Vascular ultrasound for screening and diagnosis in GCA

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MARTINA HANSENS HOSPITAL, BÆRUM, OSLO, NORWAY
65-year-old man

- Admitted to the local hospital due to transient vision loss
- Previous history of fibromyalgia
- Ultrasound carotids (neurologist): Calcified plaques in bifurcation/ICA severe (>90%) stenosis
- Treatment: Alteplase, Carotid endarterectomy at Oslo University Hospital
65-year-old man

- Slightly elevated CRP and ESR
- No headache, polymyalgic symptoms or jaw claudication
- Examination of the temporal artery: Normal findings
- Fast-tack GCA ultrasound clinic: Received an appointment within the same day
Outline

- Ultrasound in GCA
- Controversies
- The Fast Track ultrasound GCA clinic
Disclosures

- Advisory board and speaker honoraria from Lilly, Pfizer, UCB, MSD, Abbvie, Roche
Why ultrasound in GCA?
Which is the best imaging approach to diagnose GCA?

- Diagnostic accuracy
- Availability
- Cost
- Safety
- Reproducibility
Ultrasound in Cranial GCA

Table 1  Summary of the meta-analyses examining ultrasound in GCA [10–12]

<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td># of studies</td>
<td>3</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>evaluated</td>
<td>3</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>87%</td>
<td>68%</td>
<td>78%</td>
</tr>
<tr>
<td>Specificity</td>
<td>96%</td>
<td>91%</td>
<td>88%</td>
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</table>

# number

aHalo, occlusion, or stenosis vs. ACR GCA classification criteria
bHalo vs. ACR GCA classification criteria
## Ultrasound in Large vessels GCA

- **LVV observed in 29% - 53.6% of GCA patients**
  

- **48.2% - 98% have axillary involvement**
  

### Table: Ultrasound findings in GCA

<table>
<thead>
<tr>
<th></th>
<th>LV-GCA</th>
<th>CRANIAL-GCA</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N</strong></td>
<td>53</td>
<td>121</td>
<td></td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td>66</td>
<td>72</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Females</strong></td>
<td>83 %</td>
<td>65 %</td>
<td>0.019</td>
</tr>
<tr>
<td><strong>AION</strong></td>
<td>4 %</td>
<td>19 %</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td><strong>Time to diagnosis</strong></td>
<td>7.2 mo.</td>
<td>1.9 mo.</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>PMR</strong></td>
<td>45 %</td>
<td>42 %</td>
<td>n.s.</td>
</tr>
<tr>
<td><strong>ESR</strong></td>
<td>76 mm/h</td>
<td>74 mm/h</td>
<td>n.s.</td>
</tr>
<tr>
<td><strong>TA-US pathology</strong></td>
<td>62 %</td>
<td>95 %</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>TA-Histology</strong></td>
<td>67 %</td>
<td>78 %</td>
<td>n.s.</td>
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</table>
Ultrasound in LVV GCA

- Involvement of the extremity arteries in LVV GCA: Upper-60%, lower-55%  
  *Aschwanden M, Ann Rheum Dis 2010*

- Examination of the common carotid in addition to temporal and axillary arteries in GCA: sensitivity of 100%  
  *Diamantopoulos AP, Arthritis Care Res 2013*

- US of the vertebral artery: could be useful at infarctions of the vertebrobasilar territory  
  *Garcia-Garcia J, Stroke 2011*
US IN GCA

ADVANTAGES

- High resolution (0.1 mm) *Schmidt WA, Best Practice & Research Clinical Rheum 2013*

- Depicts the whole length of temporal, occipital, and partially the facial arteries *Schmidt WA, Clinical and Exp Rheum 2002; Pfadenhauer K ,J Neurol 2003*


- Information on blood flow characteristics
ADVANTAGES

- Inexpensive, easy accessible, no radiation involved (70 $ for US vs 465 $ for MRA)  
  Pipitone N, Rheumatology 2008

- Equal sensitivity to 18F-FDG PET-CT  
  Forster S, Vasa. 2011

- Could be useful as a follow up tool  
  Diamantopoulos AP, EUROSON Tel Aviv 2014
DISADVANTAGES

- Operator dependent not universally reproducible

- Poor imaging of the thoracic aorta, proximal subclavian and carotid (without the appropriate equipment)

- Sensitivity and specificity reduces quickly after introduction of GC (>4 days: US 50% and MRI 56%) \cite{Hauenstein2012}
65-year-old man
65-year-old man

Courtesy Are Lindland MD
65-year-old man

- Temporal artery biopsy: Giant cells and inflammatory infiltrations in media/adventitia

