Intratesticular Arterial Pulsatility and Resistance Index in Males with Scrotal Varicocele

Shih-Feng Wang¹,²,⁴ I-Jen Chiang¹,* Wah-On Lo² Kuo-Chiang Chen²,³,⁴ Teh-Sheng Hsieh²,⁴ Chih-Ming Lin²

Background: To investigate difference in intratesticular arterial pulsatility index (PI) and resistance index (RI) between varicocele and healthy testes using power Doppler ultrasonography.

Materials and Methods: Patients undergoing scrotal ultrasonography were recruited. PI and RI of the intratesticular artery were measured using a 12-MHz power Doppler ultrasound, and varicocele grades were obtained by physical examination.

Results: Forty-four males with left scrotal varicocele and 12 healthy males were included. PI and RI were similar in the right testis between groups (p = 0.31 and 0.404, respectively), but significantly higher RI in the left varicocele testis (p = 0.013). The left testes of varicocele patients had a higher RI and smaller size than their right testes (p = 0.036 and 0.001, respectively). No significant differences in PI, RI, and testicular size between different varicocele grades were observed.

Conclusions: The study findings reveal that RI was higher in the varicocele testis. Thus, varicocele may have influence in the vascularity and circulation within the testis.

Key words: Doppler ultrasonography, Pulsatility index, Resistance index, Varicocele

Introduction

Scrotal varicocele is an abnormal dilation and tortuosity of the internal spermatic veins within the pampiniform plexus of the spermatic cord. Idiopathic varicoceles are more common on the left side, where the left spermatic vein enters perpendicular to the left renal vein. The underlying pathological process is unknown, but is considered related to increased hydrostatic pressure and valvular incompetence. Retrograde flow into the internal spermatic vein results in dilatation and tortuosity of the pampiniform plexus.

Doppler ultrasonography has been used for assessing diseases of testis and scrotum[1]. Additionally, some studies reported different results of potential alterations in the microcirculation of capsular branch of testicular artery in the presence of varicocele[2, 3]. Clinical varicocele can lead to Impaired testicular circulation This clinical study aimed to compare intratesticular arterial blood flow using power Doppler ultrasonography (PDUS) in scrotal varicocele patients and healthy males.
Methods

This was an observational clinical study of patients from our outpatient clinic with a request of scrotal ultrasonography. Exclusion criteria included a history of inguinal or scrotal surgery, testicular trauma, genital infectious diseases, congenital scrotal anomalies such as undescending testis, hydrocele, and inguinal hernia, or other clinically detectable diseases. The varicocele grades were determined during physical examination (Table 1) [4]. All patients were assessed using scrotal gray-scale ultrasonography and PDUS with a 12-MHz linear-array transducer of a BK medical ultrasound scanner. Ultrasonography was performed in a warm room with the patients in the supine position, and their penis resting on the lower abdomen.

Table 1. Varicocele grading

<table>
<thead>
<tr>
<th>Grade 1</th>
<th>Varicocele only palpable during or after Valsalva maneuver on physical exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 2</td>
<td>Varicocele palpable on routine physical exam without the need for Valsalva maneuver</td>
</tr>
<tr>
<td>Grade 3</td>
<td>Varicocele visible to the eye and palpable on physical exam</td>
</tr>
</tbody>
</table>

The pulsatility index (PI) and resistance index (RI) were assessed from the intratesticular branch of the testicular arteries from both the left and right testes in the patient and control groups using PDUS. PI and RI were calculated automatically using the scans from at least five continuous identical waveforms (Fig. 1). The same operator made all measurements. A p-value of 0.05 was considered statistically significant.

Results

From October 2010 to January 2013, 46 males with scrotal varicocele were enrolled in the study, and 12 healthy males were recruited to the control group. Two patients with clinical right scrotal varicocele were excluded; the remaining 44 patients had left-sided clinical varicocele. The mean age of the two groups was similar (30.02 ± 15.39 and 37.83 ± 10.82, respectively, p = 0.106).

A comparison of the testicular length, PI, and RI values between the two groups are shown in Table 2. There was no statistically significant difference between the size of the left and right testis in each group. PI and RI of the intratesticular arterial branch were similar in the right testis between groups, but were significantly higher in left varicocele testis (p = 0.05 and 0.013, respectively).

We also compared these parameters between the left and right testis within each group, and the data are shown in Table 3. In the patient group, the testis was smaller and RI was higher on the left side. There was a similar trend in PI, but the
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Data were not statistically significant (p = 0.06). In contrast, there were no differences in the testicular size, PI, and RI in the control group. The mean peak systolic velocity was 11.33 +/- 3.74 centimeter per second (cm/s).

