

High-Resolution Sonography of the Normal Extrapelvic Vas Deferens

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Objective. The purpose of this study was to determine the reliability of sonographic visualization of the normal extrapelvic vas deferens and to analyze its appearance and dimensions. **Methods.** Scans of the scrotum and spermatic cords were obtained in 25 fertile volunteers. Identification of the vas deferens was attempted bilaterally in the scrotal, suprascrotal, and prepubic segments in all volunteers. When possible, the total thickness and the diameter of the lumen were measured. Visualization and dimensions were correlated with the body mass index (BMI) and abstinence interval. **Results.** All segments of the vas deferens were identified bilaterally in all volunteers. In all cases, it appeared as an anechoic or very hypoechoic tubular structure that was noncompressible and contained no detectable blood flow. It was convoluted inferiorly and became straight as it progressed from the scrotum to the suprascrotal and prepubic segments. The lumen was seen in the suprascrotal segment in all of the volunteers except the one with the highest BMI. The total thickness of the vas ranged from 1.5 to 2.7 mm (mean, 1.89 mm). The lumen of the vas ranged from 0.2 to 0.7 mm (mean, 0.43 mm). There was no correlation between the luminal diameter and the abstinence interval. **Conclusions.** The extrapelvic portion of the vas deferens is reliably visualized sonographically. Its appearance is characteristic and reproducible. The lumen can be measured in almost all cases. **Key words:** infertility; scrotum; vas deferens.

Abbreviations

BMI, body mass index; MRI, magnetic resonance imaging; 1.5D, 1.5-dimensional

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Male infertility can be caused by a variety of morphologic abnormalities of the seminal duct system. These abnormalities can be evaluated in a variety of ways, including transrectal sonography, transrectal magnetic resonance imaging (MRI), seminal vesiculography, and vasography. Although it is known that conventional sonography is capable of visualizing the extrapelvic portion of the vas deferens in the scrotum and spermatic cord,¹ there has been very little detailed sonographic analysis of this portion of the vas deferens.² The purpose of this study was to determine the reliability of using sonography to document the presence of a normal extrapelvic vas deferens, to analyze the appearance of the normal vas deferens, to measure the size of the vas deferens and its lumen, and to compare the in vivo appearance with the appearance of specimens resected at the time of vasectomy.

Materials and Methods

A group of 25 men who either had fathered children or had a partner who was currently pregnant volunteered for this study. One volunteer was excluded because of a prior vasectomy. None of the 25 volunteers included in the study were having fertility difficulties. In addition, 3 specimens from vasectomies were scanned in a water bath. Appropriate Institutional Review Board approval was obtained before initiation of the study. After informed consent was obtained, scans of the scrotum and spermatic cords were performed bilaterally with an Antares or Sonoline Elegra unit (Siemens Medical Solutions, Mountain View, CA) and a commercially available 13–5 MHz 1.5-dimensional (1.5D) linear array transducer. Tissue harmonic imaging and real-time compounding were used for 24 of the 25 volunteers. All scans were performed by the first and second authors. The vas deferens was scanned in both transverse and longitudinal planes in the volunteers as well as the specimens. With electronic calipers, the total thickness (outer to outer) and luminal diameter of the vas were prospectively measured in its straight suprascrotal segment in all cases. Compression of the spermatic cord was performed with the transducer to subjectively determine the relative compressibility of the vas when compared with the adjacent arteries and veins in the spermatic cord. Color Doppler imaging was performed to ensure that the structure identified as the vas was not a vascular structure. The manufacturer’s low-flow Doppler preset was selected, and the Doppler parameters of transmit frequency, Doppler gain, pulse repetition frequency, and wall filter were individually optimized for detection of slow flow. The transmit Doppler frequency ranged from 5.3 to 8.9 MHz; the pulse repetition frequency ranged from 488 to 868 Hz; and the wall filter was always set at its lowest setting. Doppler gain was adjusted to maximize sensitivity without producing color noise.

