Portal Vein Stenosis in Live Liver Donors after Right Hemihepatectomy for Living Donor Liver Transplantation

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Purpose

Introduction

Liver transplantation (LT)

• Therapeutic option for patients with end stage liver disease

Living donor LT

• Procurement of partial hepatic lobe from a live donor
  Mainly performed with right-lobe graft: due to importance of graft volume for recipients' outcome

Portal ven (PV) complications

• PV stenosis or thrombosis
  Have been rarely reported in live liver donor after the partial liver procurement

Purpose

• Mild stenosis is not uncommonly encountered in practice
  The optimal cutoff for clinically relevant stenosis has not been established

  To evaluate the range of PV stenosis in live liver donors after the partial liver procurement and to determine the effect on the postoperative liver regeneration and splenic enlargement
Methods and Materials

Donors

- Approved by the Institutional Review Board
- A retrospective study
- Included from November, 2008 to May, 2009
- 92 consecutive live donors (right hepatic lobe without middle hepatic vein)

Preoperative CT --> Postoperative CT 1 week and 1 month --> Follow up CT (about 6 months)

92 donors included (mean age, 27.2 ± 7.1 years)

- 58 males (mean age, 25.7 ± 6.6 years) and 34 females (mean age, 29.9 ± 7.3 years)
- Healthy volunteers with normal liver function
- Remnant liver volume (RLV) > 30%, graft-to-recipient body weight ratio > 0.8%

CT techniques

Preoperative CT scans

- Obtained with 16-row multidetector CT scanners (Somatom Sensation 16; Siemens Medical Solutions, Erlangen, Germany)
- Precontrast, hepatic arterial phase, venous phase
- The scanning and reconstitution parameters for venous phase scanning: detector collimation, 0.75 x 16 mm; table feed, 12 mm per gantry rotation; gantry rotation time, 0.5 seconds; 200 effective mAs; 120 kVp
- Reconstructed with section thickness and interval of 5 mm

Postoperative CT scans

- Venous phase with reduced radiation dose (100 effective mAs and 100 kVp)
- The scanning and reconstitution parameters: similar as those of preoperative CT

CT analysis: preoperative CT

- PV anatomic variations: classic group and non-classic group
LPV diameter (LPV_B): left PV diameter at the point less than 1 cm from bifurcation

Liver volume: total liver volume (TLV), base line remnant liver volume (RLV_B), \%RLV_B = RLV/TLV \cdot 100

Spleen volume: base line spleen volume (SV_B)

**CT analysis: postoperative CT**

- LPV diameter: %LPV_{1W-B} = 100 \cdot LPV_{1W}/LPV_B, %LPV_{1M-B} = 100 \cdot LPV_{1M}/LPV_B, %LPV_{1M-1W} = 100 \cdot LPV_{1M}/LPV_{1W}
- Liver volume: %RLV_{1W-B} = 100 \cdot RLV_{1W}/RLV_B, %RLV_{1M-B} = 100 \cdot RLV_{1M}/RLV_B, %RLV_{1M-1W} = 100 \cdot RLV_{1M}/RLV_{1W}
- Spleen volume: %SV_{1W-B} = 100 \cdot SV_{1W}/SV_B, %SV_{1M-B} = 100 \cdot SV_{1M}/SV_B, %SV_{1M-1W} = 100 \cdot SV_{1M}/SV_{1W}

**Statistical analysis, follow-up**

Box and whisker diagram

- The distributions of measurement data (LPV_B, LPV_{1W}, LPV_{1M}; RLV_B, RLV_{1W}, RLV_{1M}; SV_B, SV_{1W}, SV_{1M})

Unpaired T-test

- Evaluate if there was difference in the mean %LPV_{1W-B} between classic and non-classic groups

Univariate regression analyses

- Evaluate associations between %LPV_{1W-B} and %RLV_B, %RLV_{1W-B}, %RLV_{1M-B}, %RLV_{1M-1W}, %SV_{1W-B}, %SV_{1M-B}, or %SV_{1M-1W}

