Oral Session III – Clinical Aspects, Hypertension and Diabetes

Chair: M Lorenza Muiesan, B Benczur

Maastricht UMC+

STRAIN DISCONTINUITIES IN CAROTID ATHEROSCLEROTIC PLAQUES – A NOVEL MARKER FOR PLAQUE VULNERABILITY?

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Disclosures

No disclosures

Atherosclerotic Plaques

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- Risk stratification relies on degree of stenosis and symptomatology

Atherosclerotic Plaques

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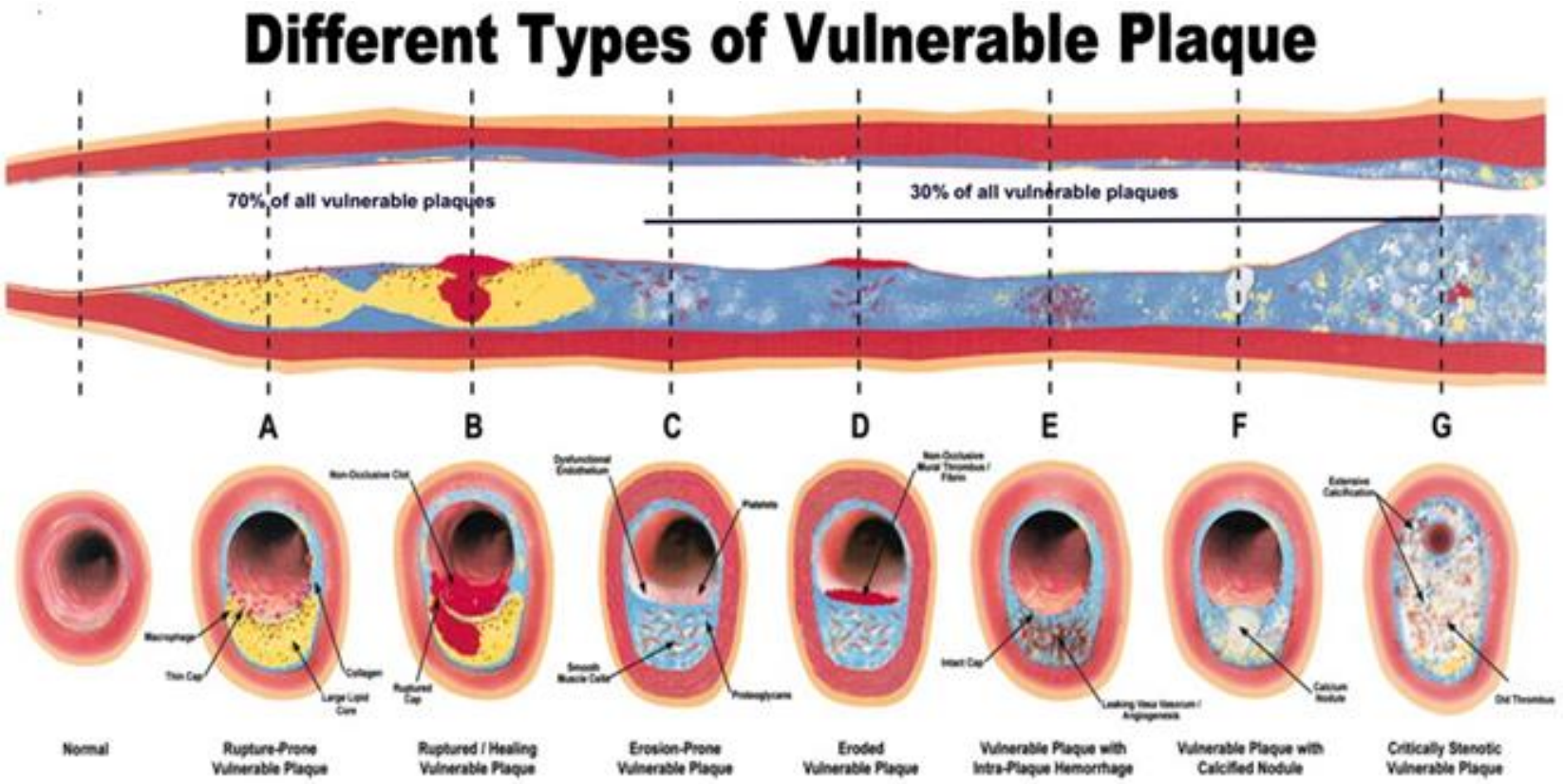
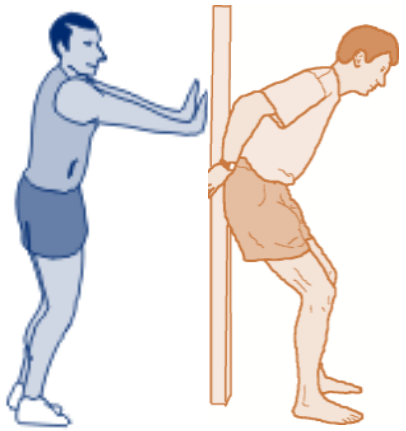


