The compression of the left renal vein in the aortomesenteric angle: Possible value of the computed tomography in the diagnosis of the Nutcracker syndrome

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Purpose

- The Nutcracker syndrome (NS) is believed to be the result of the compression of the left renal vein (LRV) in the aortomesenteric angle (AMA). For the first time it was described in 1950 by El-Sadr and Mina as a possible reason for a varicocele by congestion [1]. The synonym Nutcracker syndrome (NS) was established by De Schepper shortly afterwards [2].
- 3 different types of clinical appearance of the Nutcracker syndrome were described:

1. In men, the compression of the left renal vein leads to a varicositas of the left testicular vein and a varicocele [3].

2. In women, the compression leads to the so called pelvic congestion syndrome. This syndrome includes lower abdominal pain, dysmenorrhea, dysuria and dyspareunia. The clinical symptoms are explained by venous congestion with pelvic, vulvar and gluteal varices [4, 5].

3. Non-specific pain in the left flank and abdominal pain which is often accompanied with haematuria and orthostatic proteinuria. The orthostatic proteinuria is a benign disease and is the representative symptom of the Nutcracker syndrome [6, 7].

- Many different anatomical situations of the LRV have to be included in the pathology of the nutcracker syndrome, e.g. double inferior cava vein, retroaortal, "circumaortic" left renal vein and other variants.
- For establishing the diagnosis "nutcracker syndrome", demonstration of the compression of the LRV is required. The key points for the diagnosis are:

  - clinical presentation with unexplainable (unilateral) haematuria, left flank pain, and orthostatic proteinuria
  - B-scan sonography & duplex sonography of the left renal vein demonstrating the compression with a ratio between the vessel diameters proximal and within the aortomesenteric angle higher than 5 [8]
  - i.v. impedance-indices; retrograde left renal phlebography with reflux in the left ovarica/testicularis vein; mean i.v. catheter-pullback-pressure of the left renal vein in the cava inferior vein
higher than 3mmHg [9]

- Risk factors for the nutcracker syndroms are fibrosis in the region of the origin of the superior mesenteric artery, ptosis of the left kidney, youth, low body mass index, reduced mesenteric artery angle, and height as a risk factor for an associated increase of hydrostatic pressure.

  - Therapy of the nutcracker syndrome:
    - in children: "wait and watch", because of possible remission [10]
    - angiotensin converting enzyme inhibitors for orthostatic proteinuria [11, 12]
    - different forms of intervention: - transposition of the left renal vein [13, 14]
    - autotransplantation of the left kidney [15, 16]
    - stent graft of the left renal vein [5, 17]

- In general the therapy of the nutcracker syndrome is discussed controversially because of major complications and the possibility that the syndrome can disappear on its own [18, 19].

- The aim of the study was to specify the anatomic situations accounting for the compression of the left renal vein in the aortomesenteric angle, and to determine the extent of the interrelations.

Methods and Materials

- Contrast-enhanced abdominal CT`s of 1099 patients (489 women; 610 men) were analyzed retrospectively.
- Age at the time of examination was 59.5 ± 18 years (range 1.7 - 99.3 years).
- 6 patients were excluded because of nephrectomy of the left side, 42 patients because of urogenital diseases and/or incomplete or inadequate quality of demonstrating the urogenital system.
- A 64-slice MDCT was used (Light Speed VCT XT, General Electric. Milwaukee, USA). The most frequently used protocol was a standard liver
A protocol with native, early arterial, portal venous and a late venous phase. The contrast medium (Iodixanol 320) was injected automatically with an injection rate of 4 ml/sec. The generated slice thickness was 2.5 and 5 mm. The 0.625 mm collimation source images were sent to the PACS as well and used for analyzes.

- The parameters analyzed were:
  - localization, derivation and course of arteries and veins of the left kidney, mesenteric superior
  - diameter of the testicularis/ovarian vein; left kidney vein distal and in the aortomesenteric angle with its resulting compression in percent
  - length and width of the left kidney, width of the kidney parenchyma and renal pelvis
  - thickness of the subcutaneous fat tissue at the position of LWK4 and distance LWK1-5 as a surrogate for the BMI/body height

**Results**

- The relevant anatomical details can be described as follows:
  - Figure 1 shows the classic nutcracker situation with a constriction of the left renal vein in the aortomesenteric angle.
  - Figure 2 shows the distribution of the height of the confluence of the LRV and the inferior caval vein in relation to the vertebral body.

Mostly, it is located in proximity of the disc between L1 and L2.

- The AMA averaged out 48.3±24.8°, and the constriction of the LRV was 37.8±26.1%. The extent of the constriction showed no correlation with the width of LRV proximal to the stenosis, as shown in figure 3.
- The diameters of the LOV/LTV showed no correlation with the degree of the constriction of the left renal vein. The detected anatomical variants, like
retroaortic renal veins, or rings, did not influence the diameters of the LOV or LTV.

