Varicocele anatomy during subinguinal microsurgical varicocelectomy in Chinese men


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Anatomy—Infertility—Microsurgery—Pain—varicocele

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Introduction

Varicoceles are present in approximately 15–20% of the general male population, and in 19–41% of men with primary infertility and 45–81% of men with secondary infertility (Jarow, 2001; Cocuzza et al., 2008; Abdel-Meguid et al., 2011). There is significant evidence in the literature to support the thesis that varicocele repairs can improve semen parameters (Madgar et al., 1995; Nieschlag et al., 1998; Agarwal et al., 2007). Although the relationship between varicocele and infertility has never been precisely examined, varicocelectomy remains the most commonly performed surgical procedure in the treatment of male infertility. Due to high patient-reported success rates, varicocelectomy continues to be regarded as an indication for the treatment of classical varicocele-associated pain (Mehta & Goldstein, 2013). Many and different techniques (conventional inguinal, retroperitoneal, laparoscopic, embolisation, microsurgical inguinal or subinguinal) have been used for varicocelectomy (Zini, 2007; Mirilas & Mentessidou, 2012). A microsurgical approach to varicocelectomy has been recommended to identify and ligate the spermatic veins and to preserve the branches of internal spermatic arteries and lymphatics, the outcome is better with a resultant substantial decrease in the incidence of post-operative hydrocele, recurrence and testicular artery injury (Cayan et al., 2000; Ramasamy & Schlegel, 2006; Al-Kandari et al., 2007).

The microsurgical varicocelectomy can be performed versus inguinal or subinguinal approach. According to improvement in post-operative semen parameters, ratio of achieving pregnancy, complications and operation periods, there are no significant differences between the two approaches (Orhan et al., 2005). But, the subinguinal approach is associated with a faster and less painful recovery (Gontero et al., 2005; Al-Kandari et al., 2007; Zini, 2007; Mehta & Goldstein, 2013).

Owing to the greater number of vessels encountered at the subinguinal level, the subinguinal approach is more challenging compared with the inguinal approach (Orhan et al., 2005; Zini, 2007). It is necessary to know the subinguinal varicocele anatomy for the surgeons. Some reports have described the varicocele anatomy during subinguinal microsurgical varicocelectomy in western
men (Hopps et al., 2003; Libman et al., 2010). Knowledge of our study aimed to investigate the varicocele anatomy during subinguinal varicocelectomy in Chinese men. The numbers of venous, arteries and lymphatics encountered during surgeries were recorded and compared between two sides, between patients with different complaints and between varicoceles with different clinical grades.

Materials and methods

Patients

Consecutive patients presenting for infertility or chronic testicular pain evaluation between January 2012 and July 2013 were examined for the presence of a varicocele. All men presenting to our clinic with 1 year or more of infertility, abnormal semen parameters (<20 sperm million mL⁻¹, <50% progressive motility, or <15% normal strict morphology on two or more semen samples) (World Health Organization, 1999) and a clinically palpable varicocele were deemed to be candidates for varicocele repair.

Chronic testicular pain with a clinically palpable varicocele is another indication for surgery. Subinguinal microsurgical varicocele ligation is an effective treatment for chronic testicular pain when performed in selected patients (Yaman et al., 2000; Chawla et al., 2005; Libman et al., 2010). Men with chronic testicular pain were carefully screened to rule out other potential sources of pain (e.g. epididymitis, epididymal cysts, prostatitis and inguinal hernia). All men complained of a dull ache associated with prolonged activity in the upright position and had failed conservative measures for 3 months or longer.

Varicocele grades were defined as follows: grade I, palpable only with Valsalva; grade II, palpable without Valsalva; and grade III, visible. The preoperative grading of the varicoceles was based on physical examination performed by 1 of 2 experienced examiners. Men with a history of previous surgical varicocele repair were excluded from the study. Preoperatively, each patient was counselled about the available treatment options, the cost, potential complications and chance of success. The study protocol was approved by the Ethical Committee of the First Affiliated Hospital of Sun Yat-Sen University, and informed consent was signed by the patients.