From *Naghavi et al. 2003*

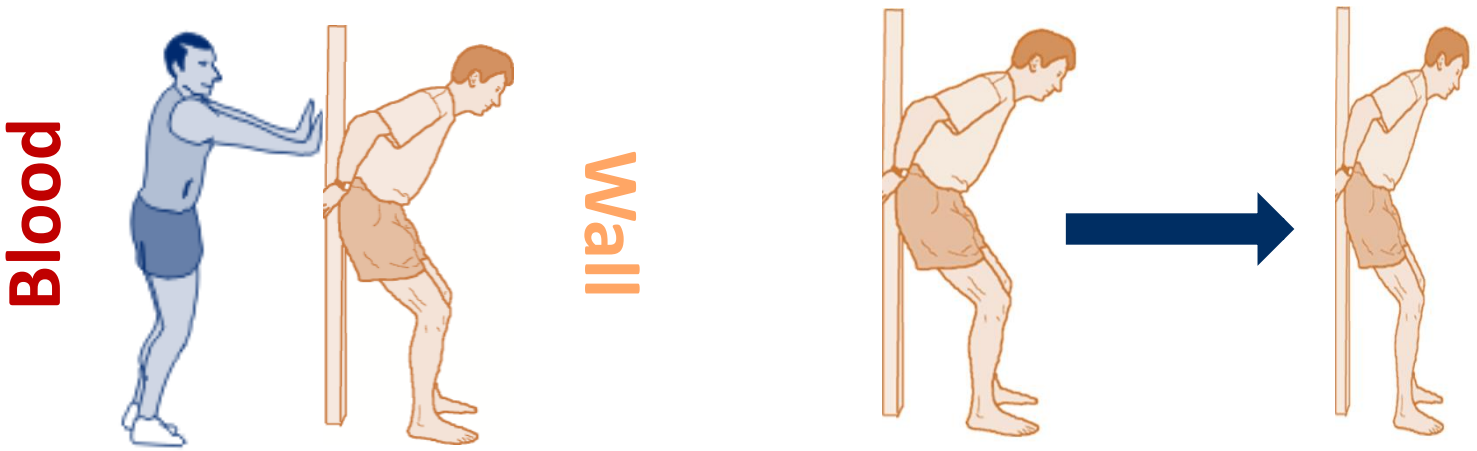
Strain and plaques

Blood

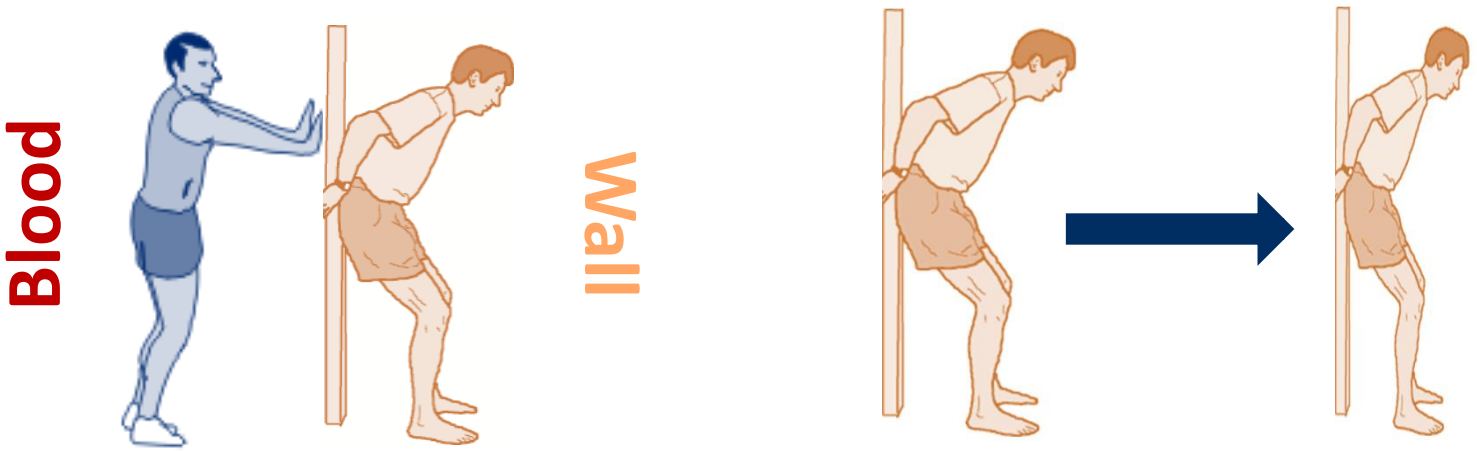


Wall

Strain and plaques



Strain and plaques



- Strain (ε) indicative for local mechanical stress (σ)
- Rupture of plaque occurs if local mechanical stress (σ) > material strength
- Rupture of plaque is pure biomechanical event

Aim of the study

- Develop new method for high resolution strain measurements