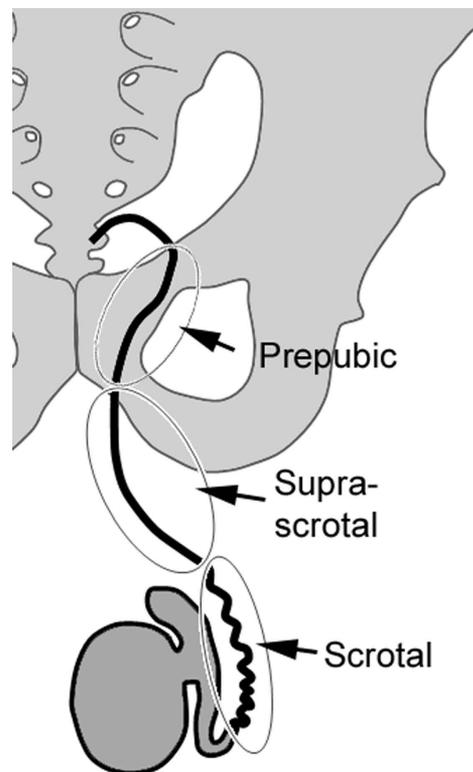
The vas was divided into 3 segments: (1) scrotal, inferior; (2) suprascrotal, mid; and (3) prepubic, superior (Figure 1). Attempts were made with real-time scanning to follow the vas deferens from its junction with the epididymal tail to the inguinal canal. The testes and epididymis were also scanned to exclude substantial abnormalities.

All volunteers completed a questionnaire that included a history of fertility difficulties and other genitourinary diseases. Patients with a positive history of these conditions were excluded from the study. The questionnaire also documented height, weight, body mass index (BMI), and ejaculation status in the period preceding the examination. Statistical analyses were done to look for a correlation between the luminal diameter of the vas deferens and the time from the last ejaculation and average time between ejaculations using the Spearman correlation coefficient and linear regression analyses.

Results

The volunteers ranged in age from 29 to 52 years (mean, 32.2 years). The BMI ranged from 21.2 to 34.5 (mean, 24.9). The typical frequency of sexual activity resulting in ejaculation in each volunteer ranged from every 2 to every 7 days (mean, 4.4 days). The abstinence interval before the sonographic examination ranged from 1 to 16 days (mean, 3.6 days).

Figure 1. Segmentation of the vas deferens.



All 3 segments of the vas deferens were reliably identified bilaterally in all 25 volunteers. It appeared very hypoechoic in all locations. The scrotal segment was located immediately adjacent to the epididymis in all cases. It had a convoluted, tortuous appearance at its origin (Figure 2) and gradually straightened as it approached the suprascrotal segment.

The suprascrotal segment was a linear structure superior to the epididymis. The sonographic signature of the vas in the straight suprascrotal segment was of a cordlike structure with central parallel linear reflectors representing the anterior and posterior walls of the lumen (Figure 3). The cross-sectional view showed a classical “target” or “doughnut” appearance (Figure 4). The anterior and posterior reflections from the lumen of the vas were visible in 48 of the 50 vasa. In 1 volunteer with a BMI of 34.5, it was not possible to see the luminal reflections on either the right or left side (Figure 5).

The full-thickness measurement of the suprascrotal segment of the vas varied from 1.6 to 2.7 mm on the right side and 1.5 to 2.6 mm on the left side. The mean thickness of the vas was 1.89 mm. The lumen of the vas ranged from 0.2 to 0.7 mm (mean, 0.43 mm) with a maximal difference between the two sides of 0.3 mm. Visualization of the lumen in the suprascrotal segment ranged from near total when the lumen was wide (Figure 3A) to segmental when the lumen was narrow (Figure 3B).

A test of the correlation between the luminal diameter and the time from the last ejaculation and average time between ejaculations was done with the Spearman correlation coefficient and linear regression analyses. The analyses revealed a non-normal distribution for the variables ($P = .0003$ –.2634; $r^2 = 0.0548$ –0.1315). The low values indicated that there was no correlation between the luminal diameter and the frequency of sexual activity or duration of abstinence before the sonographic examination.

