Volume of the Seminal Vesicles and Cross-Sectional Area of the Ampulla of Vas Deferens: Measurement on Trans abdominal Sonography

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With the rapid advances of medical imaging and computer technologies, sonography has been widely applied to the abdominal organs in order to benefit and/or replace other more complicated and invasive examinations. Sonography is very convenient and simple for the examination of male reproductive system. However, there are limited literatures concerning its application for the measurement of seminal vesicles and ampulla of vas deferens.

We used trans-abdominal sonography to examine the seminal vesicles and ampulla of vas deferens. The examination was performed after oral ingestion of about 800 c.c. of water. The examination was performed when the urinary bladder is full with the sense of need to urination. By using the distended urinary bladder as a window, we measured the volume and size of the seminal vesicles and ampulla of vas deferens. There are altogether 82 males received the examination. Adequate measurements were obtained in 78 patients (95%). The mean values of cross sectional area and diameter of the right and left ampulla of vas deferens (mean ± 1 S.D.) were 41.2 ± 16.6 mm\textsuperscript{2}, 39.4 ± 18.5 mm\textsuperscript{2}, 8.8 ± 2.1 mm, and 8.4 ± 1.9 mm, respectively. The mean value of volume and length of the right and left seminal vesicles were 1284.4 ± 792.0 mm\textsuperscript{3}, 1375.2 ± 853.7 mm\textsuperscript{3}, 28.4 ± 6.6 mm, and 28.2 ± 8.5 mm, respectively. All patients had no past history of genitourinary tract infection or infertility. They had no clinical symptoms or signs of prostatism prior to the ultrasonographic examination. The results showed that there is no significant variation between the age and the volume of seminal vesicles and cross-sectional area of the ampulla of vas deferens. There was positive relationship between volume of the left and right side seminal vesicle and cross-sectional area of the ampulla of vas deferens. The results of this study would be useful as a reference in the evaluation of congenital anomalies and pathology of seminal vesicle and in diagnosis of inflammatory disease. They can be also of value in assessing ejaculation dysfunction and male infertility related to anatomical condition.

Key words: Seminal vesicle; Vas deferens; Volume, ultrasound (US)

In 1968, Watanabe was the pioneer to introduce the transrectal sonography (TRS) for diagnosing prostate disease. Evaluation of male infertility and analysis of the fluid from the seminal vesicles have also been done with the assistance of TRS [1]. However, TRS is a relatively invasive method. Patient receiving the TRS might feel stressed and uncomfortable. Furthermore TRS is not suitable for patients having a mass in the rectum which may hinder the placement of the transducer. Trans-abdominal sonography (TAS) is simple and convenient to perform with the bladder distended after oral ingestion of about 800 c.c. of water for a period of time. No sexual abstinence is needed since there is no significant change in

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the anterior-posterior diameter and length of the seminal vesicle before and after sexual activity [2].

Sonography is the most convenient examination for the seminal vesicle and ampulla of vas deferens. It is useful for evaluating congenital anomalies, such as hypoplasia, agenesis, obstruction of the seminal vesicles, cystic anomalies of the ducts and male infertility. According to Kuligowska et al., about 40% of all cases of infertility are considered to be male factor, and about 2.5% of male infertility had developmental anomalies or anatomical changes of seminal vesicle [3]. The purpose of this study is to obtain the nomograms of the seminal vesicles and ampulla of vas deferens on transabdominal sonography.

**MATERIAL AND METHODS**

Transabdominal ultrasound examination for the seminal vesicle and ampulla of vas deferens was performed with transverse (axial) and sagittal (longitudinal) planes, and oblique scan if needed. Coupling agent is applied on the body of the patient in order to eliminate air between the transducer and body surface. Gray-scale images were obtained for structural anatomy and further measurement.

The seminal vesicle is a pear-shaped hypoechoic (cystic) structure (Fig. 1, 2) [4]. It is superior-posterior to the prostate gland, posterior to the base of the urinary bladder, and lateral to the ampulla of vas deferens. The ampulla of vas deferens is located between the base of the urinary bladder and seminal vesicle [5-7].

There were altogether 82 males with normal fertility function receiving sonographic examination from June 2004 to December 2004. Their ages ranged from 40 to 93 years, with an average of 64.5 years (Table 1). The machines included: HDI 5000 (Advanced Technology Laboratories, Bothell, WA, USA), Logiq 500 and Logiq 9 (GE Healthcare, Milwaukee, WI, USA), all equipped with curved linear transducers of 3.5MHz and 5.0MHz.

