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Ultrasoundographic diagnosis of varicoceles

L. Andrew Eckow, M.D.*  Robert Bechhold, M.D.*
Neal E. Watson, M.D.†  Eric Scharring, M.D.†
Neil Wolfman, M.D.*†  Jonathan P. Jarow, M.D.*†

The Bowman Gray School of Medicine of Wake Forest University, Winston-Salem, North Carolina

Objective: To assess the ability of color duplex scrotal ultrasonography to detect subclinical varicoceles and confirm the diagnosis of clinical varicoceles.

Design: Physical examination, color duplex scrotal ultrasonography and internal spermatic venography were performed on 36 testicular units in 11 men.

Setting: Male fertility center.

Patients: Two hundred sixty-two consecutive men being evaluated for male factor infertility of whom 33 agreed to undergo venography.

Main Outcome Measures: Ultrasonographic measurement of scrotal vein diameter of patients in the upright and supine position, before and during valsalva manoeuvre, and scrotal vein blood flow reversal with valsalva manoeuvre was compared with the findings of varicocele by physical examination and venography.

Results: The best predictor of a varicocele was internal spermatic vein diameter, and the best overall performance of ultrasonography was achieved with the patient at rest in the supine position. The best cutoff point for venous diameter for a clinical varicocele was 3.6 mm and 2.7 mm for a subclinical varicocele, but the overall accuracy was only 60%.

Conclusions: Confirmatory studies are needed to support the ultrasonographic diagnosis of varicoceles before considering surgical repair.

Key Words: Varicocele, ultrasonography, venography

Varicocele is the most frequently observed surgically correctable cause of male infertility (1). The repair of palpable varicoceles is generally accepted as an efficacious modality of therapy. However, the repair of subclinical varicoceles remains controversial (2). Physical examination is the gold standard for the diagnosis of clinical varicoceles, whereas venography is currently the gold standard for subclinical varicoceles. Thermography (3-6), Doppler (7-10), radioscintiography (11), and ultrasonography (12-15) have been used to objectively confirm physical findings of a varicocele or detect a subclinical varicocele less invasively than venography. Because it is noninvasive, readily available, and familiar to urologists, scrotal ultrasonography is now the most popular technique for evaluating scrotal pathology. However, prior studies have not objectively compared ultrasonography with gold standard methods for the diagnosis of varicoceles in a rigorous fashion. The purpose of this study was to determine the sensitivity and specificity of color duplex ultrasonographic diagnosis of both clinical and subclinical varicoceles.

MATERIALS AND METHODS

We performed a physical examination and scrotal color duplex ultrasonography on 262 consecutive men without history of prior varicocele repair who were referred for evaluation of possible male factor infertility over a 30-month period. Physical

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*Department of Urology.
†Department of Radiology.
‡Beprint requests: Jonathan P. Jarow, M.D., Department of Urology, Bowman Gray School of Medicine, Medical Center Boulevard, Winston-Salem, North Carolina 27157-1004.

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study at the level of the renal veins was negative. The radiologists performing venography were not aware of the results of ultrasonography, physical examination, or semen analysis.

The sensitivity and specificity of color duplex ultrasonographic diagnosis of clinical and subclinical varicoceles were calculated. Linear regression analysis was used to determine whether on ultrasonography there was a sensitivity of 67% and specificity of 65%. Using the 5-mm cutoff value previously described, varicocele diameter had a sensitivity of 79% and specificity of 59%. To assess the accuracy of ultrasonography in confirming the diagnosis of clinical varicocele and detecting subclinical varicocele, the patients were divided into the following groups: clinical varicocele: positive physical exam (18 tests); subclinical varicocele: negative physical exam/positive venography (26 tests); and no varicocele: negative physical exam (20 tests). The mean varicocele diameter by ultrasonography for tests with clinical varicoceles was 3.7 ± 1.1 mm, with subclinical varicoceles it was 3.1 ± 0.8 mm, and without a varicocele it was 2.6 ± 0.7 mm (P < 0.01).