Technique

We chose to perform microsurgical subinguinal varicocelectomy without testicular delivery. All surgeries were performed by the same surgeons (Chun-Hua Deng and Xiang-An Tu). Briefly, the spermatic cord was delivered through a 2-cm oblique skin incision performed immediately below the external inguinal ring. After the spermatic cord was elevated on a self-made large Penrose drain, a Leica M520 MC-1 operating microscope (Leica Microsystems (Schweiz) AG, Heerbrugg, Switzerland) was then brought into the operating field and the cord examined under 8–15 power magnification. The external fascia and cremasteric fibres were incised and external spermatic vessels were ligated with 4-0 silk. The internal spermatic fascia with its structures (except vas deferens and its vessels) was bluntly separated from the rest elements of the cord and then encircled by a loop (Fig. 1a).

A 1% lidocaine solution was dripped on the spermatic cord to aid in identifying the internal spermatic artery or arteries. An intra-operative vascular Doppler flow detector (VTI 20 MHz Microvascular Doppler, Fig. 1b) was used to help distinguish arteries from veins. All of the identified arteries were preserved, counted and dissected free from the adjacent veins and lymphatics. All of the internal and external spermatic veins within the spermatic cord were measured, counted, doubly ligated with 4-0 silk

Fig. 1 Procedures for microsurgical subinguinal varicocelectomy. (a) The internal spermatic fascia with its structures (except vas deferens and its vessels) was separated from the external spermatic fascia and cremasteric fibres by a loop. (b) An intra-operative vascular Doppler flow detector was used to help distinguish arteries from veins. (c) The internal and external spermatic veins ligated were measured with a microruler.
ties and divided. All of the identified lymphatics were preserved and counted. The vas deferens and its associated vessels were identified and preserved. The vasal veins were found attached to the vas deferens and they were ligated and divided when the diameters were larger than 2 mm (measured with a microruler).

According to the diagnostic criteria of varicocele by ultrasonography in Chinese men (Chen et al., 1995; Chu et al., 2005), the internal and external spermatic veins ligated were measured with a microruler (Fig. 1c) and classified into three grades: large ($\geq 3$ mm in diameter), medium (1–3 mm) and small (≤1 mm) at every procedure. The locations of the internal spermatic arteries were categorised as ‘encircled (artery is adherent to two or more small or medium veins)’ or ‘isolated (artery is anterior or posterior to veins)’. The number of lymphatics, vein and arteries was recorded.

**Statistical method**

The results were expressed as the mean (range). The number of vessels found in left versus right varicoceles in the subinguinal approach was evaluated using the t-test. A comparison of the mean number of vessels found in patients with different complaints was made using ANOVA, followed by the LSD t-test; the same method was used to compare the mean number of vessels found in varicoceles with different clinical grades. $P$ values $<0.05$ were accepted as significant.

**Results**

We examined the records of 102 Chinese men who underwent primary microsurgical subinguinal varicocelectomy. The mean age of the patients was 28.9 years (range: 13–63 years). 23.5% patients underwent surgery for solo infertility, 29.6% for solo chronic testicular pain and the other 46.9% for both the two complaints. Of these, 60 men underwent bilateral repair, 41 men underwent a unilateral left varicocelectomy, and one man had a unilateral right varicocelectomy, for 162 varicocele units. The varicocele grades distribution of the varicocele units ($n = 162$) was as follows: 9.9% was grade I, 72.2% was grade II and 17.9% was grade III varicoceles.

**Anatomy at subinguinal microsurgical varicocelectomy**

**Internal spermatic veins**

In all the varicocelectomies, an average of 12.9 internal spermatic veins was counted and ligated per cord (Table 1). The difference between the two sides was not significant in the mean number of small, large or total internal spermatic veins ($P > 0.05$). A significant finding was that the mean number of medium internal spermatic veins on the left was larger than that on the right ($P < 0.001$).