The vas was seen in all cases in the prepubic areas (Figure 6). However, luminal reflections were seen in only 2 of 50 cases at this level.

In all cases, the vas deferens was noncompressible in all segments (Figure 7, A and B). With Doppler analysis, flow was detectable in adjacent arteries of the spermatic cord, but there was

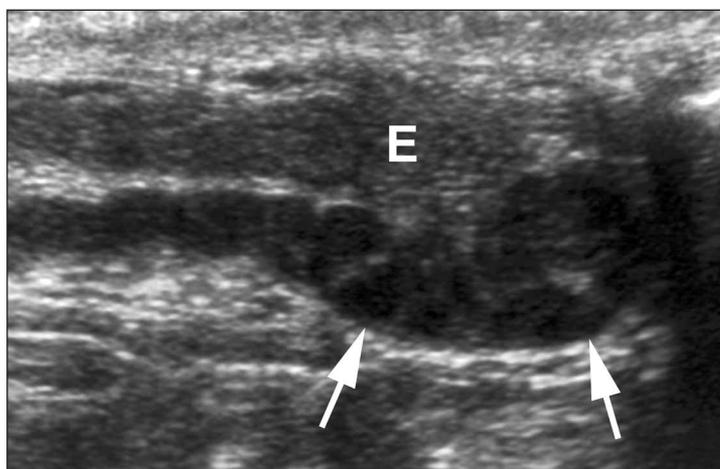
a lack of flow in the vas (Figure 7C). The combination of the lack of blood flow and lack of compression confirmed that the structure being imaged was neither an artery nor a vein.

The 3 specimens from vasectomy procedures scanned in a water bath had an appearance that was identical to the appearance of the vas in vivo. The total thicknesses of these specimens were 2.2, 2.2, and 2.4 mm. The luminal reflections were more difficult to see in the specimens than in vivo. Nevertheless, the lumens were visible in all 3 specimens and measured 0.2, 0.3, and 0.3 mm (Figure 8).

Discussion

Currently, imaging of the vas deferens is limited to vasography, seminal vesiculography, transrectal sonography, and transrectal MRI. Vasography is the reference standard for imaging the vas deferens. It confirms vasal patency and can localize obstructions when present. Vasography requires intubation of the vas deferens lumen either via direct cannulation after vas deferens incision or by needle insertion into the vasal lumen. In either case, vasography is an invasive procedure that requires isolation of the vas deferens in the operating room under anesthesia. It can potentially cause scarring and obstruction of the vas³ as well as bleeding, infection, and sperm granulomas.⁴ Seminal vesiculography is also an invasive procedure typically performed with transrectal

Figure 2. Sonogram from a 35-year-old man showing a convoluted, tortuous appearance of the vas (arrows) close to its junction with the tail of the epididymis (E). The image depth is 2 cm.