- However, there is a significant correlation between the degree of narrowing of the left renal vein, and the heigth of its orifice in relation to the vertebral column (Figure 4). The distance between the heighth of the offspring of the SMA, and the heighth of the orifice of the left renal vein correlates with the degree of the narrowing of the left renal vein as well (Figure 5).

- In linear regression analysis of the compression of the LRV turned out to be aggravated by female gender. It is diminished by age, increase of the AMA, increase of adipous tissue, and the broadness of the inferior caval vein.

<table>
<thead>
<tr>
<th></th>
<th>odds ratio</th>
<th>lower limit</th>
<th>upper limit</th>
<th>significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-0.165</td>
<td>-0.342</td>
<td>-0.142</td>
<td>p &lt; 0.0001</td>
</tr>
<tr>
<td>Sex</td>
<td>-0.127</td>
<td>-0.342</td>
<td>-0.142</td>
<td>p = 0.001</td>
</tr>
<tr>
<td>Aortomesenteric Angel</td>
<td>0.254</td>
<td>-0.334</td>
<td>-0.186</td>
<td>p &lt; 0.0001</td>
</tr>
<tr>
<td>Subcutaneous fat tissue</td>
<td>-0.087</td>
<td>-0.328</td>
<td>-0.039</td>
<td>p = 0.013</td>
</tr>
<tr>
<td>Diameter of the left ovarian/ testicularis vein</td>
<td>0.063</td>
<td>-0.044</td>
<td>2.042</td>
<td>p = 0.06</td>
</tr>
<tr>
<td>Diameter of the inferior caval vein</td>
<td>-0.243</td>
<td>-1.294</td>
<td>-0.743</td>
<td>p &lt; 0.0001</td>
</tr>
<tr>
<td>Diameter of the left renal vein</td>
<td>0.0006</td>
<td>-0.593</td>
<td>0.71</td>
<td>p = 0.86</td>
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</tbody>
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- In linear regression analysis of the AMA the age, length of the left kidney, and heighth of the orifice of the left renal vein showed to be independent positive factors.

<table>
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<tbody>
<tr>
<td>Age</td>
<td>0.1</td>
<td>p = 0.008</td>
<td>0.007</td>
<td>0.045</td>
</tr>
</tbody>
</table>
Length of the left kidney 0.119  $p = 0.006$  0.012  0.079
Height of the orifice of the left renal vein 0.091  $p = 0.018$  0.144  1.533

- Independent factors influencing the width of the left ovarian or testicular vein were age, gender, diameter of the left renal vein, and the length of the left renal vein, but neither the degree of the constriction of the left renal vein, nor the width of the AMA.

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<tr>
<td>Age</td>
<td>0.137</td>
<td>0.006</td>
<td>0.019</td>
<td>$p &lt; 0.0001$</td>
</tr>
<tr>
<td>Sex</td>
<td>-0.179</td>
<td>8.2</td>
<td>-0.332</td>
<td>$p &lt; 0.0001$</td>
</tr>
<tr>
<td>Diameter of the LRV</td>
<td>0.231</td>
<td>0.09</td>
<td>0.176</td>
<td>$p &lt; 0.0001$</td>
</tr>
<tr>
<td>Length of the left kidney</td>
<td>0.075</td>
<td>-0.001</td>
<td>0.02</td>
<td>$p = 0.069$</td>
</tr>
</tbody>
</table>

Images for this section:
Höhe der Mündung der linken Nierenvene bezogen auf die Wirbelkörper

Fig. 2
Diameter of the left renal vein (mm)

Spearman $\rho = 0.01278$
$p = 0.6851$

Angle in between aorta and mesenteric superior artery (°)

Fig. 3

Degree of narrowing of the LRV (%)

$\text{p} > 0.05$ (Kruskal Wallis Test)
$p = 0.0046$ (Post test for linear trend)

Heigh of the orifice of the LRV in relation to the vertebral column
Fig. 4

Diameter of the LRV (mm)

Heighth of the orifice of the superior mesenteric artery

p=0.0310 (Kruskal Wallis Test)
p>0.05 (Post tests)

Fig. 5
Conclusion

- A factor influencing the width of the LRV and the LOV/LTV emerged to be the width of the inferior cava vein as a surrogate for the fluid status which affects the venous system in almost the same manner.
- The amount of compression of the LRV in the AMA showed no relevant effect on the diameter of the LRV and LOV/LTV.
- The aortomesenteric angle correlates only slightly with the amount of compression of the LRV. The AMA is significant smaller in women than in men.
- A statistic significant positive correlation between the BMI and AMA was found assisting the theory that the nutcracker syndrome can disappear in children because of higher storage of retroperitoneal fat tissue.
- In summary, we found only a very week correlation between the AMA and the width of the LRV. Neither the AMA, nor the degree of constriction of the left renal vein are factors, which influence the width of the left ovarian or renal vein. Therefore, it can be concluded with certainty, that the CT does not play a role in the diagnosis of the nutcracker syndrome. The congestion of the left ovarian vein cannot be shown to be connected with peculiar anatomical situations or variants.

References


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