- Final diagnosis: GCA

- 500 mg methylprednisolone iv and subsequently 40 mg prednisolone daily

- Controls: at 4 months, 1, 2 and 5 years with normalization of the ultrasonographic findings/ no relapses
65-year-old man

Before treatment

After treatment

Courtesy Are Lindland MD
US IN GCA

Temporal Artery
US IN GCA

Temporal Artery
US IN GCA

Axillary artery
Controversies

“Skepticism is the first step towards truth”  D Diderot
Controversies

Temporal Artery-Anatomy

Axial Resolution and Frequency

- 5 MHz: 0.6 mm
- 7.5 MHz: 0.4 mm
- 12 MHz: 0.25 mm
- 20 MHz: 0.15 mm
- 30 MHz: 0.1 mm


Controversies

Ultrasound in cranial GCA

Table 1  Summary of the meta-analyses examining ultrasound in GCA [10–12]

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aHalo, occlusion, or stenosis vs. ACR GCA classification criteria

bHalo vs. ACR GCA classification criteria
Controversies

Ultrasonographic evaluation
A linear 5-10 MHz pulsed wave probe (Aplio-80, Toshiba) was used for the assessment of both temporal and ophthalmic arteries. Temporal and oph-
Controversies

Limited Value of Temporal Artery Ultrasonography Examinations for Diagnosis of Giant Cell Arteritis: A Multi-Center Study

Axial Resolution and Frequency

- 5 MHz: 0.6 mm
- 7.5 MHz: 0.4 mm
- 12 MHz: 0.25 mm
- 20 MHz: 0.15 mm
- 30 MHz: 0.1 mm

Is Duplex Ultrasonography Useful for the Diagnosis of Giant-Cell Arteritis?

Carlo Salvarani, MD; Mauro Silingardi, MD; Angelo Ghirarduzzi, MD; Giovanni Lo Scocco, MD; PierLuigi Macchioni, MD; GianLuigi Bajocchi, MD; Marco Vinceti, MD; Fabrizio Cantini, MD; Ido Iori, MD; and Luigi Boiardi, MD, PhD


Conclusion: Evidence on ultrasonography of a halo around temporal arteries, either any halo or a halo 1 mm or greater in thickness, only modestly increased the probability of biopsy-proven giant-cell arteritis but did not improve the diagnostic accuracy of a careful physical examination.
Controversies

phy were performed by using a 5- to 10-MHz linear probe (Aspen, Acuson Corp., Mountain View, California) along
Controversies

Pitfalls

Colour gain low or PRF high:
Pseudohalo!!!
Pitfalls

Vasculitis is hypoechoic not anechoic!

Controversies
Controversies

WHY?

- Equipment of low quality - continuous Doppler and B-mode <10 MHz
- Inadequate adjustments
- Unexperienced ultrasonographer
- Poor knowledge of the Doppler physics and vascular ultrasound pitfalls
Controversies

Poster Presentations
Diagnostics and imaging procedures

FRI0518 Ultrasound Definitions for Vasculitis in Cranial and Large Vessel Giant Cell Arteritis: Results of A Delphi Survey of The Omeract Ultrasound Large Vessel Vasculitis Group


“Halo” - Sign:

Homogeneous, Hypoechoic wall thickening well delineated towards luminal side
Visible both in longitudinal and transverse planes
Most commonly concentric in transverse planes
Compression-Sign:
The thickened arterial wall remains visible upon compression, i.e. the echogenicity contrasts hypoechoic due to vasculitic vessel wall thickening in comparison to the mid- to hyperechoic surrounding tissue.
## Controversies

### Interobserver agreement at the exercise in Berlin, February 2017

<table>
<thead>
<tr>
<th>Section</th>
<th>Mean agreement</th>
<th>mean Paba $\kappa$</th>
</tr>
</thead>
<tbody>
<tr>
<td>US positive for GCA</td>
<td>0.88-0.93</td>
<td>0.77-0.86</td>
</tr>
<tr>
<td>Halo inter-reader</td>
<td>0.77-0.86</td>
<td>0.54-0.72</td>
</tr>
<tr>
<td>Compression inter-reader</td>
<td>0.75-0.84</td>
<td>0.49-0.68</td>
</tr>
<tr>
<td>Intra-reader</td>
<td>0.96</td>
<td>0.92</td>
</tr>
<tr>
<td>Halo intra-reader</td>
<td>0.87-0.90</td>
<td>0.73-0.81</td>
</tr>
<tr>
<td>Compression inter-reader</td>
<td>0.88-0.89</td>
<td>0.75-0.78</td>
</tr>
</tbody>
</table>
## Cut-off Values for Each Artery