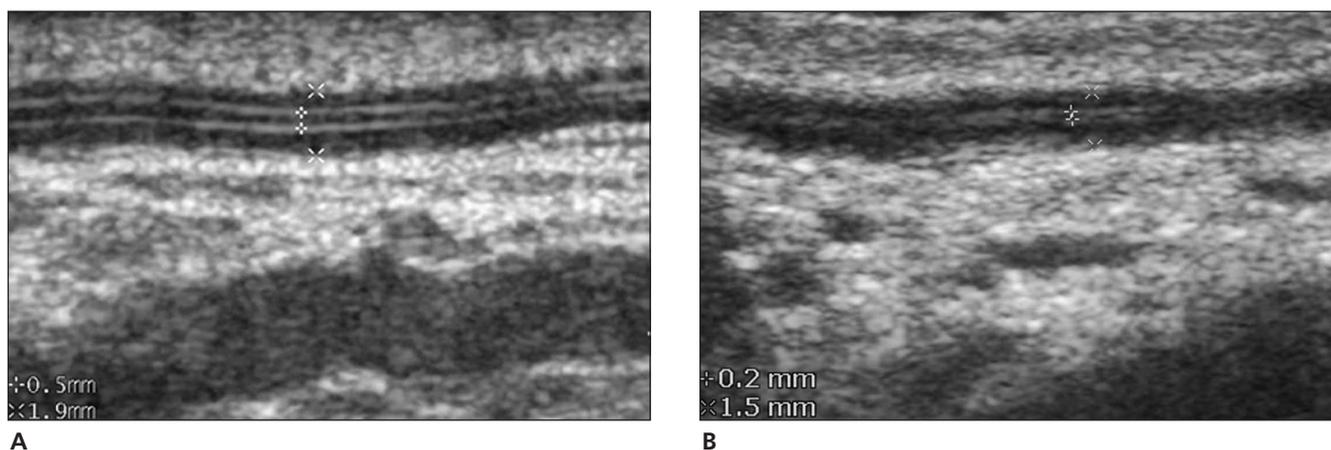
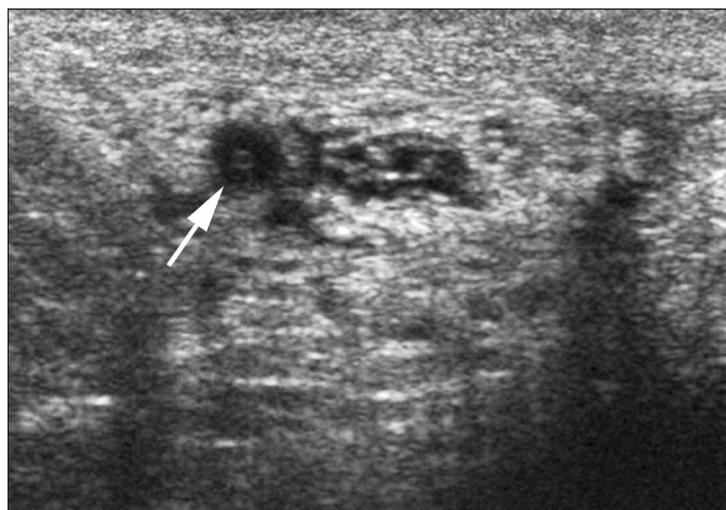


Figure 3. Longitudinal views of the suprascrotal vas in 2 different volunteers. Cursors show the technique of measuring the outer thickness and the inner lumen of the vas. The image depth is 1.2 cm in both images. **A**, Sonogram from a 31-year-old man showing visualization of the vas and its lumen. The total thickness measures 1.9 mm, and the lumen measures 0.5 mm. **B**, Sonogram from a 33-year-old man showing segmental visualization of the vas and its lumen. The total thickness measures 1.5 mm, and the lumen measures 0.2 mm.

sonographic guidance. It is used primarily to evaluate the seminal vesicles and ejaculatory duct. However, retrograde flow into the vas is usually present and can provide useful information about the vas. Potential complications from this procedure include damage to the vasal or epididymal epithelium from the contrast agent itself and epididymal rupture if the injection pressure is too high.⁵ Transrectal sonography and MRI are both uncomfortable procedures that only visualize the seminal vesicles, ejaculatory ducts, and vasal ampulla.⁶⁻⁹

Given its ability to obtain high-resolution images of superficial structures elsewhere in the body, it seems appropriate to consider sonography as a means of studying the extrapelvic portion of the vas deferens. A previous retrospective study indicates that sonography can, in fact, reliably identify the vas deferens.² At the very least, simple identification of the vas can be important. Congenital absence of the vas is a rare cause of infertility, but it is present in 12% of infertile men with azoospermia.¹⁰ This is currently diagnosed on physical examination by the inability to palpate the vas in the spermatic cord. An experienced urologist, (ie, one who sees a high volume of infertile men) can make this diagnosis with high reliability. Nevertheless, a diagnosis based on a negative finding (ie, the inability to detect a structure) is not as convincing as one based on a positive finding. In addition, bilateral absence is more problematic because a contralateral normal vas is not available as a control. Diagnosis by palpation can also be problematic in obese patients and patients with a high-riding scrotum. Consequently, even experienced urologists typically will ask patients with an initial diagnosis of agenesis of the vas to return on a separate occasion for another physical examination and confirmation. In a study with surgical proof, the absence of a vas on the physical examination was a reliable finding.¹¹ However, of 47 proven cases of absent vasa, 5 were misclassified clinically as having palpable vasa, for an error rate of 10.6%.¹¹

Figure 4. Transverse view from a 37-year-old man showing a classic target or doughnut appearance of the right vas (arrow) with the lumen appearing as central paired reflectors. The image depth is 2 cm.