Linear regression analysis was applied to the ultrasonographic vascular diameter measurements to identify the best cutoff points for confirming clinical varicoceles and detecting subclinical varicoceles. The overall results did not reveal a significant advantage of measurements in the upright position or with valsalva (Table 3). We were unable to obtain varicocele diameter measurements during valsalva with the patient upright in 11 of the 64 testicular units despite the experience of our sonographers using this technique. Therefore, without significant sacrifice in accuracy, it appears that measurements of scrotal varicocele diameter at rest in the supine position is the best overall method in terms of both ease of performance and accuracy (Table 3). Accuracy is defined as the number of correct diagnoses divided by the total population studied. The accuracy of ultrasonographic confirmation of a clinical varicocele was 63% using the cutoff point of 3.6 mm. The accuracy of ultrasonographic detection of subclinical varicoceles was also 63% using the cutoff point of 2.7 mm.

**DISCUSSION**

Scrotal ultrasonography has the unique ability to image the testis and adnexal structures noninvasively. The addition of color duplex ultrasonography including the ability to evaluate the testicular vasculature. Prior reports of the use of venography as gold standards, respectively.*

### Table 2

<table>
<thead>
<tr>
<th>Group</th>
<th>Venography</th>
<th>Fertility &amp; Sterility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phys + U/S</td>
<td>4 (27)</td>
<td>1 (7)</td>
</tr>
<tr>
<td>Phys - U/S</td>
<td>15 (100)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Phys - U/S</td>
<td>2 (13)</td>
<td>2 (13)</td>
</tr>
<tr>
<td>Phys + U/S</td>
<td>6 (42)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Phys - U/S</td>
<td>19 (130)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

* Phys, physical exam; U/S, color duplex ultrasonography. Values in parentheses are percentages.

### Table 3

<table>
<thead>
<tr>
<th>Venous Diameters</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varicocele</td>
<td>0.60</td>
<td>0.39</td>
</tr>
<tr>
<td>Valsalva</td>
<td>0.56</td>
<td>0.43</td>
</tr>
<tr>
<td>Upright</td>
<td>0.57</td>
<td>0.50</td>
</tr>
<tr>
<td>Subclinical varicocele</td>
<td>0.60</td>
<td>0.39</td>
</tr>
</tbody>
</table>

* The best cutoff point for venous diameter for each position was determined by linear regression analysis. Venography used as gold standard for this analysis.
Table 1 Results of Physical Exam and Color Duplex Ultrasoundography Diagnosis of a Varicocele in 282 Consecutive Men Referred for Infertility Evaluation and Varicocele Physical Examination and Varicocelectomy as Gold Standards, Respectively

<table>
<thead>
<tr>
<th>Examination and Varicocele Physical Examination</th>
<th>Ultrasonography</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left varicocele</td>
<td>68 (25%)</td>
</tr>
<tr>
<td>Right varicocele</td>
<td>2 (1%)</td>
</tr>
<tr>
<td>Bilateral</td>
<td>21 (7%)</td>
</tr>
<tr>
<td>Total positive</td>
<td>90 (33%)</td>
</tr>
</tbody>
</table>

* Values in parentheses are percent.

examination was performed by our investigator (P.J.Z.) with the patient standing in a warm room. The scrotal cord was palpated in the scrotum both before and during valsalva maneuver. Scrotal color duplex ultrasonography was performed using an Aloka 128 ultrasound unit (Mountain View, CA) with a 7.5-MHz transducer. The patient was examined before and during valsalva maneuver in both the supine and standing positions. The following ultrasonographic criteria were assessed: largest scrotal cord diameter before and during valsalva maneuver in both positions, flow reversal (noted by color change) during valsalva maneuver in both positions, and presence of a tangle of veins within the scrotum. For the purpose of the study, an ultrasonographic study was initially considered positive if there was a scrotal cord diameter >3 mm during any maneuver, flow reversal with valsalva or a tangle of veins present in the scrotum. Physical examination and scrotal ultrasonography were performed independently without knowledge of the results of the other study or the results of the patients’ semen analyses.