Follow-up

- 82 donors: approximately six months after the surgery
- LPV_{6M}, RLV_{6M}, SV_{6M}
Results

Pre-donation CT data in 92 live liver donors

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>25&lt;sup&gt;th&lt;/sup&gt; percentile</th>
<th>75&lt;sup&gt;th&lt;/sup&gt; percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPV&lt;sub&gt;B&lt;/sub&gt;</td>
<td>11.7 ± 1.2</td>
<td>11.9</td>
<td>11.1</td>
<td>12.4</td>
</tr>
<tr>
<td>RLV&lt;sub&gt;B&lt;/sub&gt;</td>
<td>373.9 ± 68.8</td>
<td>370.0</td>
<td>322.5</td>
<td>401.0</td>
</tr>
<tr>
<td>%RLV&lt;sub&gt;B&lt;/sub&gt;</td>
<td>37.5 ± 3.1</td>
<td>37.2</td>
<td>35.1</td>
<td>40.0</td>
</tr>
<tr>
<td>SV&lt;sub&gt;B&lt;/sub&gt;</td>
<td>179.6 ± 60.7</td>
<td>164.2</td>
<td>140.5</td>
<td>217.8</td>
</tr>
</tbody>
</table>

Table 1

Post-donation CT data in 92 live liver donors on post 1 week and 1 month

<table>
<thead>
<tr>
<th></th>
<th>LPV&lt;sub&gt;1&lt;/sub&gt;&lt;sub&gt;W&lt;/sub&gt;</th>
<th>%LPV&lt;sub&gt;1&lt;/sub&gt;&lt;sub&gt;W-B&lt;/sub&gt;</th>
<th>LPV&lt;sub&gt;1&lt;/sub&gt;&lt;sub&gt;M&lt;/sub&gt;</th>
<th>%LPV&lt;sub&gt;1&lt;/sub&gt;&lt;sub&gt;M-1&lt;/sub&gt;&lt;sub&gt;W&lt;/sub&gt;</th>
<th>%LPV&lt;sub&gt;1&lt;/sub&gt;&lt;sub&gt;M-B&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>8.9 ± 1.1</td>
<td>76.9 ± 9.9</td>
<td>9.6 ± 1.4</td>
<td>108.1 ± 9.8</td>
<td>82.9 ± 11.8</td>
</tr>
<tr>
<td>Median</td>
<td>8.9</td>
<td>76.2</td>
<td>9.6</td>
<td>106.2</td>
<td>81.6</td>
</tr>
<tr>
<td>Range</td>
<td>5.3, 11.3</td>
<td>57.4, 98.9</td>
<td>5.3, 12.3</td>
<td>90.5, 138.1</td>
<td>60.7, 118.5</td>
</tr>
<tr>
<td>25&lt;sup&gt;th&lt;/sup&gt; percentile</td>
<td>8.4</td>
<td>69.3</td>
<td>8.7</td>
<td>101.7</td>
<td>73.5</td>
</tr>
<tr>
<td>75&lt;sup&gt;th&lt;/sup&gt; percentile</td>
<td>9.7</td>
<td>85.4</td>
<td>10.6</td>
<td>113.6</td>
<td>92.4</td>
</tr>
</tbody>
</table>

Table 2-1

PV anatomic variation (LPV<sub>1</sub><sub>W</sub>, %LPV<sub>1</sub><sub>W-B</sub>)

- Classic group: 8.9 ± 1.0 mm (5.9-10.8) and 76.7 ± 9.7% (57.4-98.9)
- Non-classic group: 8.9 ± 1.8 mm (5.3-11.3) and 77.6 ± 12.5% (62.4-93.5)
- Student t-test: no significant differences in the mean LPV<sub>1</sub><sub>W</sub> and %LPV<sub>1</sub><sub>W-B</sub> between the two groups ($P = .918, .828$)