**External spermatic veins**

All external spermatic veins encountered during the dissections were smaller than 3 mm. For all varicocelectomy cases, an average of 0.9 external spermatic veins was counted and ligated per cord (Table 2). The external spermatic vein or veins were found in 49.4% of the varicocele units. In 24.2%, 17.6%, 5.5% and 3% of the varicocele units, 1, 2, 3, 4 or more external spermatic veins were identified respectively. There were no significant differences in the mean number of external spermatic veins between left and right sides ($P > 0.05$).

**Internal spermatic arteries**

Overall, 1.8 internal spermatic arteries were identified and preserved per cord (Table 3). In 41.4%, 38.9% and 19.8% of the varicocele units, 1, 2, 3 or more internal spermatic arteries were identified respectively. There were no significant differences in the mean number of internal spermatic arteries between left and right ($P > 0.05$). 88.4% of the internal spermatic arteries were located within a complex of veins, and the other 11.6% were isolated.

| Table 1 Evaluation of internal spermatic veins in subinguinal approach |
|-------------------------------------------------|-----------------|-----------------|-----------------|---------------|
| No. of varicocele units | Left 101 | Right 61 | Total 162 | $P^*$ |
| Mean ± SD No. veins/cord (range) | 8.1 ± 4.9 (0–24) | 9.9 ± 6.9 (1–27) | 8.8 ± 5.8 (0–27) | >0.05 |
| Small | 4.2 ± 2.1 (0–11) | 3.0 ± 1.8 (0–8) | 3.8 ± 2.1 (0–11) | <0.05 |
| Medium | 0.3 ± 0.6 (0–2) | 0.4 ± 0.6 (0–2) | 0.4 ± 0.6 (0–2) | >0.05 |
| Large | 12.6 ± 5.1 (4–28) | 13.3 ± 6.6 (5–31) | 12.9 ± 5.7 (4–31) | >0.05 |

*The difference between the left and right side is statistically significant.
*Comparison between left and right varicocelectomies.
Subinguinal varicocele anatomy

K.-L. Lv et al.

Table 2 Evaluation of external spermatic veins in subinguinal approach

<table>
<thead>
<tr>
<th>Grade</th>
<th>Left</th>
<th>Right</th>
<th>Total</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of varicocoele units</td>
<td>101</td>
<td>61</td>
<td>162</td>
<td></td>
</tr>
<tr>
<td>Mean ± SD No. veins/cord (range)</td>
<td></td>
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<td></td>
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<tr>
<td>Small</td>
<td>0.9 ± 1.1 (0–6)</td>
<td>0.7 ± 1.1 (0–4)</td>
<td>0.8 ± 1.1 (0–6)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Medium</td>
<td>0.03 ± 0.2 (0–2)</td>
<td>0.02 ± 0.1 (0–1)</td>
<td>0.02 ± 0.2 (0–2)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Total external</td>
<td>1.0 ± 1.1 (0–6)</td>
<td>0.7 ± 1.1 (0–4)</td>
<td>0.9 ± 1.1 (0–6)</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

*Comparison between left and right varicocelectomies.

Table 3 Evaluation of internal spermatic arteries in subinguinal approach

<table>
<thead>
<tr>
<th>Grade</th>
<th>Left</th>
<th>Right</th>
<th>Total</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of varicocoele units</td>
<td>101</td>
<td>61</td>
<td>162</td>
<td></td>
</tr>
<tr>
<td>Mean ± SD No. arteries/cord (range)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Encircled</td>
<td>1.6 ± 0.7 (0–4)</td>
<td>1.7 ± 0.7 (1–3)</td>
<td>1.6 ± 0.7 (0–4)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Isolated</td>
<td>0.3 ± 0.5 (0–2)</td>
<td>0.2 ± 0.4 (0–1)</td>
<td>0.2 ± 0.5 (0–2)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Total internal</td>
<td>1.8 ± 0.9 (1–4)</td>
<td>1.8 ± 0.8 (1–4)</td>
<td>1.8 ± 0.8 (1–4)</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

*Comparison between left and right varicocelectomies.