Provided sonography is capable of reliably detecting the normal vas, it could potentially be used to either confirm the clinical suspicion of an absent vas or establish the diagnosis initially. The results of our study indicate that in healthy men, it is possible to identify the vas deferens 100% of the time with sonography. In fact, all 3 segments of the vas could be seen in every case. Therefore, sonography should be a valid method of diagnosing congenital absence of the vas deferens. However, familiarity of the normal appearance of the vas is important to aid in its identification.

As shown in Figure 2, the tail of the epididymis and the vas deferens form a loop in the inferior aspect of the scrotum. At this level, the vas is very tortuous. The resulting sonographic appearance is of a series of contiguous circular and curvilinear structures. The morphologic features of this segment of the vas can simulate veins, but the lack of blood flow and lack of compressibility are distinguishing factors. In addition, with careful scanning, this segment can usually be traced into the more characteristic suprascrotal segment.

Like the epididymis, the intrascrotal portion of the vas can be found in a variety of locations with respect to the testis. This variability has been well documented by Puttemans et al.² We found that the best technique for finding this segment was to apply gentle pressure with the transducer, which usually pushed the testis posteriorly and rotated the vas and the epididymis into the anterior and lateral aspect of the scrotum.

The suprascrotal portion of the vas had a reproducible appearance that was similar to that of the specimens scanned in a water bath. On longitudinal views, the central lumen could be seen as a pair of closely spaced parallel linear reflections in all but 1 obese volunteer. This was distinctly different from any other structure in the spermatic cord. We found, however, that the luminal reflections were generally seen segmentally and not throughout the entire suprascrotal segment of the vas. In some cases, the luminal reflections were more difficult to identify than others. This is not unexpected because the diameter of the lumen was less than 0.3 mm in some cases.

In the cross-sectional view, the vas also had a distinct signature that was very recognizable.

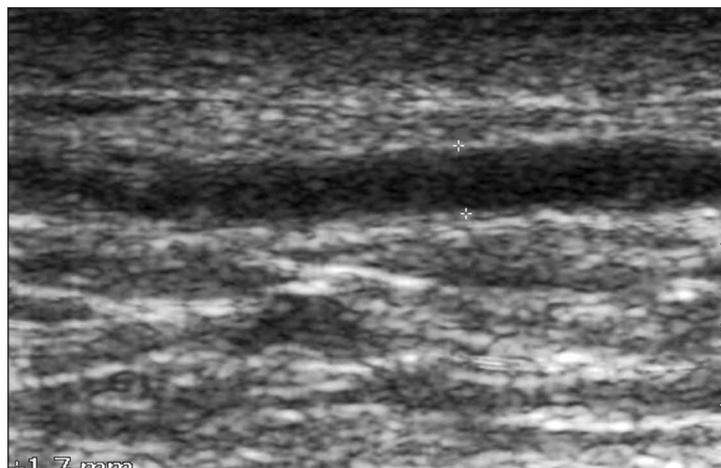
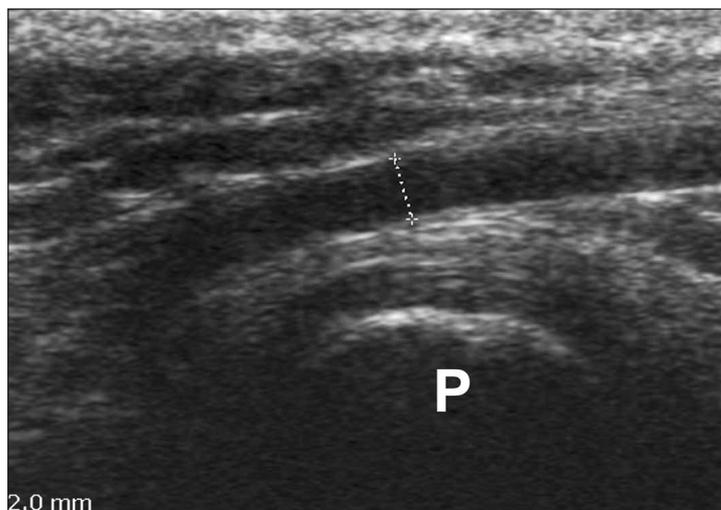


