Assessment of Mechanical Properties of Common Carotid Artery in Takayasu's Arteritis Using Velocity Vector Imaging

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Background (I)

- **Alteration of arterial elastic properties is known to occur in patients with arteritis.**
- **Widespread thickening of the walls of elastic arteries is one of the characteristics of TA.**

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- **However, mechanical properties of the involved arteries are not well known.**

Background (II)

- Recently, velocity vector imaging (VVI), a novel method based on speckle tracking, has been suggested to be useful to assess multi-dimensional regional mechanics such as velocity, strain, strain rate and displacement.
- Thereby it enables rapid and accurate quantitative measurement of myocardial velocities, strain, and strain rate.

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Purpose

- To investigate the mechanical properties of the common carotid artery using VVI in TA.

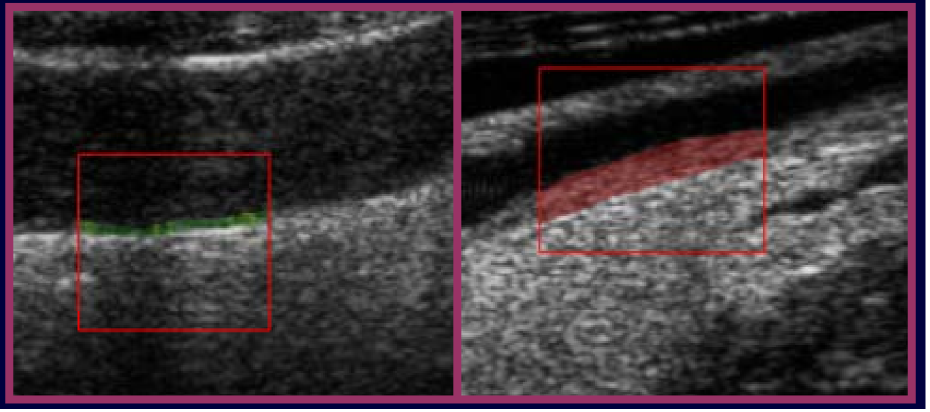
Methods

- 12 patients with Takayasu's arteritis
- 12 age-, gender-matched healthy controls

- Carotid IMT
- Carotid strain
- Carotid VVI

Carotid IMT

- **Semi-automatically measured with the *Syngo Arterial Health Package* (Siemens Medical Solutions USA, Inc., CA, USA)**
- **All the frames within a single region of interest (1 cm length) selected by the user 1 cm distal to the bulbs**

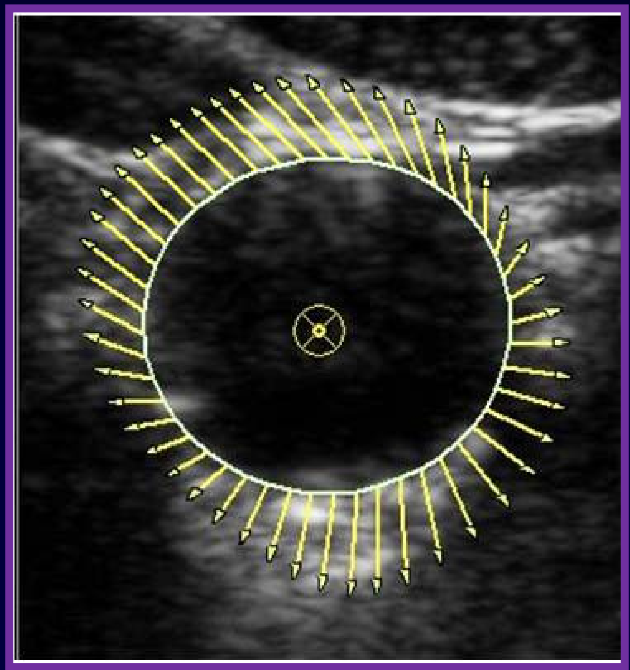


Carotid Strain

- Carotid luminal strain, the percent systolic expansion of the arterial lumen, was calculated as; luminal strain = ([internal diameter at peak systole – internal diameter at peak diastole]/internal diameter at peak diastole) $\times$ 100

Carotid VVI

- *Syngo Velocity Vector Imaging technology* (Siemens Medical Solution USA, Inc.)