Table 4 Evaluation of internal spermatic veins in varicoceles with different grades

<table>
<thead>
<tr>
<th>Grade</th>
<th>No. of varicocoele units</th>
<th>Mean ± SD No. veins/cord (range)</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade I</td>
<td>16</td>
<td>9.8 ± 7.1 (1–24)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Grade II</td>
<td>117</td>
<td>8.8 ± 5.9 (0–27)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Grade III</td>
<td>29</td>
<td>7.9 ± 4.4 (1–20)</td>
<td>&lt;0.05</td>
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</tbody>
</table>

*The difference between Grade I and Grade III is statistically significant, so is Grade II and Grade III, but is not Grade I and Grade II.

*Comparison between three grades.

Lymphatics

A mean number of 2.9 lymphatics (range 0–9) were identified and preserved per cord. The mean numbers were 2.9 (range 0–8) on the left and 2.8 (range 0–9) on the right. There were no significant differences in the mean number of lymphatics between left and right sides ($P > 0.05$).

Comparison between different clinical varicocele grades

The differences of the mean number of external spermatic veins, internal spermatic arteries and lymphatics between different clinical varicocele grades were not significant ($P > 0.05$). The mean number of medium internal spermatic veins in grade II was larger than that in grade I, but the difference was not significant ($P > 0.05$). The only significant finding was that the mean number of medium internal spermatic veins in grade III was larger than that in grade I or II ($P < 0.05$, Table 4).

Comparison between different chief complaints

The patients were classified into three groups according to their chief complaints: the men presenting for infertility only, the men presenting for chronic testicular pain only and the men presenting for both infertility and chronic testicular pain. The mean number of these three groups was evaluated, and no significant difference was found ($P > 0.05$, Table 5).

Discussion

Microsurgical varicocelectomy is considered the gold-standard technique for varicocelectomy in adults and especially for the adolescents, due to lower post-operative recurrence and complication rates compared with other techniques (Mirilas & Mentessidou, 2012; Mehta & Goldstein, 2013). Compared with the inguinal approach, the subinguinal approach obviates the need to open the aponeurosis of the external oblique, but it is associated with a greater number of complex vessels (Hopps et al., 2003). It is important to identify the exact subinguinal varicocele anatomy. Our report described varicocele anatomy during microsurgical subinguinal varicocelectomies in Chinese men and might be useful for surgeons who perform the surgeries.

In western men, Hopps et al. (2003) reported a mean of 11.1 internal spermatic veins, 5.5 external spermatic veins and 3.2 lymphatics while Libman et al. (2010)
found a mean number of 1.6 internal spermatic arteries and 4.5 lymphatics in the subinguinal dissection; both found no statistical significant differences between left and right side varicocelectomies. In our study, a mean number of 12.9 internal spermatic veins, 0.9 external spermatic veins, 1.8 internal spermatic arteries and 2.9 lymphatics were identified per cord. What is more, we found that the mean number of medium internal spermatic veins on the left was larger than that on the right \( P < 0.001 \). There are some differences between the studies, but it is unknown whether the differences are significant; more detailed data are needed to confirm it.

Internal spermatic arteries play an important role in maintenance of the testicular function even though the correlation between the number of arteries and improvement in semen parameters has not been identified (Grob-er et al., 2004). In our research, 88.4% of the internal spermatic arteries were located within a complex of veins and only 11.6% were isolated. The complex location of internal spermatic arteries indicates that the dissection and preservation of the arteries during subinguinal microsurgical varicocelectomy is difficult, and the incidence of arterial injury may increase. Thus, a meticulous identification and preservation of arteries is deserved during microsurgical varicocelectomy.

Whether the varicocele anatomy during subinguinal varicocelectomy differs in different pre-operative clinical varicocele grades is still controversial. Libman et al. (2010) found no significant relationships between grade of varicocele and vascular microanatomy while Hopps et al. (2003) determined the only intra-operative variable significantly associated with clinical varicocele grade was the number of internal spermatic veins greater than 2 mm. Belani et al. (2004) found that grade III varicoceles had a greater number of large veins compared with grade I varicoceles. According to our data, we found that the mean number of medium internal spermatic veins in grade III was larger than that in grade I or II \( P < 0.05 \). This may predict that more medium internal spermatic veins will be found in grade III varicocelectomies.