Figure 5. Longitudinal view from a 30-year-old man showing the suprascrotal portion of the vas (cursors) in an obese volunteer in whom the lumen was not visible. The image depth is 1.2 cm.

The lumen appeared as tiny paired reflections located in the center of the vas. As with the longitudinal view, the appearance mirrored the appearance seen in the specimen scans. However, the lumen was actually easier to see in vivo than in vitro. This is presumably because any fluid distending the lumen in a live volunteer would leak out of the cut ends of the vas in a specimen.

The characteristic sonographic appearance and dimensions of the vas also corresponded well with the known histologic features of the

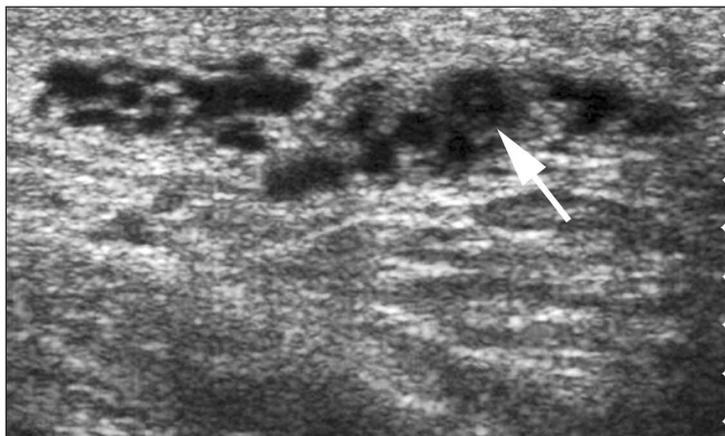
Figure 6. Longitudinal view from a 31-year-old man showing the prepubic portion of the vas (cursors). As was true in most cases, at this level the lumen was not visible in this volunteer. P indicates pubis. The image depth is 1.6 cm.



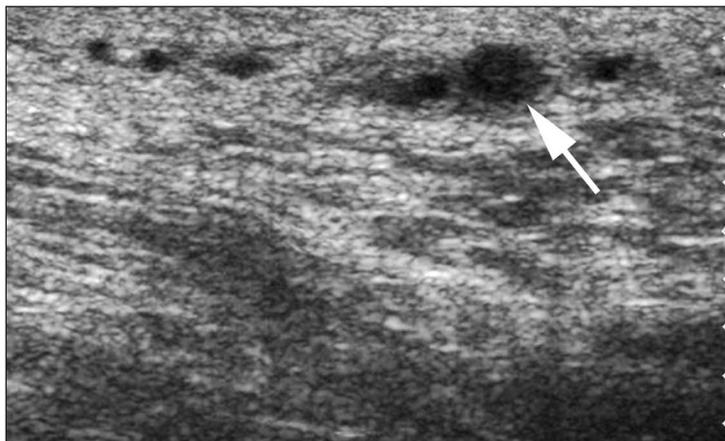
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Figure 7. Transverse views of the suprascrotal portion of the left vas from a 37-year-old man without and with compression and with color Doppler scanning. The image depth is 2 cm in all images. **A**, Gray scale sonogram without compression showing the vas (arrow) adjacent to multiple small vessels in the spermatic cord. **B**, Gray scale sonogram with compression showing collapse of many of the vessels but no compressibility of the vas (arrow). **C**, Color Doppler sonogram with compression showing no detectable flow in the vas (arrows) and flow in several adjacent arteries.

