methods: Subjected were 699 residents in Kashiwazaki city. Calf DVT was screened by ultrasound with sitting position (Fig.6). Thrombus in deep vein was determined by compression ultrasound technique. AVI was measured by AVE-1500 (Shisei Datum) at brachial artery. D-dimer was measured by VIDAS (BIOMERIEUX). Statistical analysis was performed by SSRI (version. 1.05).

Results: Asymptomatic 64 calf DVT were determined. DVT was related with age, diabetes mellitus, D-dimer and AVI by univariate analysis (Table 2). AVI correlated with age, AVI and D-dimer were statistic significant risk factors for DVT by multivariate analysis (logistic regression analysis).
The odds ratio of AVI, D-dimer for DVT was
1.83 (95%CI; 1.04-3.21, p=0.035),
2.42 (95%CI; 1.38-4.24,p=0.002), respectively.

Conclusion: AVI strongly correlated with atherosclerosis. The present results showed that AVI correlated with DVT. Mechanism of arterial sclerosis may affect formation of DVT. AVI may indicate not only arterial sclerosis but a risk of DVT. Further study is needed to clarify the common cause or mechanism of atherosclerosis and venous thrombosis.

Measuring AVI by PASESA (AVE-1500)



Ultrasound for lower legs and DVT

(Table 2)

	DVT (+) (n=64)	DVT (-) n=635	P value
Age (y.o.)	73.0±9.6	69.0±10.1	0.0028
Male	10 (15.6%)	152 (39.6%)	0.1331
Diabetes mellitus	10 15.6%)	16 (2.5%)	0.00001
Hypertension	31 (48.4%)	285 (44.9%)	0.5859
Dislipidemia	21 (32.8%)	225 (35.4%)	0.6757
SBP (mmHg)	137.1± 17.9	134.6±20.1	0.1295
DBP (mmHg)	74.7±11.2	73.6±11.6	0.2406
Heart rate (/min.)	73.3±10.1	71.1±10.7	0.0767
TC (mg/ml)	196.1±29.5	202.6±32.9	0.05
HDL (mg/ml)	57.9±13.2	58.5±13.8	0.3567
LDL (mg/ml)	109.3±25.6	114.1±27.0	0.08
TG (mg/ml)	137.9±77.9	154.7±110.1	0.06
D-dimer (ng/ml)	749.7±555.0	495.4±542.9	0.000028
AVI	29.7±7.3	26.8±8.4	0.0018

(Table 3)

For DVT	Odds ratio	95% CI	P value
Age >70	1.1629	0.642-2.1062	0.6186
Diabetes mellitus	1.3423	0.6336-2.7995	0.4325
TC>220 (mg/dl)	0.7601	0.4086-1.4139	0.3863
D-dimer>500 (ng/ml)	2.423	1.3843-4.2411	0.0019
AVI>26	1.8307	1.0431-3.213	0.00351

Left table (Table 2) shows characteristics of subjects with or without DVT. Right table (Table 3) shows odds ratio and 95 % CI for DVT by logistic regression analysis adjusted by age, DM, TC, D-dimer and AVI.