- Validate in Common Carotid Artery (CCA)
- Analyse strain in plaques in Internal Carotid Arteries (ICA)

Study set up

Population

- 22 patients
  - 17 with recent ischemic stroke or TIA
  - 5 asymptomatic

- 39 CCA's and ICA's were analyzed

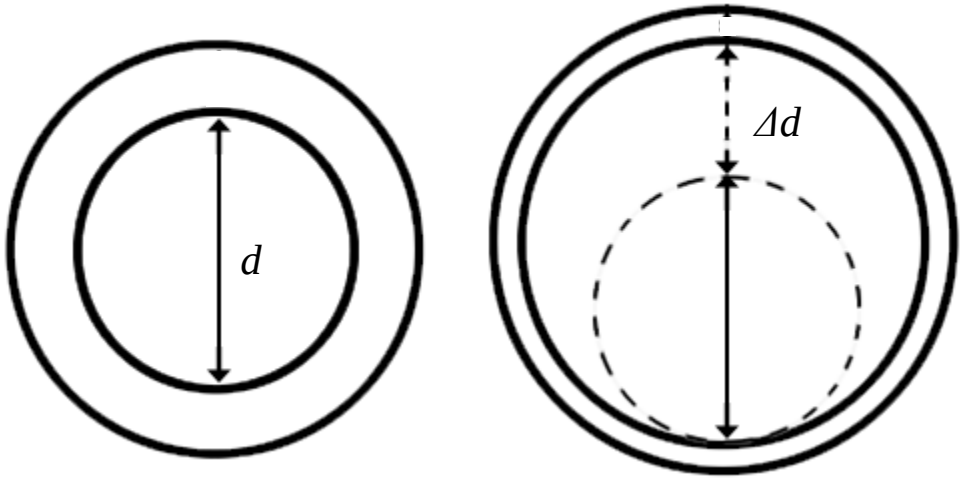
Acquisition

- PICUS (ESAOTE Europe, Maastricht, The Netherlands) with 7.5 MHz linear array and 33 MHz RF acquisition.

