

# Benefits of Volume Ultrasound imaging in the scrotum: A pictorial review

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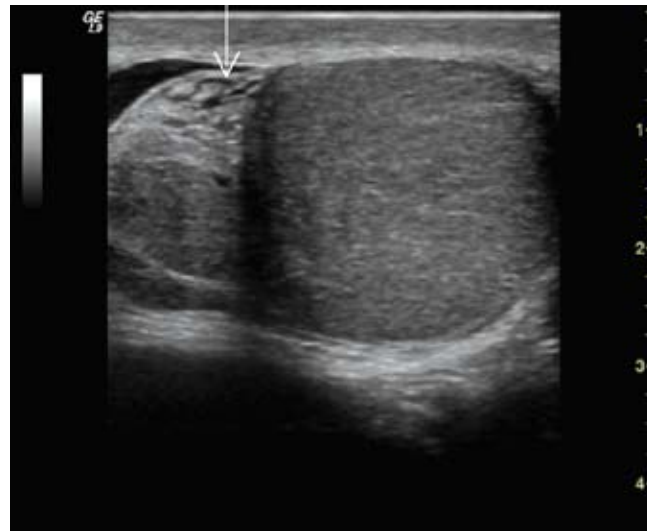
## Introduction

Two-dimensional (2D) ultrasound imaging has long been the imaging method of choice for evaluation of the scrotum. It has advantages of being readily available for emergency exams, comparatively inexpensive and does not involve ionizing radiation. Technological advancements including CrossXBeam™ imaging, SRI (speckle reduction imaging) and Coded Harmonics imaging have resulted in exquisitely detailed images of the scrotal contents (Fig 1). Yet compared to other imaging modalities such as MR and CT, ultrasound exams remain time-consuming and operator dependent. A sonographer typically follows a laboratory protocol requiring numerous static images obtained throughout the length and width of each hemiscrotum. Color Doppler images of each testis and epididymis, as well as spectral Doppler waveforms of the intratesticular vessels are obtained. The resulting quality of the study is dependent on the experience, skills and training of the sonographer. In many ultrasound departments, the request for scrotal sonography occurs with much less frequency than other ultrasound exams. This lengthens the learning curve for student and new sonographers. Furthermore, scrotal exams are often ordered through the emergency room and may be performed after regular hours, when less-skilled or more recently trained staff is on-duty (and experienced staff unavailable for consultation). This can result in equivocal exams, non-diagnostic exams or force the recall of patients for additional images, delaying necessary intervention. New tools available for Volume Ultrasound imaging can reduce operator dependence, add anatomic information and increase diagnostic confidence through visualization of the anatomy in imaging planes not available with standard 2D imaging.

This pictorial review will illustrate the benefits of volume datasets in scrotal ultrasound. The images presented were obtained with either a volumetric transducer (4D16L or 4D10L), or a Matrix Array transducer (M12) on the LOGIQ®9 ultrasound system (GE Healthcare, Wauwatosa, WI).

**Figure 1**

Cross sectional ultrasound image of the testis and epididymal head in a patient with torsion of the spermatic cord demonstrates the fine anatomical detail obtainable with the bundling of advanced imaging features. A high frequency matrix array transducer (M12) that produces a very thin slice improves visualization of such small anatomical features as the edematous tubules in the epididymis (arrow). The clarity of the hydrocele is a result of improved contrast resolution associated with Coded Harmonics imaging. By combining multiple images fired at different angles into a single displayed image, CrossXBeam enhanced the boundary definition between the epididymis, testis and surrounding tissue. Finally, the abnormal texture within the epididymis is easily recognized because the inherent overlying speckle artifact has been removed with SRI.



## Volume Ultrasound

Volume ultrasound is a method of acquiring an anatomical volume dataset either through an automated 3D sweep using a volumetric transducer or through a freehand sweep with a conventional 2D transducer. Each volume dataset can be manipulated to display many individual B-mode images in an infinite number of imaging planes. The volume image visualization is user selectable between Sectional, Render, VCI (Volume Contrast Imaging), and TUI.