Internal spermatic venography and possible percutaneous ablation were offered to any patient with a varicocele by either physical examination or ultrasonography in whom repair was indicated based on the complete evaluation of the patient and his sperm counts. Internal spermatic venography was performed on 64 testicular units in 33 men using the Seldinger technique through the right femoral vein. The left renal vein was catheterized, and nonionic contrast material was infused while the patient performed the valsalva maneuver. The right side was studied with the catheter tip placed within the inferior vena cava at the level of the right renal vein. The venogram was considered positive when contrast refluxed down to the level of the infrarenal cava because the scrotum was shielded to protect the testes from radiation exposure. The external spermatic veins were also evaluated if the initial study at the level of the renal veins was negative. The radiologists performing venography were not aware of the results of ultrasonography, physical examination, or semen analysis.

The specificity and sensitivity of color duplex ultrasonographic diagnosis of clinical and subclinical varicoceles were calculated. Linear regression analysis was used to determine the sensitivity of 67% and specificity of 65%. Using the 3-mm cutoff value previously described, venous diameter had a sensitivity of 7% and specificity of 99%. To assess the accuracy of ultrasonography in confirming the diagnosis of clinical varicocele and detecting subclinical varicocele, the patients were divided into the following groups: clinical varicocele: positive physical exam (18 tests); subclinical varicocele: negative physical exam/positive venography (26 tests); and no varicocele: negative physical exam/normal venography (20 tests). The mean venous diameter by ultrasonography for tests with clinical varicoceles was 3.7 ± 1.1 mm, with subclinical varicoceles it was 3.1 ± 0.8 mm, and without a varicocele it was 2.6 ± 0.7 mm (P = 0.01).

Linear regression analysis was applied to the ultrasonographic venous diameter measurements to identify the best cutoff points for confirming clinical varicoceles and detecting subclinical varicoceles. The overall results did not reveal a significant advantage of measurements in the upright position or with valsalva (Table 3). We were unable to obtain venous diameter measurements during valsalva with the patient upright in 11 of the 64 testicular units despite the experiences of our sonographers using this technique. Therefore, without significant sacrifice in accuracy, it appears that measurements of scrotal venous diameter at rest in the supine position is the best overall method in terms of both ease of performance and accuracy (Table 3). Accuracy is defined as the number of correct diagnoses divided by the total population studied. The accuracy of ultrasonographic confirmation of a clinical varicocele was 63% using the cutoff point of 3.6 mm. The accuracy of ultrasonographic detection of subclinical varicoceles was also 63% using the cutoff point of 2.7 mm.

DISCUSSION

Scrotal ultrasonography has the unique ability to image the testis and adrenal structures noninvasively. The addition of color duplex ultrasonography (including determination of the testicular vascular. Prior reports of the use of ultrasonography for the diagnosis of varicoceles have used different diagnostic criteria (12–14) or did not describe their method of diagnosis (15). This study demonstrates the utility of scrotal ultrasonography in a group of patients undergoing evaluation by three different techniques in a blinded fashion. The best diagnostic criteria were selected in the objective fashion on the basis of linear regression analysis. Our experience confirms that of Gonda et al. (14) that the best results are obtained using measurements of venous diameter with the patient resting in the supine position (Table 3). The slight advantage of valsalva maneuver or standing position in confirming clinical varicoceles was negated by the difficulty of obtaining accurate measurements in this position. We do not recommend this maneuver to the occasional examiner, considering the difficulty observed by our experienced sonographers.