<table>
<thead>
<tr>
<th>Artery</th>
<th>N</th>
<th>IMT in mm</th>
<th>Cut-off in mm</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Correctly classified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common superficial temporal artery</td>
<td>40</td>
<td>C: r. 0.23 (SD 0.03) l. 0.23 (SD 0.04)</td>
<td>r. 0.42 l. 0.45</td>
<td>100 % 100 %</td>
<td>100 % 100 %</td>
<td>100 % 100 %</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>P: r. 0.66 (SD 0.18) l. 0.65 (SD 0.19)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frontal branch</td>
<td>40</td>
<td>C: r. 0.19 (SD 0.03) l. 0.19 (SD 0.04)</td>
<td>r. 0.35 l. 0.34</td>
<td>100 % 100 %</td>
<td>100 % 100 %</td>
<td>100 % 100 %</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>P: r. 0.53 (SD 0.19) l. 0.55 (SD 0.18)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parietal branch</td>
<td>40</td>
<td>C: r. 0.19 (SD 0.03) l. 0.20 (SD 0.03)</td>
<td>r. 0.32 l. 0.29</td>
<td>100 % 94.4 %</td>
<td>100 % 100 %</td>
<td>100 % 98.3 %</td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>P: r. 0.51 (SD 0.18) l. 0.48 (SD 0.16)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facial artery</td>
<td>40</td>
<td>C: r. 0.24 (SD 0.05) l. 0.23 (SD 0.05)</td>
<td>r. 0.37 l. 0.40</td>
<td>92.3 % 81.8 %</td>
<td>100 % 97.5 %</td>
<td>98.1 % 94.1 %</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>P: r. 0.55 (SD 0.19) l. 0.51 (SD 0.19)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axillary artery</td>
<td>40</td>
<td>C: r. 0.59 (SD 0.10) l. 0.59 (SD 0.10)</td>
<td>r. 1.1 l. 1.0</td>
<td>100 % 100 %</td>
<td>100 % 100 %</td>
<td>100 % 100 %</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>P: r. 1.80 (SD 0.41) l. 1.62 (SD 0.39)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Controversies

Ultrasonographers vs. Pathologists Oxford 2015

**FIGURE 13** Frequency of evaluations consistent with or not consistent with GCA by 12 sonographers rating 30 cases.

**FIGURE 14** Frequency of evaluations consistent with or not consistent with GCA by 14 pathologists rating 30 cases.
Innovation: Saving sight in a cost-effective way
The Fast Track GCA clinic

**TABLE 1** Comparison of the visual outcomes between the FTC and the conventionally evaluated group

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Fast-track group</th>
<th>Conventionally evaluated group</th>
<th>RR (95% CI)</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual disturbances</td>
<td>9</td>
<td>9</td>
<td>0.74 (0.33, 1.66)</td>
<td>0.40</td>
</tr>
<tr>
<td>Permanent visual impairment</td>
<td>1</td>
<td>6</td>
<td>0.12 (0.01, 0.97)</td>
<td>0.01</td>
</tr>
<tr>
<td>Inpatient days of care</td>
<td>0.60</td>
<td>3.60</td>
<td>NA</td>
<td>&lt;0.0005</td>
</tr>
</tbody>
</table>

FTC: fast-track outpatient GCA clinic; NA: not applicable; RR: relative risk.

Total costs of diagnosing the GCA patients in the FTC and in the conventionally evaluated group. However, by only calculating costs related to inpatient services the costs were reduced by ~1,560,000 NOK, highlighting another potential advantage of the FTC. Future studies should elucidate this important aspect further.
**Fig. 1** The fast-track US GCA outpatient clinic algorithm

- New onset of localized headache
- Temporal arteries abnormalities
- Vision impairment
- Symptoms of polymyalgia rheumatica
- Unclear signs of inflammation
- Ischemia of the upper limbs, jaw claudication

**Immediate Ultrasound Examination**
Temporal, axillary, carotid arteries

**Refer to specialist within 24 hours**
- History and laboratory tests review
- Measurement of bilateral blood pressure
- Auscultation of the subclavian/axillary/heart region
- Shoulder/hip examination for a reduced ROM, arthritis

**High clinical suspicion**
**AND**
Negative ultrasonography

**Suspected LVV**
- Treat as LVV
- Perform biopsy of the Temporal Artery
- Perform MRA/CTA or PET

**High or low clinical suspicion**
**AND**
Positive ultrasonography

**LVV**
- Treat as LVV
- Large vessel affection: perform MRA or CTA to visualize the thoracic aorta

**Low clinical suspicion**
**AND**
Negative ultrasonography

**No LVV**
- Seek other diagnoses
Questions?