Tomographic Ultrasound Imaging (TUI) is a volume imaging tool that allows rapid and automated display of the volume into parallel slices in any plane. The number of slices and distance between slices can be easily adjusted. In scrotal ultrasound, a volume dataset is acquired with an automated sweep through the testis with the volumetric transducer. The sweep is obtained within a few seconds and a series of equidistant parallel slices are displayed on the monitor similar to computed tomography (CT) or magnetic resonance (MR). The "A" plane is displayed by default and represents the plane in which the volume was acquired. A reference image is shown in the upper left corner of the display. To display images of the testis in the B and C planes, the user chooses the view from a touch panel.

When a particular area of interest is detected, an axis point can be set on that anatomy, and with the 3D Visualization changed to Sectional, three orthogonal views will be displayed. The volume dataset can be reconstructed at any time to show an infinite number of planes to better display anatomical relationships.

Rendering can be applied to the volume to produce images of startling realistic quality. These images are particularly helpful when discussing the anatomy or pathology with the patient and referring physician.

## TUI and Sectional Planes

**Figure 2**

Five sets of images (A,B,C,D,E) obtained from a single transverse sweep through the left testis with the 4D16L probe. TUI was used to display equidistant slices through the left testicle in three orthogonal planes (transverse-A, Sagittal-B, Coronal-C). Orientation markers are displayed on images A,B and C (A- Anterior, Ca-Caudal, Cr- Cranial, R- Right). A small intratesticular cyst is apparent on the medial aspect of the upper pole of the testis.