<table>
<thead>
<tr>
<th></th>
<th>RLV&lt;sub&gt;1&lt;/sub&gt;&lt;sub&gt;W&lt;/sub&gt;</th>
<th>%RLV&lt;sub&gt;1&lt;/sub&gt;&lt;sub&gt;W-B&lt;/sub&gt;</th>
<th>RLV&lt;sub&gt;1&lt;/sub&gt;&lt;sub&gt;M&lt;/sub&gt;</th>
<th>%RLV&lt;sub&gt;1&lt;/sub&gt;&lt;sub&gt;M-1&lt;/sub&gt;&lt;sub&gt;W&lt;/sub&gt;</th>
<th>%RLV&lt;sub&gt;1&lt;/sub&gt;&lt;sub&gt;M-B&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>707.2 ± 124.7</td>
<td>191.6 ± 31.4</td>
<td>828.3 ± 141.8</td>
<td>117.7 ± 10.8</td>
<td>224.8 ± 38.7</td>
</tr>
<tr>
<td>Median</td>
<td>709.8</td>
<td>190.3</td>
<td>842.2</td>
<td>117.1</td>
<td>222.9</td>
</tr>
<tr>
<td>Range</td>
<td>444.7, 1058.1</td>
<td>140.9, 310.9</td>
<td>535.1, 1267.1</td>
<td>99.4, 157.7</td>
<td>150.8, 412.0</td>
</tr>
<tr>
<td>25th percentile</td>
<td>619.1</td>
<td>166.7</td>
<td>710.3</td>
<td>710.3</td>
<td>197.1</td>
</tr>
<tr>
<td>75th percentile</td>
<td>771.2</td>
<td>209.9</td>
<td>908.4</td>
<td>908.4</td>
<td>246.4</td>
</tr>
</tbody>
</table>

Table 2-2

<table>
<thead>
<tr>
<th></th>
<th>SV&lt;sub&gt;1w&lt;/sub&gt;</th>
<th>%SV&lt;sub&gt;1W-B&lt;/sub&gt;</th>
<th>SV&lt;sub&gt;1M&lt;/sub&gt;</th>
<th>%SV&lt;sub&gt;1M-1W&lt;/sub&gt;</th>
<th>%SV&lt;sub&gt;1M-B&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>263.0 ± 83.0</td>
<td>148.3 ± 18.2</td>
<td>261.5 ± 88.8</td>
<td>99.3 ± 11.4</td>
<td>146.9 ± 23.0</td>
</tr>
<tr>
<td>Median</td>
<td>253.8</td>
<td>145.1</td>
<td>247.1</td>
<td>98.7</td>
<td>142.7</td>
</tr>
<tr>
<td>Range</td>
<td>118.8, 517.5</td>
<td>105.2, 188.4</td>
<td>114.4, 506.0</td>
<td>69.6, 135.1</td>
<td>102.0, 213.1</td>
</tr>
<tr>
<td>25th percentile</td>
<td>203.8</td>
<td>135.8</td>
<td>195.3</td>
<td>92.6</td>
<td>132.6</td>
</tr>
<tr>
<td>75th percentile</td>
<td>308.6</td>
<td>163.4</td>
<td>319.2</td>
<td>104.9</td>
<td>158.4</td>
</tr>
</tbody>
</table>

Table 2-3

Post-donation data and statistical results

- Postoperative SV changes [Fig. 1 on page 7](#)
- Postoperative LPV diameter changes [Fig. 2 on page 7](#)
- Linear correlation between %LPV<sub>1W-B</sub> and %RLV<sub>B</sub> [Fig. 3 on page 8](#)
- Linear correlation between %LPV<sub>1W-B</sub> and %RLV<sub>1W-B</sub> [Fig. 4 on page 9](#)
- Linear correlation between %LPV<sub>1W-B</sub> and %SV<sub>1W-B</sub> [Fig. 5 on page 10](#)
- Linear correlation between %LPV<sub>1W-B</sub> and %SV<sub>1M-1W</sub> [Fig. 6 on page 11](#)
- Linear correlation between %LPV<sub>1W-B</sub> and %SV<sub>1M-B</sub> [Fig. 7 on page 12](#)
- Linear correlation between %LPV<sub>1W-B</sub> and %RLV<sub>1M-1W</sub> [Fig. 8 on page 13](#)
- Linear correlation between %LPV<sub>1W-B</sub> and %RLV<sub>1M-B</sub> [Fig. 9 on page 14](#)
**Fig. 1:** Postoperative SV changes Box and whisker plot shows changes of spleen volume on postoperative one week (SV1W), one month (SV1M) and six months (SV6M) compared with baseline volume (SVB). The central boxes represent the values from the lower to the upper quartiles (25th to 75th percentile). The middle lines represent the medians. Vertical lines extend from the minimum to the maximum values, excluding outside and far out values, which are displayed as separate points. The values plotted with a square marker are outside values, smaller than the lower quartile minus 1.5 times the interquartile range or larger than the upper quartile plus 1.5 times the interquartile range (inner fences).

