Cerebral Veins: Normal and Pathological Findings

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Bone Windows

• **temporal bone window**
  (Stolz et al., Stroke, 1999; Baumgartner et al. AJNR 1997)

  Deep middle cerebral vein
  Basal vein
  Great cerebral vein
  Straight sinus
  Transverse sinus
  Sup. sag. sinus (partial)
  Sphenoparietal sinus
  Sup. petrosal sinus

• **occipital bone window**

  Internal cerebral veins
  Great cerebral vein
  Straight sinus

• **medial frontal bone window**
  (Stolz et al., Stroke 1999 30: 814-820)

  Internal cerebral veins
  Great cerebral vein
  Straight sinus
TCD or TCCS?

- Limited spectrum of structures
- Necessity of landmarks
- Small sample volume
• Low-flow sensitive color programm
• No/low wall filter setting
• Low pulse repetition frequency (PRF)
• Increase color gain to artifact threshold.
Examination Technique
### Normal Values

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<tbody>
<tr>
<td>TBW</td>
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<td>OBW</td>
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<tr>
<td>FBW</td>
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<tr>
<td>N</td>
<td>120</td>
<td>130</td>
<td>120</td>
<td>75</td>
</tr>
<tr>
<td>Ø Age</td>
<td>60 ± 18</td>
<td>46 ± 17</td>
<td>50 ± 17</td>
<td>45 ± 17</td>
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<tr>
<td>dMCV</td>
<td>F 10 (4-15) / V 7 (3-11)</td>
<td>8.7 ± 2.9 / 5.8 ± 1.9</td>
<td>-</td>
<td>-</td>
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<tr>
<td>BV</td>
<td>F 13 (7-19) / V 9 (5-14)</td>
<td>12.2 ± 3.8 / 8.7 ± 2.8</td>
<td>-</td>
<td>-</td>
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<tr>
<td>GCV</td>
<td>F -</td>
<td>11.9 ± 3.6 / 7.7 ± 2.8</td>
<td>23 (12-34) / 16 (7-26)</td>
<td>-</td>
</tr>
<tr>
<td>SRS</td>
<td>F 26 (12-39) / V 17 (7-27)</td>
<td>12.1 ± 4.7 / 8.6 ± 3.7</td>
<td>35 (7-64) / 23 (2-43)</td>
<td>-</td>
</tr>
<tr>
<td>ST</td>
<td>F 32 (9-56) / V 21 (5-38)</td>
<td>14.0 ± 5.9 / 9.7 ± 4.8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SSS</td>
<td>F -</td>
<td>9.8 ± 3.6 / 6.1 ± 2.5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>ICV</td>
<td>F -</td>
<td>7.2 ± 1.7 / 4.9 ± 1.1</td>
<td>14 (10-18) / 10 (5-15)</td>
<td>13.6 ± 4.1 / 9.9 ± 2.9</td>
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### Repeatability

- **95% KI < 3.1 cm/s**
- **95% KI 3.2 - 3.5 cm/s**
- **95% KI > 3.5 cm/s**

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V. cerebri magna
Sinus sagittalis superior
V. cerebri media profunda
Sinus rectus
Sinus transversus
When is a venous TCCS/TCD finding pathological?

Do cerebral veins and arteries differ?

• Cerebral veins possess no valves → The flow direction is governed by the pressure gradient.
• Jugular veins collapse in upright or sitting position.
• Pathological findings in cerebral veins are not localised („no stenoses“).

When is a venous finding pathological?

• Venous flow velocities > mean + 2SD. Rule of thumb:
  Cerebral veins: FV > 30-35 cm/s
  Sinuses: FV > 40-45 cm/s
• The flow direction is pathological.
• The arterial side is normal (or PI ↑ when ICP ↑).
Diagnostic value of venous ultrasound in cerebral venous thrombosis

• Blinded studies exist only for the examination of the transverse sinus with echo-contrast agents:
  
  Sensitivity 73-100%
  Specificity 65-80%

• Unblinded studies:
  
  Pathological findings in 50-100% of cases
  (Canhão et al. 1999, Valdueza et al. 1999b, Stolz et al. 1999b, Stolz et al. 2002c).

⇒ With ultrasound methods a CVT can not be excluded!
Cerebral venous thrombosis – indirect signs

- Numerous veins are visible with an arterial machine setting.
- Pathological flow velocities.
- Pathological flow direction.
25 y, 2 days after uncomplicated delivery:
- Headaches since 2 days
- On day 2 left focal motor seizure with secondary generalization
- Persistent left-sides hemiparesis
Cerebral venous thrombosis – collaterals

Sphenoparietal Sinus ↑
Superior petrosal sinus ↑

Deep middle cerebral vein ↑
Basal vein ↑
Great cerebral vein (↑↑)

Cavernosus sinus drainage
Deep cerebral vein drainage
Proximal transverse sinus ↔

Basal vein ↔

Contralateral transverse sinus ↑

Straight sinus occlusion

Transverse sinus drainage
Cerebral venous thrombosis – follow-up

Day 90: 69%

<table>
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<tr>
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<th>TCCS admission pathological</th>
<th>TCCS admission not pathological</th>
<th>p</th>
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<tbody>
<tr>
<td>NIHSS</td>
<td>7.0 [7 (0-17)]</td>
<td>6.4 [5 (0-19)]</td>
<td>0.94</td>
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Initially normal venous TCCS +

Normal TCCS within 90 days:

Significant correlation with a good outcome (mRS 0+1).
Venous TCCS – other applications
- Space occupying cerebral edema -

Stolz et al Stroke 2002
Veins and ICP

Johnston, Rowan JNNP 1974

[Graph showing the relationship between intracranial pressure (ICP) and cerebral perfusion pressure (CoVP), with data points and trend lines.]
N = 37 patients after SAH with $V_{\text{mean}}$ MCA > 120 cm/s

Measurement of CBF in 14 Patients (Kety-Schmidt method)

I No delayed neurol. deficit, II transient DND, III permanent DND or death related to vasospasm.
Traumatic Brain Injury

N = 82

Traumatic head injury

Mursch et al. J Neuroimaging 2002