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**Table 1. Grouping and Measurements in 78 Normal Subjects**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Total</th>
<th>Age (Years)</th>
<th>VD*</th>
<th>SV*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N = 78</td>
<td></td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>Group 1</td>
<td>13</td>
<td>40-49</td>
<td>43.7</td>
<td>42.3</td>
</tr>
<tr>
<td>Group 2</td>
<td>21</td>
<td>50-59</td>
<td>36.9</td>
<td>35.2</td>
</tr>
<tr>
<td>Group 3</td>
<td>10</td>
<td>60-69</td>
<td>41.9</td>
<td>38.5</td>
</tr>
<tr>
<td>Group 4</td>
<td>21</td>
<td>70-79</td>
<td>40.8</td>
<td>40.0</td>
</tr>
<tr>
<td>Group 5</td>
<td>13</td>
<td>&gt;80</td>
<td>50.3</td>
<td>45.9</td>
</tr>
<tr>
<td>mean</td>
<td>64.5</td>
<td></td>
<td>41.2</td>
<td>39.4</td>
</tr>
</tbody>
</table>

*VD = ampulla of vas deferens
SV = Seminal Vesicles
The transabdominal sonography for the distal reproductive tract was done via the distended urinary bladder which was used as an acoustic window. Transverse scan was performed with the transducer tilted caudally. The seminal vesicles appeared as a pair of long ovoid structures located posterior to the basal aspect of the urinary bladder (Fig. 3). After identification of the seminal vesicles, their length and thickness were measured. In between the urinary bladder and the seminal vesicle there were ampulla of vas deferens, presenting as two tubular structures of low echogenicity, which were round on transverse scan (Fig. 4). The anterior-posterior diameter of the short axis \( r_1 \) and transverse diameter \( r_2 \) were measured. The cross-sectional area of the ampulla of vas deferens was then obtained from formula 1. The transducer was then applied in minimally oblique direction, the connection between the seminal vesicle with the prostate gland could be seen. Moving the transducer towards the right side, the right seminal vesicle was demonstrated and then towards the left side, the left seminal vesicle was found (Fig. 5). The length and thickness of the seminal vesicles were measured. The volume of the seminal vesicles could then be obtained from formula 2 [8].

From the results obtained from formula 1 and 2, the length and cross sectional area of the ampulla of vas deferens; the length and the volume of the seminal vesicle were then calculated by using SPSS.

**Formula 1:**
Cross-sectional area of the ampulla of vas deferens
\[
\frac{(r_1 \times r_2)\pi}{4}
\]

**Formula 2:**
Volume of the seminal vesicle = length of seminal vesicle \times \frac{(thickness of seminal vesicle)^2\pi}{4} ÷ 2

**RESULTS**

**Sonographical Anatomy**

The normal seminal vesicle and ampulla of vas deferens were both well demonstrated in 78 cases (95%). The paired seminal vesicles are located between the urinary bladder and rectum. Most of the seminal vesicles are symmetrical with an egg-plant appearance and smooth surfaces. There is no definite echogenicity inside except at areas with folding. The ampulla of vas deferens appears as relatively straight tubular structures close to the prostate gland in longitudinal scan. Transverse scan is best for demonstration

**Figure 3.** Transverse scan: Ultrasonography of the seminal vesicles, the seminal vesicles present as a paired ovoid structures (arrowheads), with the ampulla of vas deferens located medially (arrows).

**Figure 4.** Ultrasonography of the ampulla of vas deferens, transverse scan in more cephalic plane: The ampulla of vas deferens (arrows) present as a paired round structures.

**Figure 5.** Ultrasonography of the prostate (arrowheads) and seminal vesicles (left side) (arrow). Sagittal scan.
of the symmetry of the seminal vesicles, and
minimally oblique scan for their long axes. Scanning
can be best performed with the bladder about 80% full
(about 300-500ml).

Results of the measurements
There were altogether 82 males for scanning,
however, in four of them the exact contour of ampulla
of vas deferens on transverse scan was not well delin-
eted. The results of the remaining 78 males using
SPSS were in Table 1-3. The mean values of cross
sectional area and diameter of the right and left
ampulla of vas deferens (mean ± 1 S.D.) were 41.2 ±
16.6 mm², 39.4 ± 18.5mm², 8.8 ± 2.1mm, and 8.4 ±
1.9mm, respectively. The mean value of volume and
length of the right and left seminal vesicles were
1284.4 ± 792.0mm³, 1375.2 ± 853.7mm³, 28.4 ±
6.6mm, and 28.2 ± 8.5mm, respectively. All patients
had no past history of genitourinary tract infection or
infertility. They had no clinical symptoms or signs of
prostatism prior to the ultrasonographic examination.
There was no significant relationship with age except
the cross-sectional area of right side ampulla of vas
derferens as in Table 2. There was a significant rela-
tionship between the cross-sectional area of the
ampulla of vas deferens and the length and volume of
the seminal vesicle, as shown in Table 3. The correla-
tion of the right and left ampulla of vas deference and
the right and left seminal vesicles ranged from 0.591-
0.766, with p-value < 0.001, and was considered sig-
nificant.