Strain versus distension in CCA

- Distension:

$$D = \frac{\Delta d}{d}$$



Strain versus distension in CCA

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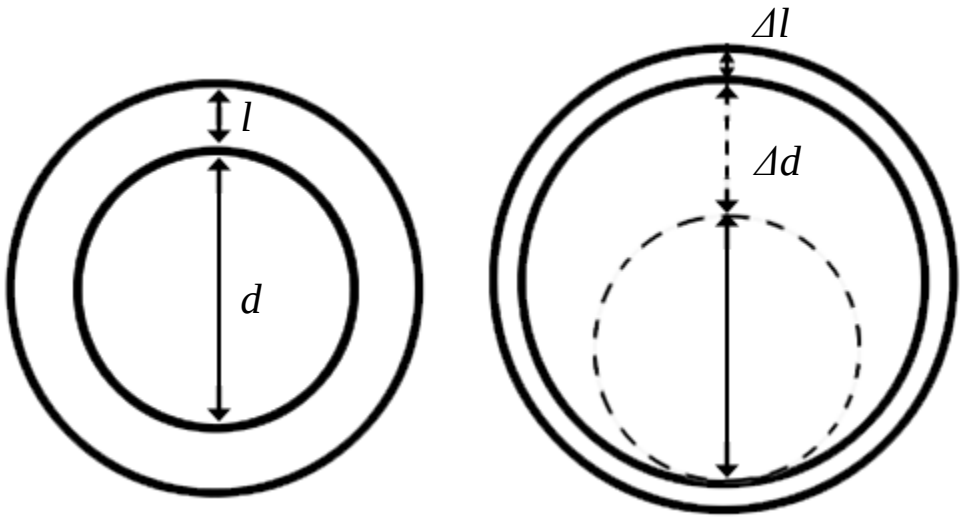


Strain versus distension in CCA

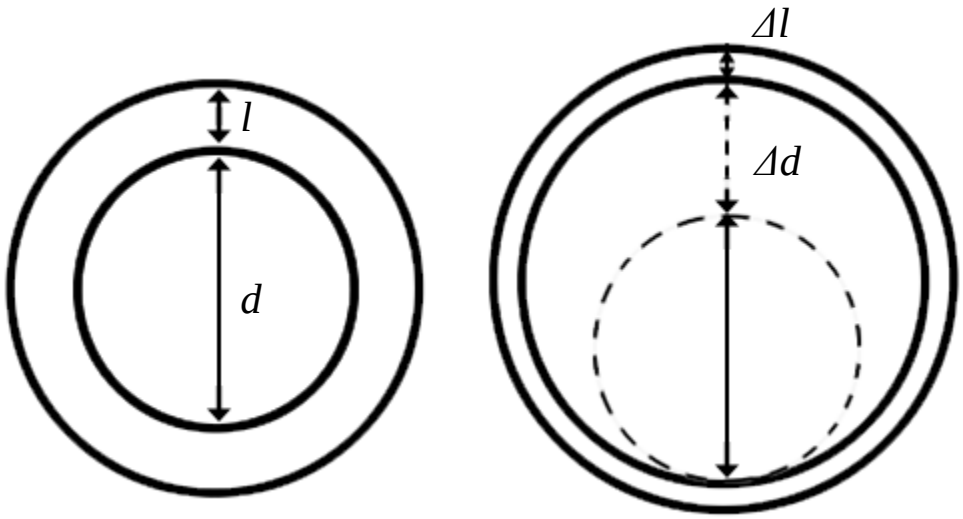
- Distension:

$$D = \frac{\Delta d}{d}$$

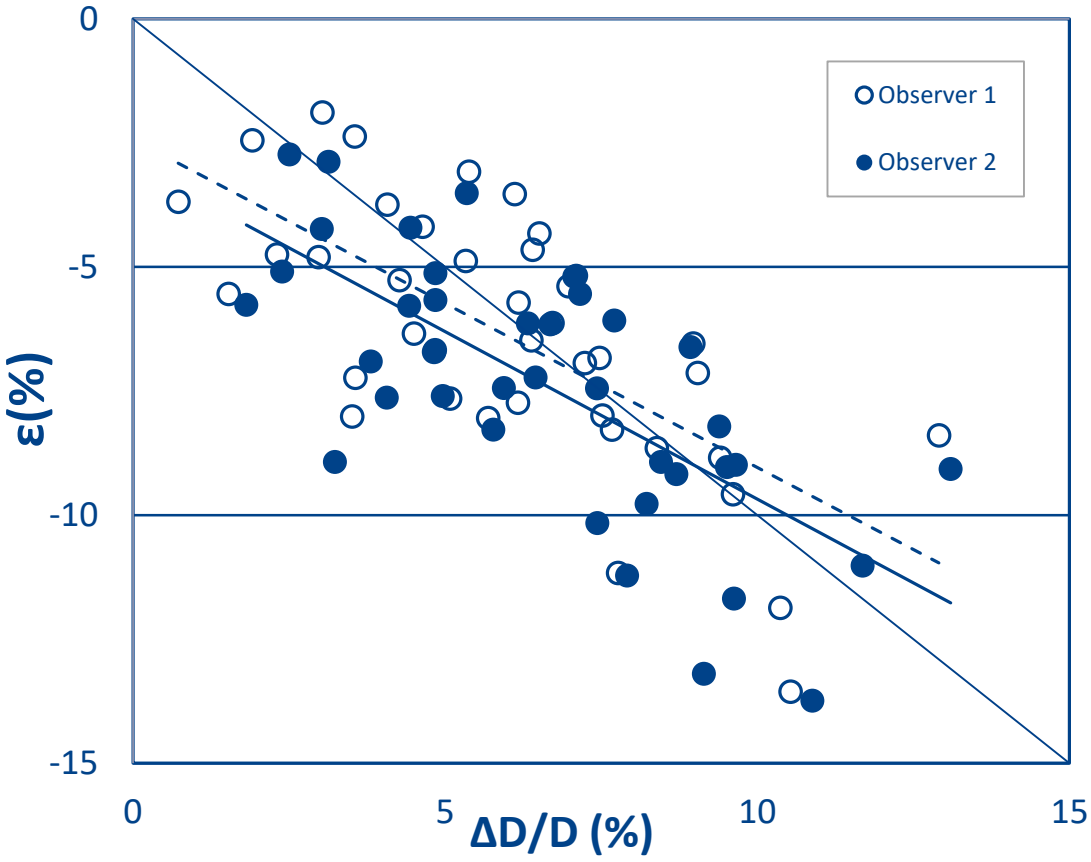
- Strain:

$$\varepsilon = \frac{\Delta l}{l}$$

$$D = -\varepsilon$$



Results: Strain versus distension in CCA



	Observer 1	Observer 2
Mean strain ± SD (%)	-7.39 ± 2.61	-6.41 ± 2.56
Distension (%)	6.62 ± 2.68	6.03 ± 2.67
Correlation coefficient strain versus distension	0.69	0.68