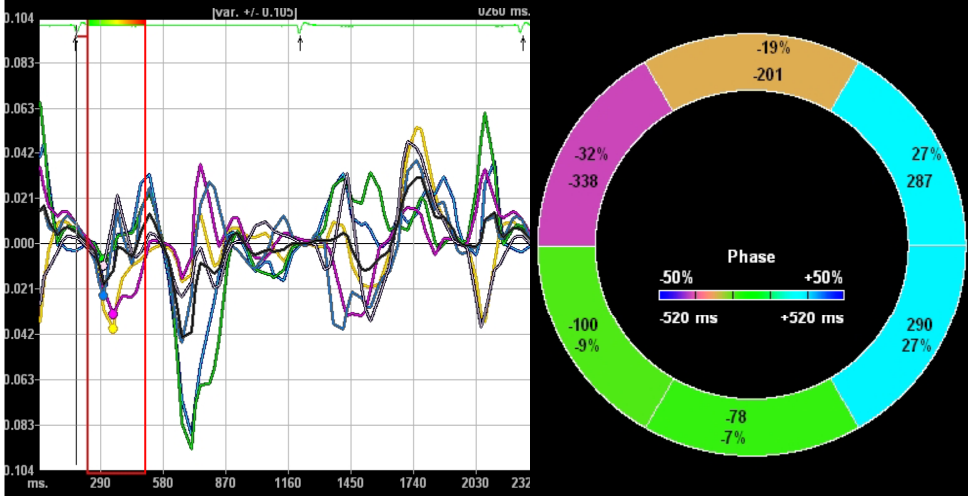


- Transverse plane of a common carotid artery about 1.5 cm from the bifurcation to the aortic arch