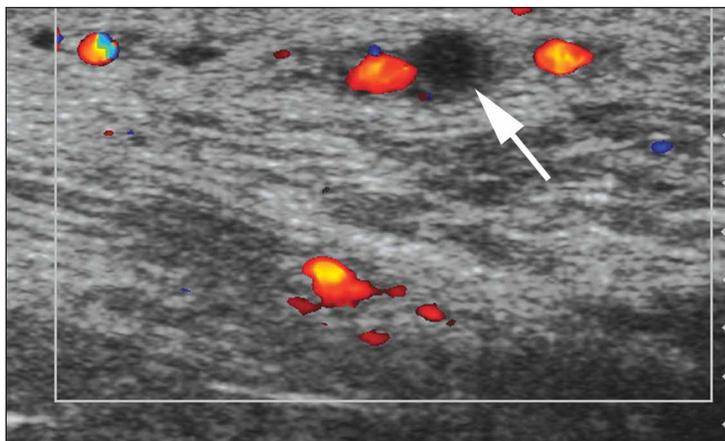
A



B



C



vas. In our group of volunteers, the total thickness of the vas ranged from 1.5 to 2.7 mm. Schlegel et al¹² reported that the thickness ranged from 2 to 3 mm. Cross-sectional histologic specimens show that the thickness of the vas is primarily due to the muscularis. In fact, the vas deferens has a higher ratio of muscle to lumen than any other hollow viscus in the body.¹² The muscularis is composed of a thick circular layer between thinner inner and outer longitudinal layers. This predominant muscular component explains the hypoechoic to anechoic appearance of the vas. The mucosa is composed of pseudostratified columnar epithelium. In the collapsed state, it forms low longitudinal folds that are well appreciated histologically.¹² With distention of the lumen, the folds would be expected to flatten and act as stronger specular reflectors. This explains why the luminal reflections are seen reproducibly in vivo.

The prepubic segment of the vas was also visible in all 50 cases and could be readily identified by simply tracing the suprascrotal segment superiorly. Unlike the suprascrotal segment, the luminal reflections were seen only occasionally. This is most likely due to the deeper location and poorer resolution of the vas at this level.

In addition to congenital absence of the vas, obstruction of the vas deferens is another potential cause of infertility.^{7,13} Central ejaculatory duct obstruction and obstruction of the distal vas may cause distension of the lumen of the extrapelvic portion of the vas, and this could potentially be detected with sonography.^{14,15} In our healthy volunteers, the range of luminal diameters was from 0.2 to 0.7 mm. This range of diameters was slightly larger than the range of 0.3 to 0.5 mm mentioned by Schlegel et al.¹² These values should prove useful in future studies of men with obstruction.

The major limitation of our study was the small number of participants. Data obtained from more volunteers could potentially expand the normal range for vas thickness and luminal diameter. Another limitation was the use of a 1.5D linear array transducer. This type of probe has the capacity for variable focusing in the elevation plane and allows for thinner slice thicknesses. Therefore, visualization of the lumen may be