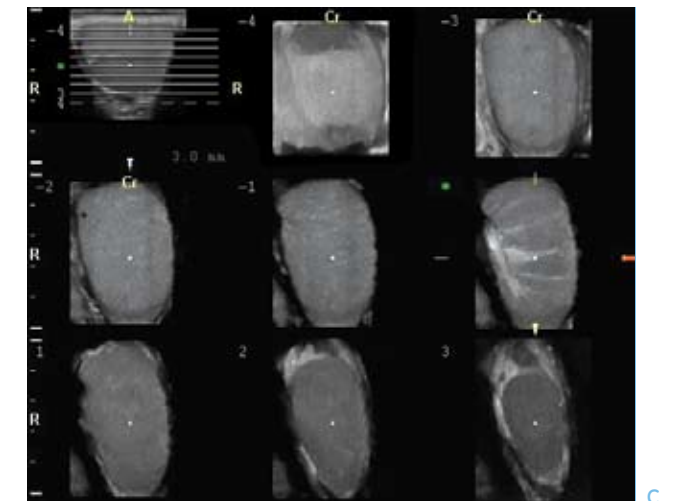
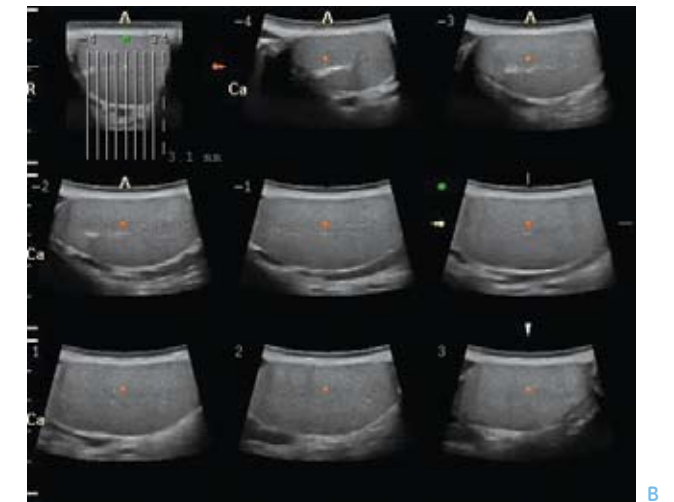
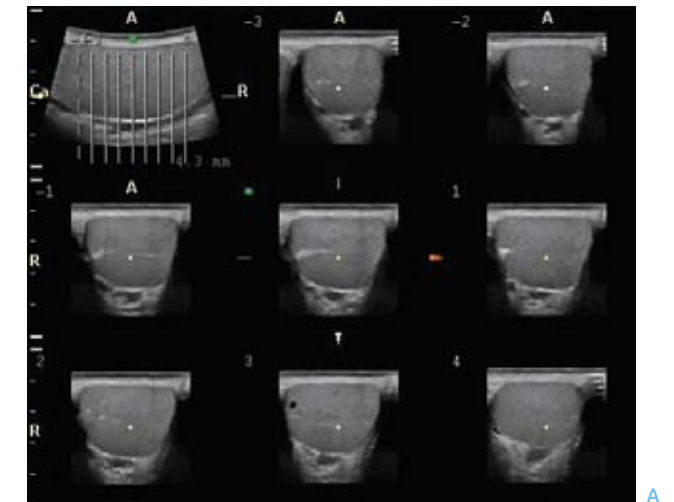
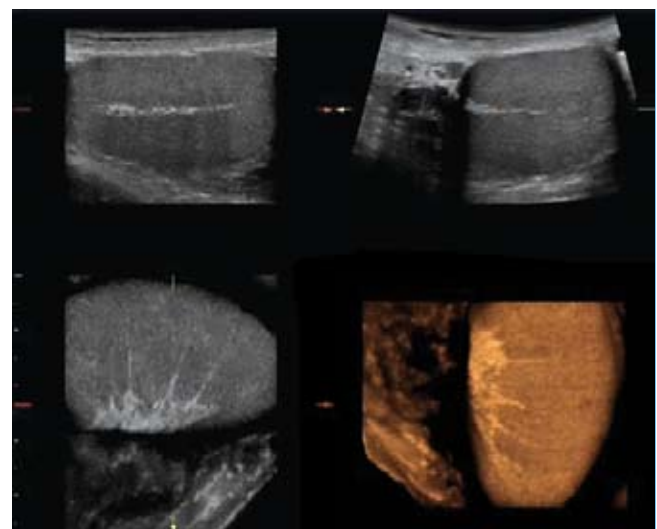
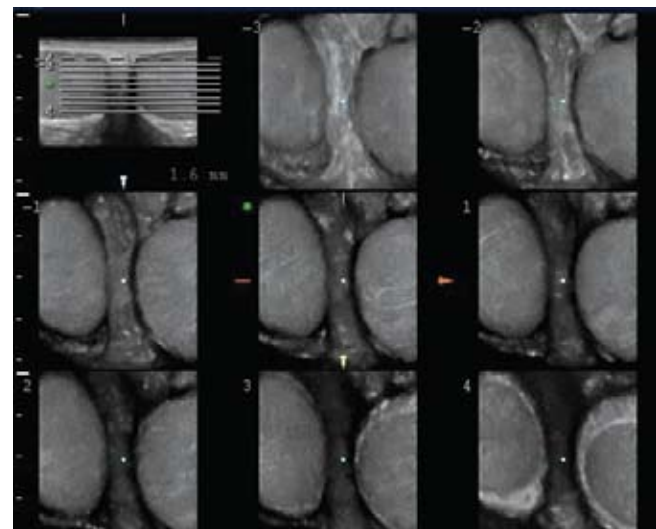
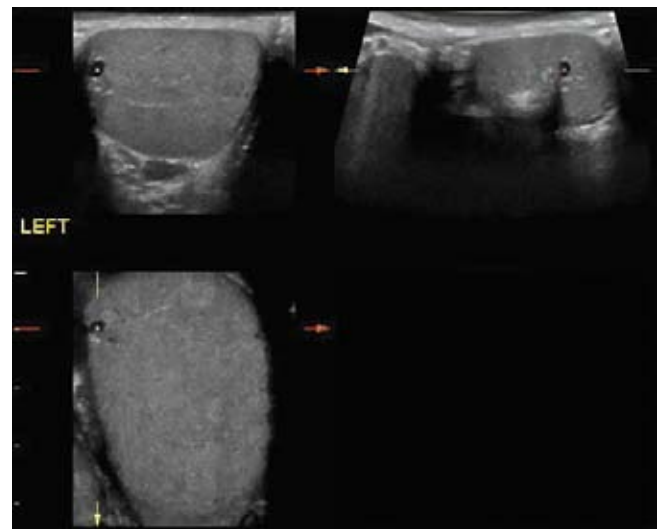