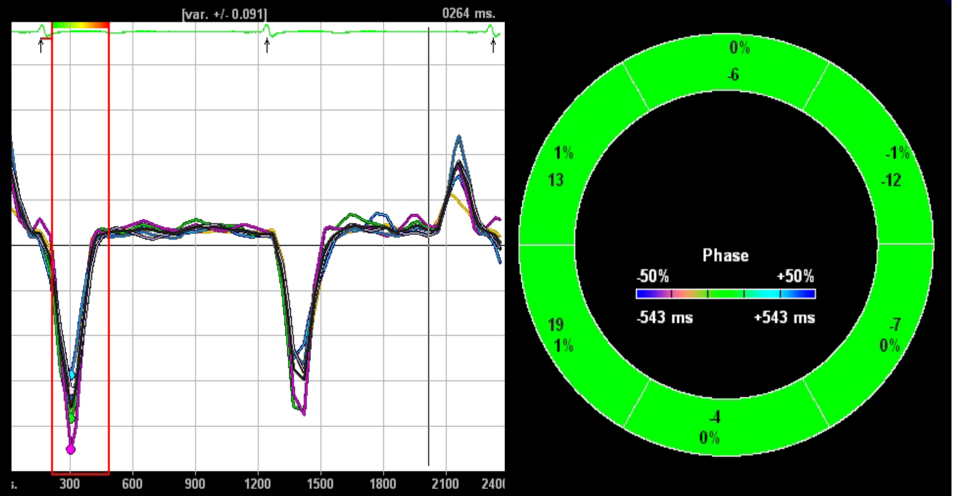
Regional Mechanics by VVI

- **The software divides arterial wall into 6 segments automatically**

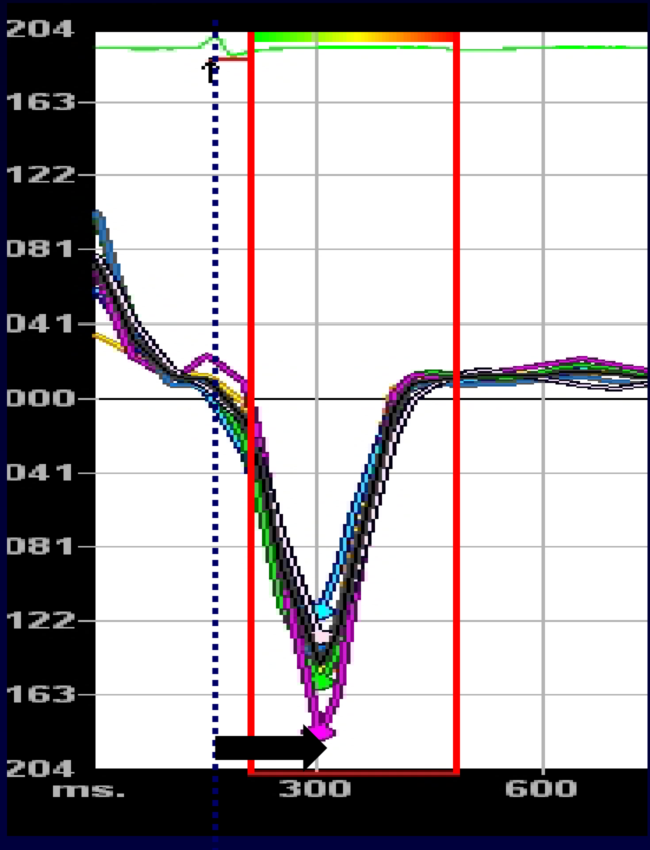
Takayasu's arteritis



Healthy control



Parameters Assessed by VVI

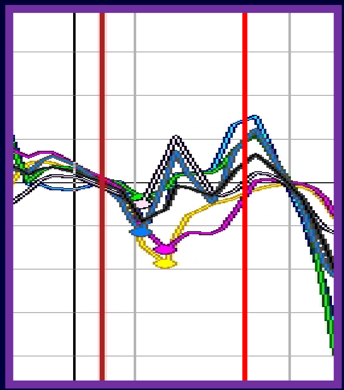


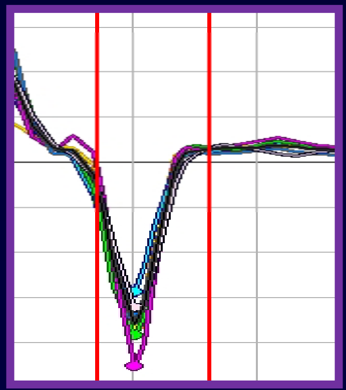
Time to peak radial velocity

- **Pv : peak radial velocity**
- **Ps : peak circ. strain**
- **Psr : peak circ. strain rate**
- **Pd : peak radial displacement**
- **Tv : time to Pv**
- **Ts : time to Ps**
- **Tsr : time to Psr**
- **Tv : time to Pd**

Dyssynchronous Motion

- Tv-SD : standard deviation of Tv
- Ts-SD : standard deviation of Ts
- Tsr-SD : standard deviation of Tsr
- Td-SD : standard deviation of Td





Clinical Characteristics

	TA (n=12)	Controls (n=12)	P value
Age (year)	38±10	38±10	0.977
Female (%)	11(91.7)	11(91.7)	0.999
SBP (mm Hg)	120±17	118±11	0.315
DBP (mm Hg)	73±9	74±8	0.606
HR (/min)	73±8	71±9	0.898
BMI (kg/m^2)	22.0±2.7	20.7±1.7	0.590