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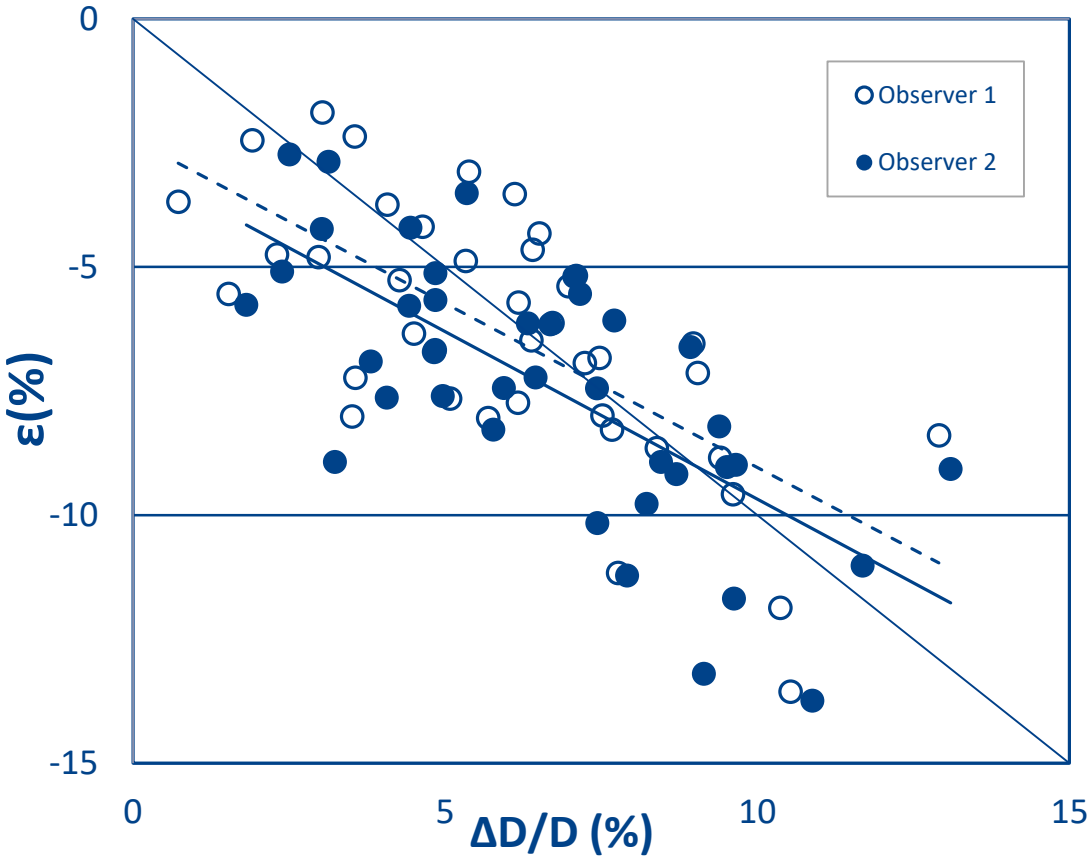