Figure 2 Continued

The 3D Visualization was changed to display sectional planes and the axis point was placed on the cyst to localize it in transverse, sagittal and coronal planes (D). The axis point was placed on the mediastinum testis and the Visualization changed to Render. The mediastinum is seen as a hyperechoic band in each view (Sagittal-upper left, Transverse-upper right, Coronal-lower left, Rendered coronal view-lower right). The coronal plane shows the septae extending from the tunica albuginea toward the mediastinum. These septae divide the testis into lobules(E). The transducer was repositioned over the midline of the scrotum and a new sweep obtained in the transverse orientation from superior to inferior (F). The TUI display was set to the C (coronal) plane and a series of images was displayed from anterior to posterior through both testes. This view is helpful to compare size and echogenicity of the right and left testes.

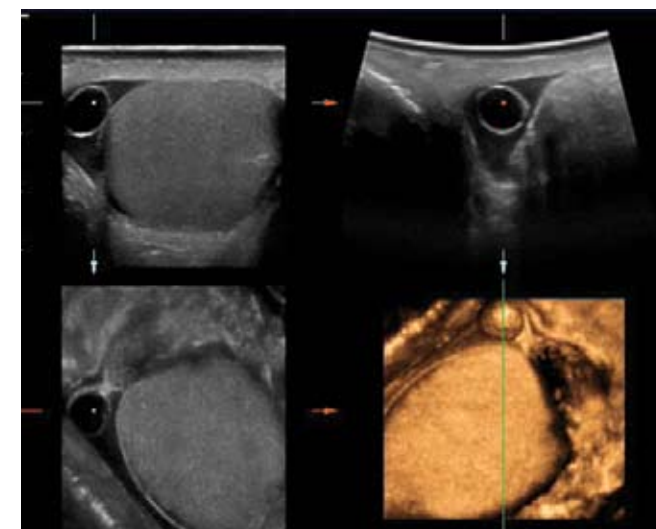
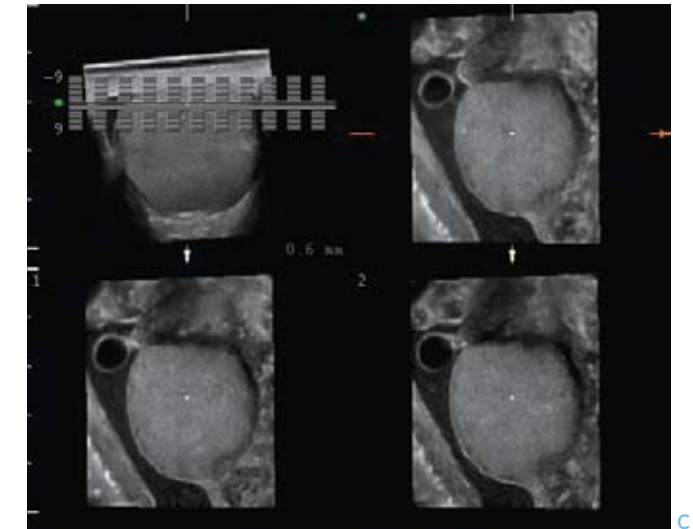
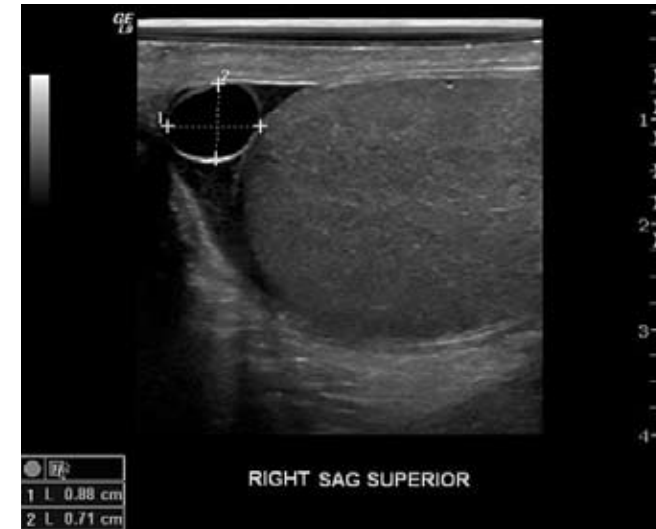