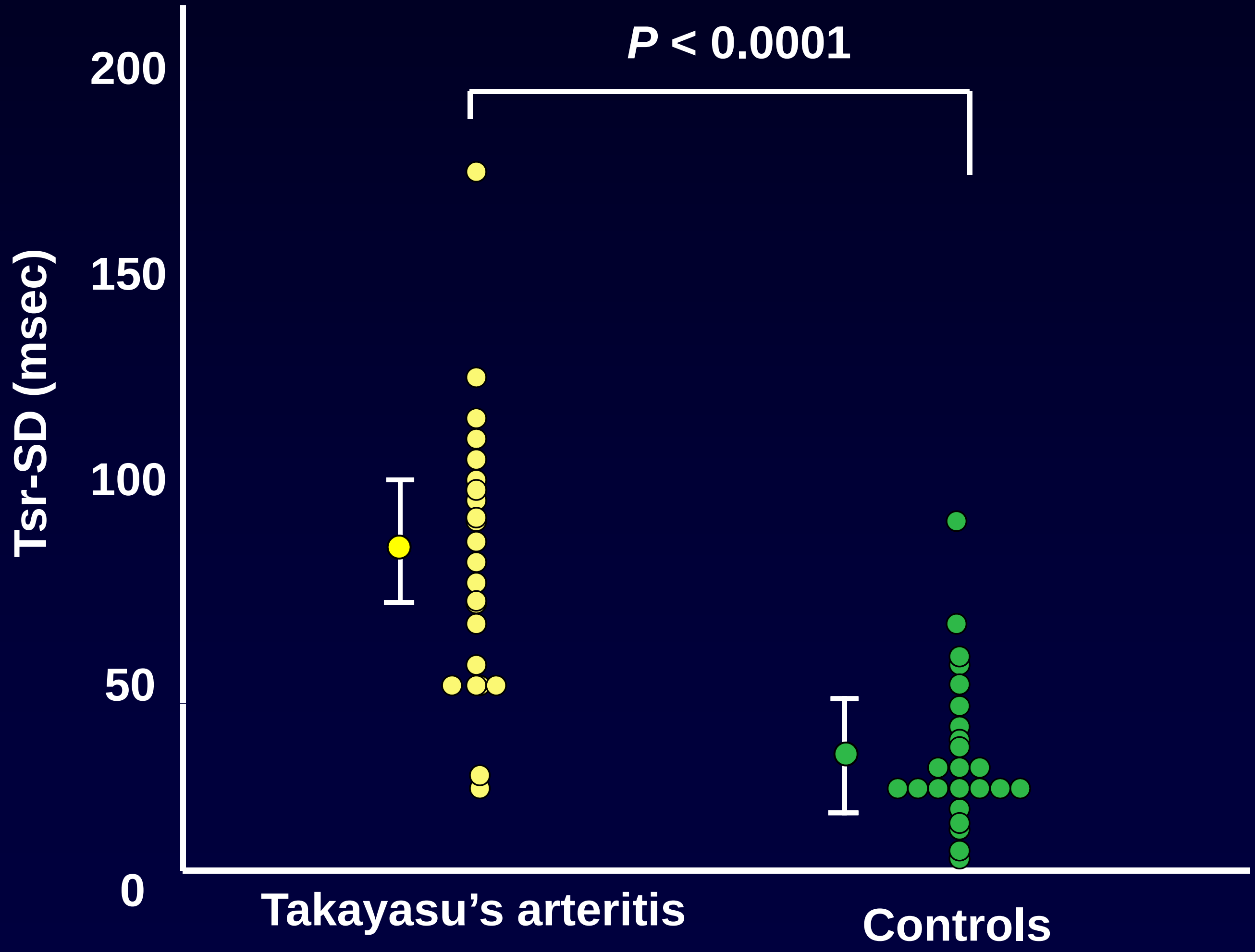
Carotid IMT, Diameter & Strain

	TA	Controls	P value
Number of examined carotid arteries	23	24	
IMT(mm)	1.16±0.48	0.46±0.07	< 0.0001
Internal diameter (mm)	4.24±2.07	5.93±0.64	0.001
External diameter (mm)	6.41±1.55	6.70±0.72	0.415
Luminal stenosis (%)	37±22	12±2	< 0.0001
Luminal strain (%)	4.16±4.15	8.66±3.34	< 0.0001