Patients were then divided into three subgroups according to varicocele grade and the results are shown in Table 4. We analyzed the ultrasonographic data of the varicocele testes using the Kruskal–Wallis test. There was no significant difference in testis size, PI, and RI among subgroups.

**Table 2. Testicular length, pulsatility index (PI), and resistance index (RI) in the control and patient groups**

<table>
<thead>
<tr>
<th></th>
<th>Patient</th>
<th>Control</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of left testis (cm)</td>
<td>3.59 ± 0.37</td>
<td>3.78 ± 0.33</td>
<td>0.12</td>
</tr>
<tr>
<td>Length of right testis (cm)</td>
<td>3.72 ± 0.31</td>
<td>3.88 ± 0.31</td>
<td>0.10</td>
</tr>
<tr>
<td>Left PI</td>
<td>1.19 ± 0.39</td>
<td>0.93 ± 0.41</td>
<td>0.05</td>
</tr>
<tr>
<td>Left RI</td>
<td>0.63 ± 0.12</td>
<td>0.53 ± 0.11</td>
<td>*0.01</td>
</tr>
<tr>
<td>Right PI</td>
<td>1.05 ± 0.44</td>
<td>0.94 ± 0.37</td>
<td>0.31</td>
</tr>
<tr>
<td>Right RI</td>
<td>0.54 ± 0.13</td>
<td>0.55 ± 0.11</td>
<td>0.404</td>
</tr>
</tbody>
</table>

*Independent t-test*

**Table 3. Testicular length, pulsatility index (PI), and resistance index (RI) between the left and right testis of each group**

<table>
<thead>
<tr>
<th></th>
<th>Left</th>
<th>Right</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of testis (cm)</td>
<td>3.59 ± 0.37</td>
<td>3.72 ± 0.31</td>
<td>*0.04</td>
</tr>
<tr>
<td>PI</td>
<td>1.19 ± 0.39</td>
<td>1.05 ± 0.44</td>
<td>0.06</td>
</tr>
<tr>
<td>RI</td>
<td>0.63 ± 0.12</td>
<td>0.54 ± 0.13</td>
<td>*0.001</td>
</tr>
<tr>
<td>Control group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of testis (cm)</td>
<td>3.78 ± 0.33</td>
<td>3.88 ± 0.31</td>
<td>0.47</td>
</tr>
<tr>
<td>PI</td>
<td>0.93 ± 0.41</td>
<td>0.94 ± 0.37</td>
<td>0.91</td>
</tr>
<tr>
<td>RI</td>
<td>0.53 ± 0.11</td>
<td>0.55 ± 0.11</td>
<td>0.21</td>
</tr>
</tbody>
</table>

*Paired t-test*

*Statistically significant*

**Table 4. Subgroups according to varicocele grade**

<table>
<thead>
<tr>
<th></th>
<th>Grade 1</th>
<th>Grade 2</th>
<th>Grade 3</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>12</td>
<td>20</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>31.33 ±17.29</td>
<td>33.15 ± 15.1</td>
<td>23.5 ± 12.93</td>
<td>0.14</td>
</tr>
<tr>
<td>Length of testis (cm)</td>
<td>3.66 ± 0.29</td>
<td>3.63 ± 0.37</td>
<td>3.45 ± 0.46</td>
<td>0.28</td>
</tr>
<tr>
<td>PI</td>
<td>1.09 ± 0.31</td>
<td>1.253 ± 0.44</td>
<td>1.17 ± 0.37</td>
<td>0.70</td>
</tr>
<tr>
<td>RI</td>
<td>0.62 ± 0.13</td>
<td>0.64 ± 0.12</td>
<td>0.63 ± 0.13</td>
<td>0.97</td>
</tr>
</tbody>
</table>

*Kruskal-Wallis Test*

Discussion

Scrotal varicocele is common in healthy males, and contributes to the risk of infertility[4]. Although it is considered to be a congenital lesion, varicocele is rarely diagnosed before school age, and the frequency and severity vary with age and method of diagnosis. The prevalence of clinically diagnosed varicocele is approximately 8%–16%[5], and some studies have shown that infertile males have a much higher incidence of bilateral varicoceles[6].