Discussions and Conclusions
Sonography has become crucial in the evaluation
of infertile couples. Any structural or anatomical
problems that block the path that sperm must travel to
eventually reach the egg for fertilization can cause
male infertility. Infertility related to structural and
anatomical problems in the male anatomy may be
caused by scar tissue, varicose veins or infection or,
in some cases, the problems exist from birth. Congenital
anomalies include bilateral or unilateral absence of
ampulla of vas deferens, other anatomical abnormali-
ties can occur in the seminal vesicles or ampulla of vas
derferens such as calcifications, cysts, and/or fibrosis,
or uni- or bilateral ejaculatory duct obstruction caused
by cysts [3, 9]. Sonography is a non-invasive and cost-
effective modality, and can be repeatedly used. It is
particularly convenient for measuring the volume of
the seminal vesicle and size of ampulla of vas
derferens as in Table 2. There was a significant rela-
tionship between the cross-sectional area of the
ampulla of vas deferens and the length and volume of
the seminal vesicle, as shown in Table 3. The correla-
tion of the right and left ampulla of vas deference and
the right and left seminal vesicles ranged from 0.591-
0.766, with p-value < 0.001, and was considered sig-
nificant.

Table 2. Measurements of Ampulla of Vas Deferens and Seminal Vesicles

<table>
<thead>
<tr>
<th></th>
<th>Vas Deferens (VD)</th>
<th></th>
<th>Seminal Vesicles (SV)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Diameter (mm)</td>
<td>Area (mm²)</td>
<td>Length (mm)</td>
</tr>
<tr>
<td></td>
<td>(mean ± SD)*</td>
<td>(mean ± SD)*</td>
<td>(mean ± SD)*</td>
</tr>
<tr>
<td>Left</td>
<td>8.4 ± 1.9</td>
<td>39.4 ± 18.5</td>
<td>28.2 ± 8.5</td>
</tr>
<tr>
<td>Right</td>
<td>8.8 ± 2.1</td>
<td>41.2 ± 16.6</td>
<td>28.4 ± 6.6</td>
</tr>
</tbody>
</table>

* SD = standard deviation

Table 3. Correlation of Measurements and Ages

<table>
<thead>
<tr>
<th></th>
<th>VD-R</th>
<th>VD-L</th>
<th>VDA-R</th>
<th>VDA-L</th>
<th>SV-R</th>
<th>SV-L</th>
<th>SVV-R</th>
<th>SVV-L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation</td>
<td>0.057</td>
<td>-0.040</td>
<td>-0.254*</td>
<td>-0.211</td>
<td>-0.010</td>
<td>-0.046</td>
<td>-0.158</td>
<td>-0.156</td>
</tr>
<tr>
<td>P-value</td>
<td>0.620</td>
<td>0.731</td>
<td>0.025</td>
<td>0.064</td>
<td>0.928</td>
<td>0.688</td>
<td>0.167</td>
<td>0.173</td>
</tr>
</tbody>
</table>

* Correlation is significant at the 0.05 level (2-tailed)

VD = ampulla of vas deferens, VDA = vas deferens area, SV = seminal vesicle,
SVV = seminal vesicle volume, R= right, L = left

Table 4. Comparison of Right and Left VDs and SVs

<table>
<thead>
<tr>
<th></th>
<th>VD-R vs. VD-L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation</td>
<td>0.591*</td>
</tr>
<tr>
<td>P value</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

* Correlation is significant at the 0.01 level (2-tailed)
cross-sectional area of the ampulla of vas deferens (Table 3). The ampulla of vas deferens is larger when the seminal vesicle increase in size.

According to the anatomy textbook, the length of the seminal vesicle is about 4-5 cm and the volume is about 4 ml. The length of the vas deferens is between 31-60 cm [10]. There is no literature on medical imaging concerning the size of the ampulla of vas deferens. While on the basis of our study the volume of the seminal vesicle is comparatively smaller. The results may be related to racial difference, different in method of measurement, and the difference in patient source. Furthermore, the seminal vesicle is a saccular structure and can be distended by fluid content, measurement error may also be part of the reasons.

It is easy to visualize the ampulla of vas deferens. It is difficult to visualize the origin of vas deferens from epididymis, therefore it is difficult to measure its actual length.

Vesiculography has been recommended to image the vas deferens, seminal vesicle, and ejaculatory duct, with better image conspicuity than the vasography. However it is an invasive method. Our study shows that transabdominal sonography can be a convenient way to provide important anatomical information of the distal reproductive tract with a success rate of 95%. The results of our study can be used as a reference for evaluation of congenital anomalies of the distal reproductive tract and inflammatory process of the seminal vesicles.

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以超音波量測儲精囊體積及輸精管截面積

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近幾年來由於影像醫學的突飛猛進，使得超音波漸漸取代了一些較為複雜或令人不適，或侵襲性較高的檢查，對於腹部器官的受檢者是一大佳音。超音波對生殖系統的檢查是最簡便有效的方法，但一般文獻上對儲精囊及輸精管的描述頗為有限，因此本研究乃以經腹部超音波掃描儲精囊及輸精管壺腹，請受檢者在檢查前喝800cc開水，待有尿意時即可掃描，以量取儲精囊及輸精管的大小。依本研究82位受檢者的統計結果顯示，各年齡層的儲精囊體積及輸精管壺腹截面積並無顯著的變化，在左右的儲精囊體積及輸精管壺腹截面積亦有正比的關係，且檢查成功率高達95%。本研究量測的數值可用於評估儲精囊先天性病變或發炎時的參考，對男性射精功能或不孕症方面的解剖學變化亦具參考價值。

關鍵詞：儲精囊，輸精管壺腹，體積，超音波