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Fig. 2: Postoperative LPV changes Box and whisker plot shows changes of left portal vein diameter on postoperative one week (LPV1W), one month (LPV1M) and six months (LPV6M) compared with baseline diameter (LPVB). The central boxes represent the values from the lower to the upper quartiles (25th to 75th percentile). The middle lines represent the medians. Vertical lines extend from the minimum to the maximum values, excluding outside and far out values, which are displayed as separate points. The values plotted with a square marker are outside values, smaller than the lower quartile minus 1.5 times the interquartile range or larger than the upper quartile plus 1.5 times the interquartile range (inner fences).

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Fig. 3: Linear correlation between %LPV1W-B and %RLVB Scatter plots shows linear correlation between %RLVB and %LPV1W-B (y = 0.799\times + 46.968; residual standard deviation, 9.645; P = .016).

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Fig. 4: Linear correlation between %LPV1W-B and %RLV1W-B Scatter plots shows linear correlation between %RLV1W-B and %LPV1W-B ($y = -0.084 \times + 92.940$; residual standard deviation, 9.606; $P = .011$).

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**Fig. 5:** Linear correlation between \%LPV_{1W-B} and \%SV_{1W-B} Scatter plots shows linear correlation between \%LPV_{1W-B} and \%SV_{1W-B} (y = -0.118 \times x + 157.380; residual standard deviation, 18.228; P = .543).

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Fig. 6: Linear correlation between %LPV1W-B and %SV1M-1W Scatter plots shows liner correlation between %LPV1W-B and %SV1M-1W ($y = -0.338 \cdot x + 125.276$; residual standard deviation, 10.916; $P = .004$).

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Fig. 7: Linear correlation between %LPV1W-B and %SV1M-B Scatter plots shows linear correlation between %LPV1W-B and %SV1M-B (y = -0.647•x + 196.698; residual standard deviation, 22.262; P = .007).

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Fig. 8: Linear correlation between %LPV1W-B and %RLV1M-1W Scatter plots shows linear correlation between %LPV1W-B and %RLV1M-1W ($y = -0.097 \times x + 110.244$; residual standard deviation, 10.856; $P = .401$).

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Fig. 9: Linear correlation between %LPV1W-B and %RLV1M-B Scatter plots shows linear correlation between %LPV1W-B and %RLV1M-B ($y = -0.862 \times + 291.173$; residual standard deviation, 37.936; $P = .034$).

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Conclusions

Discussion

Fig. 10: This diagram summarizes associations between %LPV1W-B and the other CT parameters. %RLVB and %RLV1W-B were significantly associated with %LPV1W-B. Also, there were significant associations between %LPV1W-B and %SV1M-1W or %SV1M-B through univariate regression analyses.

References: Radiology, Asan Medical Center - Seoul/KR

Conclusion

- LPV diameter tends to decrease in varying degree in live liver donors shortly following right hemihepatectomy and mostly improves on follow-up spontaneously.
- %LPV1W-B may be one of indicators predicting further splenic enlargement.
Fig. 10: This diagram summarizes associations between %LPV1W-B and the other CT parameters. %RLVB and %RLV1W-B were significantly associated with %LPV1W-B. Also, there were significant associations between %LPV1W-B and %SV1M-1W or %SV1M-B through univariate regression analyses.

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References


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