Ultrasonography is the primary imaging modality to evaluate scrotal diseases. We can obtain valuable information by assessing the acute scrotum, scrotal mass, and male infertility using B-mode and Doppler ultrasonography. Ultrasonography is used to evaluate testicular size and location as well as detect varicoceles[7]. Color Doppler ultrasonography (CDUS) has a sensitivity of 83%–95% for assessing subclinical varicocele[8, 9]. Several studies have proposed a venous diameter ranging from 2 to 3 mm as the diagnostic criteria for varicocele[10, 11]. Changed diameter during Valsalva maneuver[12, 13], the sum of venous diameter[14], and flow volume[15] are also used for ultrasonographic diagnosis.
Varicoceles might contribute to testicular atrophy, which has been suggested as an indication for prophylactic varicocelectomy\[^{16}\]. In males with varicocele, the decreased testicular volume is related to the loss of seminiferous tubule elements and decreased tubular diameter\[^{17}\]. However, subclinical varicocele is not associated with ipsilateral testicular atrophy and does not affect the intratesticular circulation\[^{18}\]. In our patient group, the diameter of the varicocele testis was less than that of the contralateral site. In contrast, there was no significant difference in testicular size in the healthy control group.

Doppler ultrasonography has been used to assess organ perfusion and the microcirculation in many organs, and it can help with the evaluation of scrotal diseases\[^{19, 20}\]. The testicular microcirculation has been evaluated using CDUS, but its relationship with scrotal varicocele is controversial. In early studies, there was no effect of the testicular microcirculation on testicular RI or volume changes in patients with subclinical varicocele\[^{2, 18}\]. Testicular arterial blood flow was significantly decreased in males with varicocele\[^{21}\]. A study evaluated the testicular arteries of azoospermic patients with CDUS\[^{22}\]. The authors concluded that RI and peak systolic velocity were reliable indicators for routine clinical use to identify infertile or dyspermic men. More recently, varicocele was reported to affect testicular arterial blood flow. For example, increased capsular branches of the testicular arterial PI and RI were reported by Ünsal et al.\[^{3}\], which might be an indicator of impaired testicular microcirculation. Another study investigated RI of intratesticular arteries and assessed its relationship with spermatogenesis\[^{23}\]. The authors suggested that RI of >0.6 might be suggestive of a pathological sperm count in andrological patients, and is likely to be a reliable indicator for routine clinical use to identify subfertile males.

Some studies have discussed the relationship between varicocele grade and CDUS findings. PI and RI were similar among the three subgroups. Although the data were not statistically significant, there seemed to be a trend that higher grade varicocele led to smaller testis. However, a larger-scale clinical study is necessary to confirm any potential relationship.

The limitations of this study are the small number of patients and the absence of semen analysis. In addition, the cut-off values for PI and RI in varicocele are not well-established. A future study should be performed with more patients and younger healthy males as the control group.

In conclusion, our preliminary data show that clinical varicocele results in ipsilateral testicular atrophy and impaired microcirculation. Intratesticular PI and RI measured using PDUS seem to be valuable for urologists during the analysis of patients with scrotal varicocele.

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**Conflicts of interest**

The authors declare no financial or non-financial conflicts of interest related to the subject matter or materials discussed in this manuscript.
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References


精索靜脈曲張男性睾丸內部脈動與阻力指數分析

王世鋒1,2,4 蔣以仁1* 羅華安2 陳國強2,3,4 謝德生2,4 林志明2

背景：以杜卜勒超音波，分析精索靜脈曲張患者與健康人睾丸內部脈動指數與阻力指數之間的差異。材料及方法：我們將那些接受過睾丸超音波的患者納入研究分析，利用 12-MHz 的強力杜卜勒超音波來測量睾丸內部動脈的脈動指數與阻力指數，此外靜脈曲張的程度是依照身體檢查來判斷。結果：共有 44 名左側精索靜脈曲張患者以及 12 名健康男性納入本研究，這兩組的右側睾丸的脈動指數及阻力指數是差不多的 (p=0.31 及 0.404)，然而病患的左側睾丸比健康者有較高的阻力指數 (p=0.013)。病患的左側睾丸比右側有較高的阻力指數，也比較小 (p=0.036 及 0.001)，此外在於不同程度的靜脈曲張中尚未發現在脈動指數、阻力指數及睾丸大小上有顯著差異。結論：研究結果發現阻力指數在精索靜脈曲張患者較高，因此我們認為精索靜脈曲張對於睾丸內部的血流狀況有顯著影響。

關鍵字：杜卜勒超音波，脈動指數，阻力指數，精索靜脈曲張