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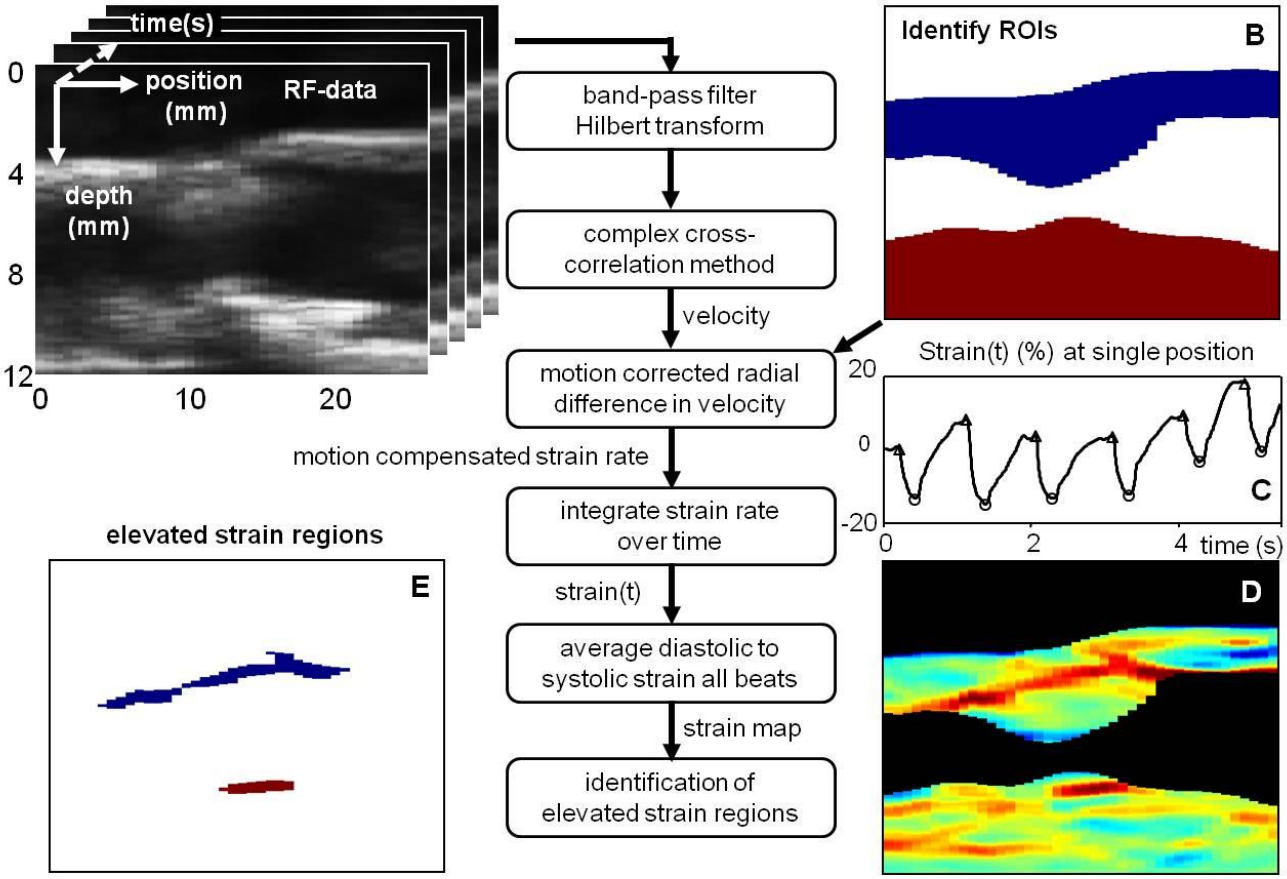
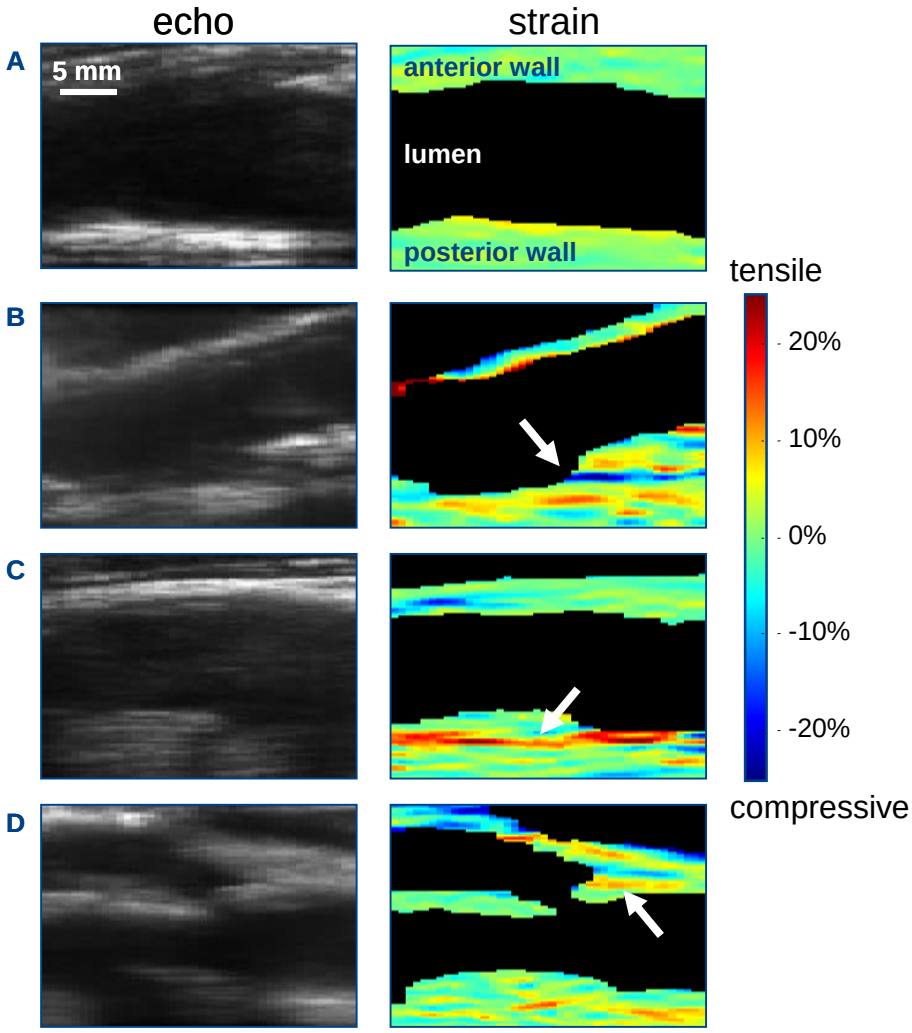
$r \approx 0.7$