## The Value of Volume Ultrasound: Improved Diagnostic Confidence in Abnormal Anatomy

### Cystic Appendix Epididymis

Figure 3

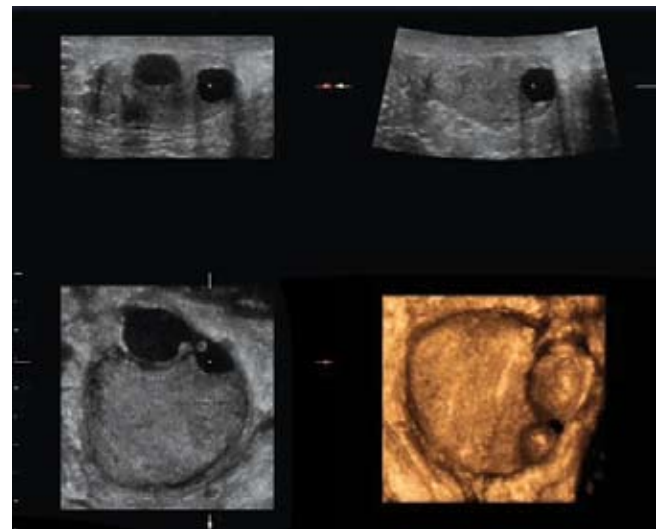
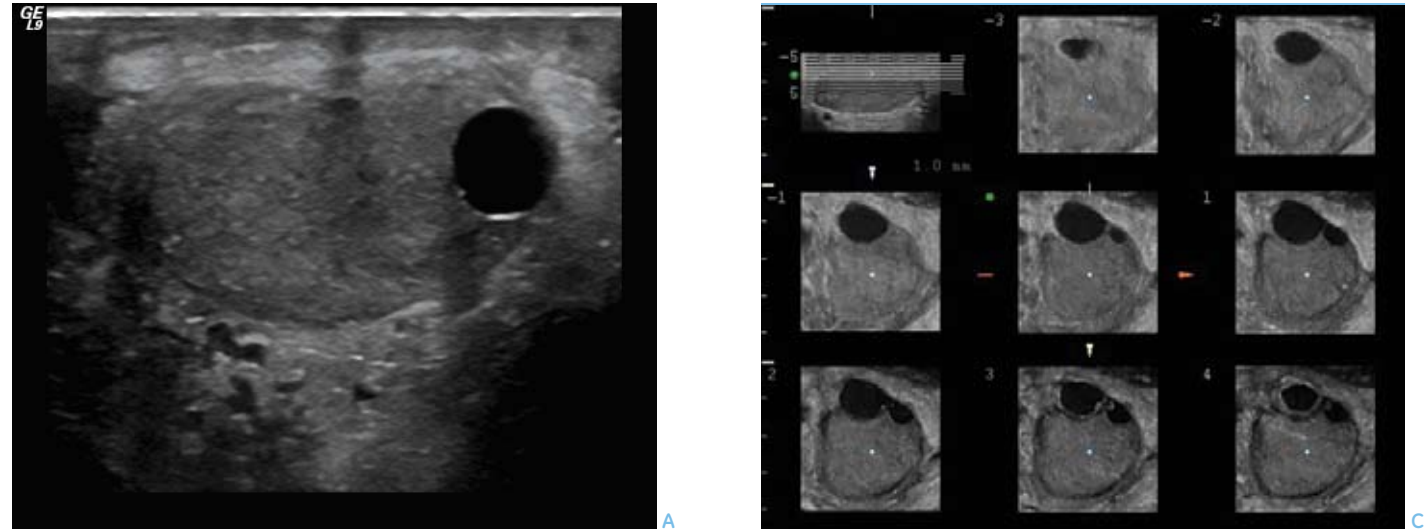
Cystic appendix epididymis in a 53 year old male with diabetes and left scrotal pain. Conventional 2D imaging(A) demonstrated a cystic mass slightly superior and lateral to the right testis. The left testis was unremarkable. The etiology of the cyst was not determined. The patient was rescanned with the 4D16L transducer and a 3D volume was obtained. Sectional planes with a surface rendering (B -lower right image) demonstrated smooth walls and confirmed the extratesticular location of the cyst near the epididymal head. The coronal -plane image (B- lower left image) demonstrated a stalk connecting the cyst to the epididymal head. The 3D Visualization was then changed to TUI of the coronal plane (C). The distance between the slices was set to 0.6mm with the number of slices at 19 with a 2x2 display to enlarge the image. This allowed for translation through the epididymal head at very fine intervals. This improved diagnostic confidence of a pedunculated cystic appendix epididymis.