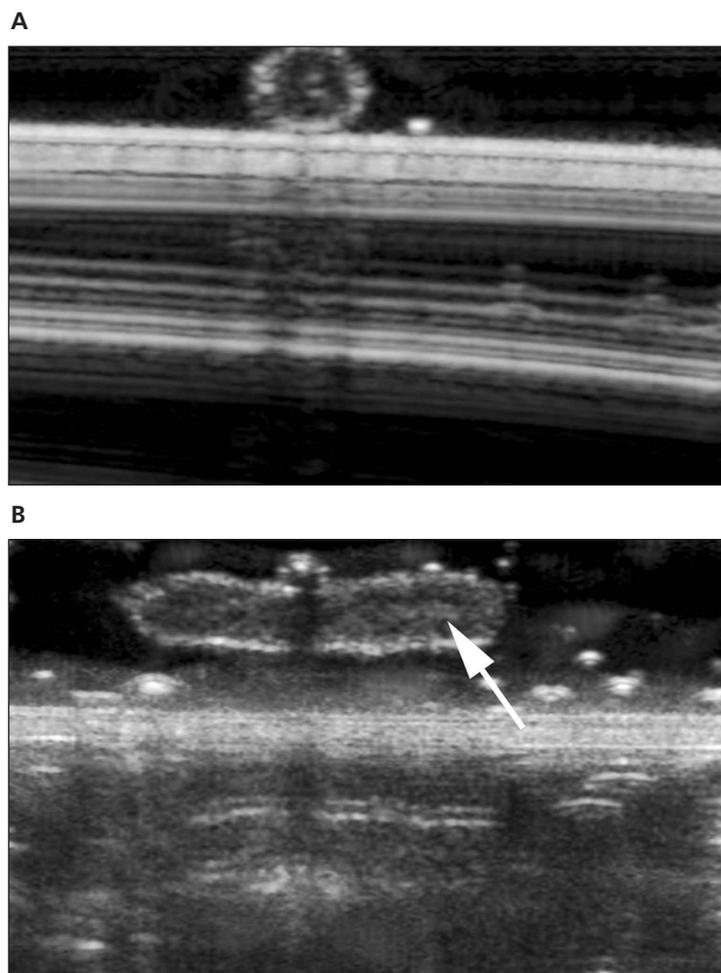
more difficult with conventional probes. Finally, no attempt was made to control the duration of abstinence before the examination. We did, however, gather these data from our volunteers, and within a range of 1 to 7 days, no correlation was found between the diameter of the vasal lumen and the duration of abstinence. Perhaps longer periods of abstinence would show changes that were not discovered in this study, a subject that requires further investigation.

A previous retrospective study by Puttemans et al² analyzed the epididymis and vas deferens in a large series of patients with infertility and a control group of patients who were referred for scrotal sonography for reasons other than infertility. In the group with infertility, they assumed that the vas was normal and found that the total thickness varied from 1.4 to 3.4 mm (mean, 1.9 mm). In the control group of patients referred for reasons other than infertility, the vas thickness ranged from 1.5 to 2.6 mm (mean, 1.9 mm). Our results in healthy volunteers with no fertility problems were similar, with a thickness range of 1.5 to 2.7 mm (mean, 1.89 mm).

In our prospective study, the lumen of the vas was visible bilaterally at least segmentally in the suprascrotal region in all volunteers except for the one with the highest BMI. In the previous study, the lumen was visible in 10% of the group with infertility and in 12% of the control group.² There are several potential reasons for this difference. First, it is not clear from the study methods that a concerted effort was made to identify the lumen in the prior retrospective study. Second, as mentioned earlier, the transducer that we used was a 1.5D linear array. It contains both rows and columns of transducer elements, thus allowing for electronic focusing in the elevation plane. This allows for a thinner slice thickness and potentially better resolution, particularly in sagittal views of the vas. Third, the study population that we evaluated was composed of volunteers who had no genitourinary symptoms and no fertility problems, as opposed to the prior study, which included only patients with either infertility or some other genitourinary condition requiring a scrotal sonogram. Finally, body habitus was not documented in the prior study, and as we found, the lumen of the vas may not be visible in obese individuals.

In summary, the extrapelvic portion of the vas deferens is reliably visualized sonographically. Its appearance is characteristic and reproducible. With a combination of compression and color Doppler imaging, it can be separated from the other structures in the spermatic cord and scrotum. Although the lumen is extremely small, it is visible and can be measured in almost all cases. We believe that identification and evaluation of the vas deferens will become a valuable addition to the routine sonographic protocol for patients with infertility.

Figure 8. Scans of resected segments of the vas in a water bath. The image depth is 1.2 cm in both images. **A**, Transverse view from a 38-year-old man showing a typical target appearance of the vas. **B**, Longitudinal view from a 39-year-old man showing a short segment of the vas. The decompressed lumen (arrow) can be partially seen with some difficulty.



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