We observed a gradual increase of venous size between tests without varicoceles, with subclinical varicoceles, and with clinical varicoceles. Therefore, the same cutoff points for venous size should not be used for confirmation of a clinical varicocele and detection of a subclinical varicocele. We found that the choice of cutoff point has a marked effect on the sensitivity. Specifically, at the highest cutoff point, the effect is inverse, i.e., a high specificity can only
be gained at the expense of sensitivity or vice versa. For the purpose of this study, we arbitrarily chose the cutoff point with the highest sum of sensitivity plus specificity. The final choice of cutoff point must be determined by the examiner and/or managing physician based on the clinical situation. For instance, a cutoff point with a high sensitivity but low specificity may be chosen for selection of patients undergoing venography in a study of subclinical varicoceles. However, a higher specificity may be desired when planning surgical therapy. Therefore, it is important that the gonadotropin report includes the longest scrotal venous diameter for each testis.

McClure and Hricak (13) compared ultrasonography to physical examination. They were able to detect all palpable varicoceles using a 3-mm cutoff point and also identified subclinical varicoceles. This cutoff point appears to have been chosen arbitrarily because confirmatory studies of subclinical varicoceles were not performed. Gonda and co-workers (14) reported a 96% sensitivity of ultrasonography using a 2-mm cutoff point, but a confirmatory test was not used and specificity was not reported. We also observed a high sensitivity with a cutoff point of 2 mm but an extremely low specificity. Rifkin and co-workers (12) also used 2 mm as a cutoff point for confirming clinical varicoceles. They reported a 100% sensitivity but did not report specificity or use another confirmatory test such as venography. Fetos and associates (15) reported a 93% sensitivity and a 33% specificity of color duplex ultrasonography in the diagnosis of varicoceles in left testes that were also studied with venography. However, they did not describe the criteria they had used to interpret the US study.

What is a varicocle? The standard definition is dilatation of the veins of the pampiniform plexus because of the reflux of blood. The gold standard for clinical varicocele can be nothing other than physical examination. Yet whether a subclinical varicocele exists is clinically relevant, and the gold standard method of diagnosis remains controversial. All methods of diagnosis, including physical examination, may have false-positive or -negative results. Reflux of blood can be detected by either venography, Doppler evaluation, or color duplex ultrasonography. Because venography has been around longer and has been used as a gold standard in many previous studies (1–6, 15), we arbitrarily chose venography as the gold standard for diagnosing subclinical varicoceles in this study. We found that the color change during duplex ultrasonography associated with reflux of blood had a very high specificity but extremely low sensitivity. This is most likely due to the extremely slow rate of blood flow in varicoceles, particularly large ones. We found that venous diameter, as measured ultrasonographically, had a direct correlation with reflux visualized during venography. Venography may have a false-positive result if the testes or veins have been bypassed by catheterizing the spermatic vein (16). This was avoided by positioning the catheter tip in the left renal vein and vena cava for left- and right-sided studies, respectively. Conversely, false-negative results may occur if the patient is not upright or performing a valsalva maneuver. We performed venography with the table tilted head up 20° and the patient awake so that a valsalva maneuver could be performed at the appropriate time. It is unclear which test is correct when there was disagreement between physical examination and venography, but it is our personal bias that venography is the correct one. Because some studies have shown that size of a clinical varicocele does not appear to be a significant factor in outcome, it would be ideal to have an objective test that would confirm this physical finding accurately (17). Although color duplex scrotal ultrasonography can diagnose subclinical varicoceles, it is not the purpose of this study to prove or disprove the utility of subclinical varicocelectomy.

Our results reveal that color duplex ultrasonography is far from perfect as a screening test for subclinical varicoceles or as a confirmatory test of clinical varicoceles. Either a high sensitivity or specificity can be achieved with manipulation of the cutoff point, but a high specificity and sensitivity cannot be achieved simultaneously. We recommend obtaining venous measurements at rest in the supine position and using a cutoff point of 0.6 mm for diagnosing clinical varicoceles and 2.7 mm for detecting subclinical varicoceles when using scrotal color duplex ultrasonography. However, the accuracy of this test using those cutoff points is only 63%. Because of the inaccuracies of scrotal ultrasonography, we recommend that all future studies evaluating the management of subclinical varicoceles should use a more accurate diagnostic test than ultrasonography.

REFERENCES
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