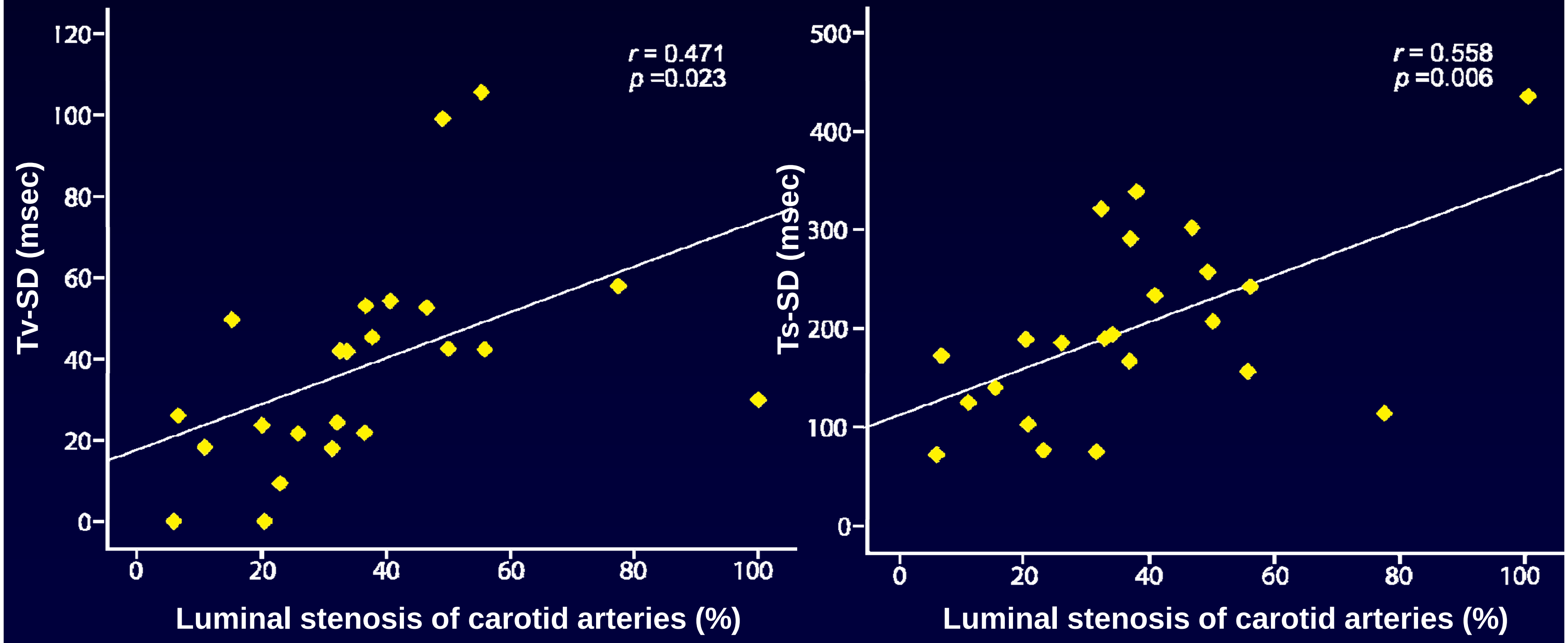
VVI Parameters

	TA	Controls	P value
Pv (mm/s)	1.17±1.36	1.42±0.59	0.032
Ps (%)	3.58±2.99	4.99±2.05	0.015
Psr (/s)	0.23±0.18	0.39±0.18	0.004
Pd (mm)	0.15±0.06	0.31±0.20	0.007
Tv-SD (msec)	38.2±26.4	13.3±10.0	< 0.0001
Ts-SD (msec)	199.3±93.7	87.1±58.4	< 0.0001
Tsr-SD (msec)	74.9±34.8	28.7±19.4	< 0.0001
Td-SD (msec)	125.4±93.1	41.9±36.4	< 0.0001