Infertility and chronic testicular pain are two important indications for varicocelectomy, patients underwent surgeries for one or both of the complaints (Mohammed & Chinegwundoh, 2009; Mehta & Goldstein, 2013). Pasqualotto et al. (2005) evaluated the semen quality after varicocelectomy according to the number of ligated veins and demonstrated that patients with more than 10 ligated veins had better chances of improving sperm concentration. It suggests that a large number of varicocele veins may have a bad effect on sperm concentration. However, our study did not find any differences between the three groups in the mean number of internal spermatic veins, external spermatic veins, internal spermatic testicular arteries or lymphatics. Further research is needed to clarify the association between varicocele vascular numbers and clinical symptoms.

According to our research, a large number of vessels will be encountered in subinguinal microsurgical varicocelectomy. The position relation of veins and arteries is complex. More medium internal spermatic veins are likely to appear in the left and grade III varicocele. The clinical symptoms may not predict the quantity of vessels. However, the research is limited by the number of cases, and more studies are needed to confirm our conclusion.

**Table 5 Evaluation of vessels in patients with different complaints**

<table>
<thead>
<tr>
<th></th>
<th>Infertility(^a)</th>
<th>Pain(^b)</th>
<th>Both(^c)</th>
<th>( P^* )</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of varicocele units</td>
<td>38</td>
<td>48</td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>Mean ± SD No. veins/cord (range)</td>
<td></td>
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<tr>
<td>Internal spermatic veins</td>
<td>12.3 ± 6.8 (4–31)</td>
<td>13.3 ± 5.7 (6–27)</td>
<td>12.9 ± 5.1 (5–25)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>External spermatic veins</td>
<td>1.0 ± 1.1 (0–4)</td>
<td>0.8 ± 1.3 (0–6)</td>
<td>0.9 ± 1.1 (0–4)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Internal spermatic arteries</td>
<td>1.9 ± 0.9 (1–4)</td>
<td>1.8 ± 0.8 (1–4)</td>
<td>1.8 ± 0.9 (1–4)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Lymphatics</td>
<td>2.8 ± 1.1 (1–6)</td>
<td>2.5 ± 1.6 (0–7)</td>
<td>3.1 ± 1.5 (0–9)</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

\(^a\)Patients presenting for infertility.
\(^b\)Patients presenting for chronic testicular pain.
\(^c\)Patients presenting for both infertility and chronic testicular pain.

\(*\)Comparison between patients with different complaints.

Infertility and chronic testicular pain are two important indications for varicocelectomy, patients underwent surgeries for one or both of the complaints (Mohammed & Chinegwundoh, 2009; Mehta & Goldstein, 2013). Pasqualotto et al. (2005) evaluated the semen quality after varicocelectomy according to the number of ligated veins and demonstrated that patients with more than 10 ligated veins had better chances of improving sperm concentration. It suggests that a large number of varicocele veins may have a bad effect on sperm concentration. However, our study did not find any differences between the three groups in the mean number of internal spermatic veins, external spermatic veins, internal spermatic testicular arteries or lymphatics. Further research is needed to clarify the association between varicocele vascular numbers and clinical symptoms.

According to our research, a large number of vessels will be encountered in subinguinal microsurgical varicocelectomy. The position relation of veins and arteries is complex. More medium internal spermatic veins are likely to appear in the left and grade III varicocele. The clinical symptoms may not predict the quantity of vessels. However, the research is limited by the number of cases, and more studies are needed to confirm our conclusion.

**Author contributions**

KLL designed the study and drafted the manuscript. JTZ carried out the microsurgical procedure and drafted the manuscript. LZ carried out the microsurgical procedure. ZW, YDZ and YG participated in the acquisition and analysis of the data. XZS and SPQ provided important intellectual advice and helped to revise the manuscript. CHD and XAT conceived of the study and carried out the microsurgical procedure.

**Competing financial interests**

All authors declare that there are no competing financial interests.
Acknowledgements

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