Method of analysis



Results: Internal Carotid Artery strain characteristics



A. Homogeneous strain distribution

B. Narrow elongated region with deviating compressive strain

C. Narrow elongated region with deviating tensile strain

D. Narrow region with tensile strain

Results: Internal Carotid Artery strain characteristics

		mean±SD
Total of ICA's analyzed		N=39
Average strain		–0.1±1.2
High strain regions		N=26
Absolute strain (%)		12.6±6.5
Geometry	area (mm^2)	4.7±2.2
	width (mm)	0.7±0.3
	length (mm)	11±5

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- 86% of symptomatic ICAs had >1 strain inhomogeneity as compared to 56% of the other ICA's.

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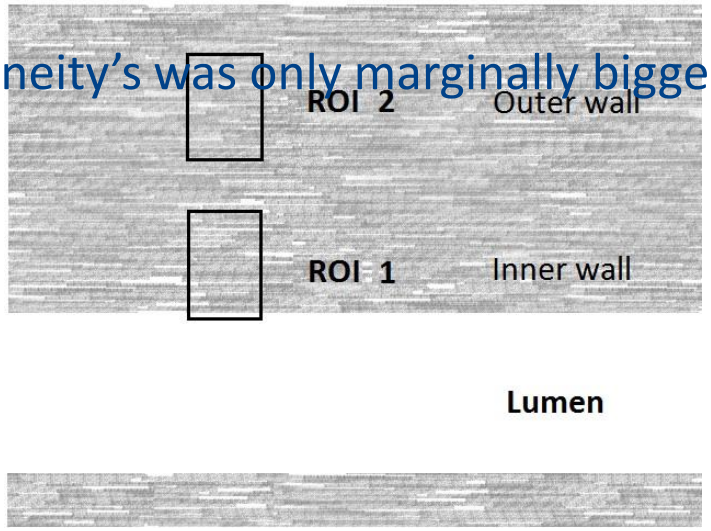
- 58% of deviating strain regions demarked the plaque-adventitia boundary
- Percentage of ICAs with >1 strain inhomogeneity increases with degree of stenosis (p = 0.03)
- 86% of symptomatic ICAs had >1 strain inhomogeneity as compared to 56% of the other ICA's.
- Strain in deviating strain regions was higher at the symptomatic side compared to the asymptomatic side (p = 0.02). Average strain values were comparable.

Discussion

- Loss of correlation between strain and distension with ROI more distant from lumen
- Average thickness of strain inhomogeneity's was only marginally bigger than the resolution



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- Loss of correlation between strain and distension with ROI more distant from lumen
- Average thickness of strain inhomogeneity's was only marginally bigger than the resolution
- Future study should investigate causal relationship

Conclusion

- Successfully developed and validated a novel method to determine intraplaque inhomogeneity's in strain distribution with high axial resolution.

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- Successfully developed and validated a novel method to determine intraplaque inhomogeneity's in strain distribution with high axial resolution.
- Intraplaque strain inhomogeneity's in ICA's frequently demarcated the plaque-adventitia boundary.
- These strain inhomogeneity's could be a promising marker for plaque vulnerability since they appear to be linked to recently symptomatic plaques.

Thank you for your attention