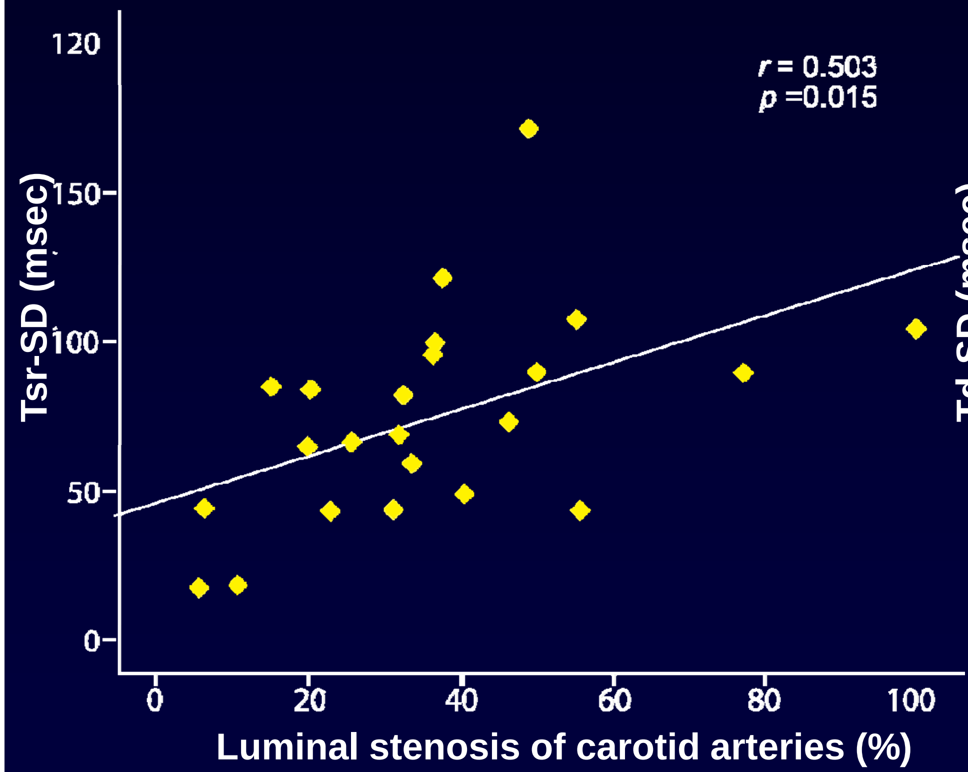
Standard Deviation of Tsr

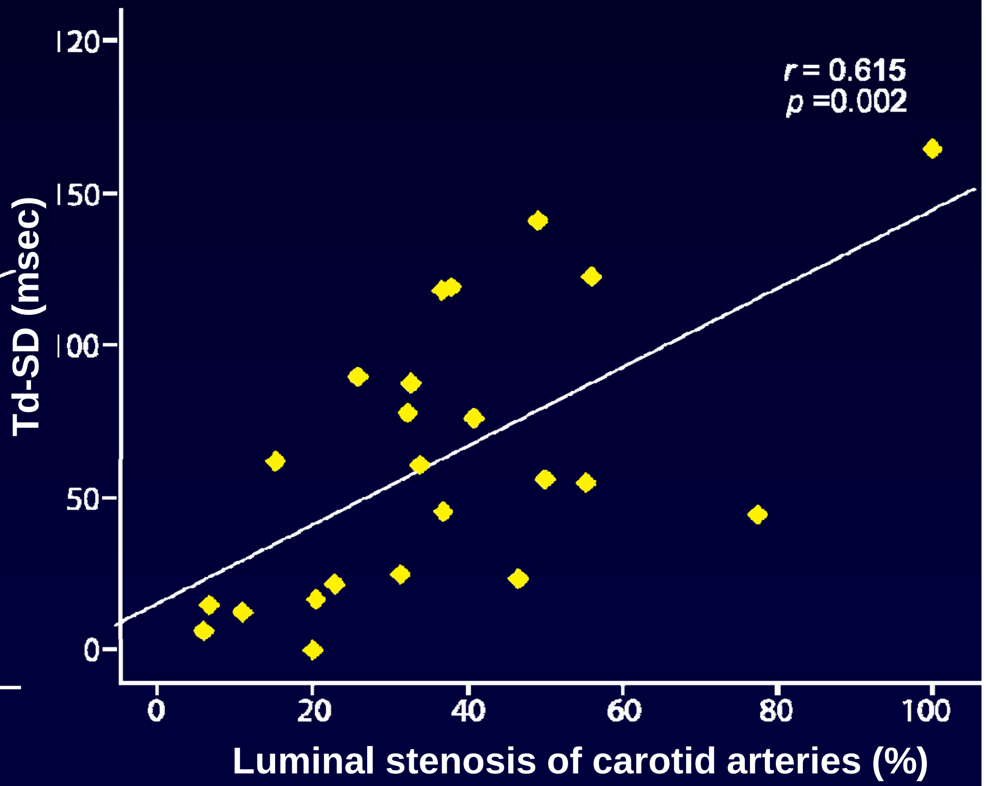


Dyssynchronous Motion & Stenosis



Dyssynchronous Motion & Stenosis





Summary

- Velocity, strain, strain rate and displacement were decreased significantly in TA.
- SDs of Tv, Ts, Tsr and Td of multiple arterial wall segments were higher in TA, suggesting disturbance of symmetric arterial expansion during systole.
- The severity of carotid stenosis was positively correlated with SDs of Tv, Ts, Tsr and Td.

Limitations

- Small number of the patient population, reflecting the rarity of TA
- Two-dimensional speckle tracking algorithms used in VVI are dependent on image quality and intima-media complex border definition
- Application of VVI for arterial wall has not been validated

Conclusion

- In patients with TA, carotid artery showed dyssynchronous arterial expansion during systole when compared with healthy controls.
- Arterial assessment using VVI may represent a new noninvasive method for quantifying vascular alteration associated with arteritis.

Thank you for your attention.