Extraction Method for Blood Vessels, Based on the Velocity Profile Measured by Phase Shift Method

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Computational Model
-What is the most important?- 

The Model is…

Reflecting the characteristics of the object

Constructed quantitatively.

Material Property
Geometry
Characteristics of Sequences

-What does the signal mean?-

To observe the blood vessel, PS and TOF are usually used:

**PS**
The phase shows the velocity.
(Velocity=VENC*Phase/π)

**TOF**
The intensity is proportional to the velocity.
(Relative Velocity)
Past Studies

The smoothness of the geometry has been received attention, because the histogram is so unique.

••••• > The setting of the threshold value is difficult.
••••• > The accuracy could not be discussed.
Purpose

- Investigate the accuracy of velocity measurement.
- Propose the extraction method of the blood vessel, based on the velocity.

The model is made, whose accuracy is known.
Accuracy of the Velocity Measurement (PS Method)

Influences • Relaxation Time, TR, TE, VENC

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 [msec]</td>
<td>5.6 \times 10^2 - 2.5 \times 10^3</td>
</tr>
<tr>
<td>TR [msec]</td>
<td>50,100</td>
</tr>
<tr>
<td>TE [msec]</td>
<td>10.16</td>
</tr>
<tr>
<td>VENC [cm/s]</td>
<td>Integer nearest to the Maximum Velocity</td>
</tr>
</tbody>
</table>

Reynolds number 300
Resolution 1mm/pixel
Diameter of Vessel 8mm

All the measurements were done by 1.5 T EXCELART MR System (TOSHIBA Corporation, JAPAN).
Result

TR •••• no influence in the range
T1, VENC•••• no influence in the range of $1.7 \times 10^3 - 5.6 \times 10^2$ msec
TE •••• no influence, except $T1 = 1.7 \times 10^3$ (not the maximum error)

The maximum error was less than 10%.
Dephasing Effect

Longitudinal Direction

Transverse Direction
Discussion

Considering T1 of Blood is 700 - 1500 msec:
The value was not influenced by these parameters.
Maximum error < 10 %

Measurements in PS images are reliable.
**Extraction Method**
*PS Images*

The characteristics of this method:
Using the continuity of the blood vessel
The data in the boundary is known.

What the operator have to do:
Set the starting point
Set the minimum velocity in the blood vessel.
Example (Femoral Artery)
Example (Femoral Artery)

Binarized Image

Original Image

50mm
Example (Cerebral Artery)
Extraction Method
-TOF Images-

The Starting point and the threshold value are decided automatically.

Starting Point  ••••  1-100 points in the highest intensity
Threshold Value  •••• the frequency is 10 times higher at the value.
Example (TOF)
Example (TOF)

Binarized Image

Original Image

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Conclusion

- PS method has enough accuracy to measure the blood flow.
- The automatic extraction method was proposed, which could be evaluated quantitatively.
- This extraction method could apply to PS and TOF images.
Evaluate the geometrical data quantitatively and automatically

• Decide the centerline based on the reasonable assumption

   Diameter, shear stress, …..