## Tunica Albuginea Cyst

Figure 4

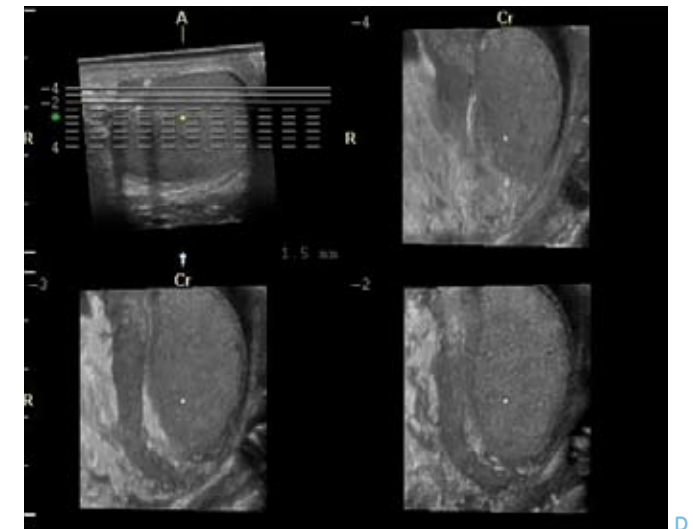
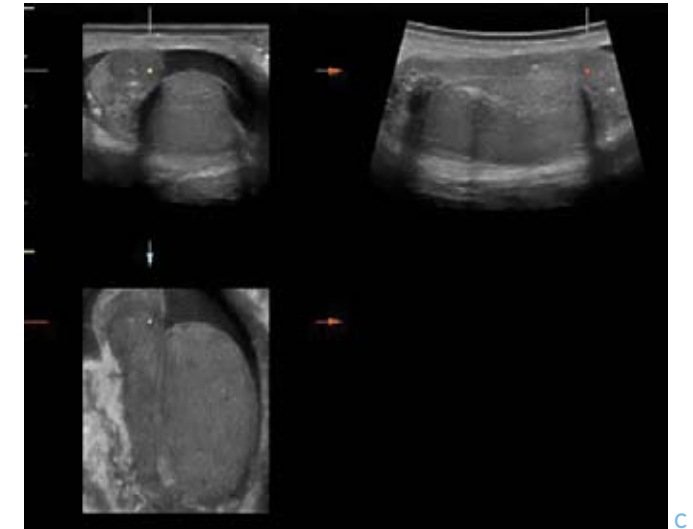
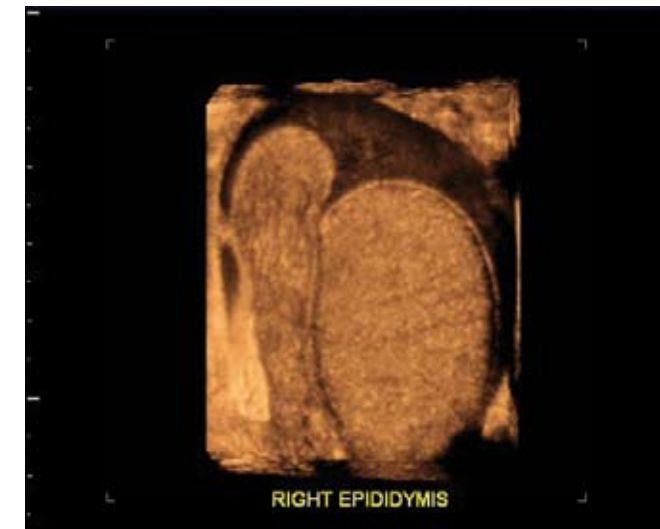
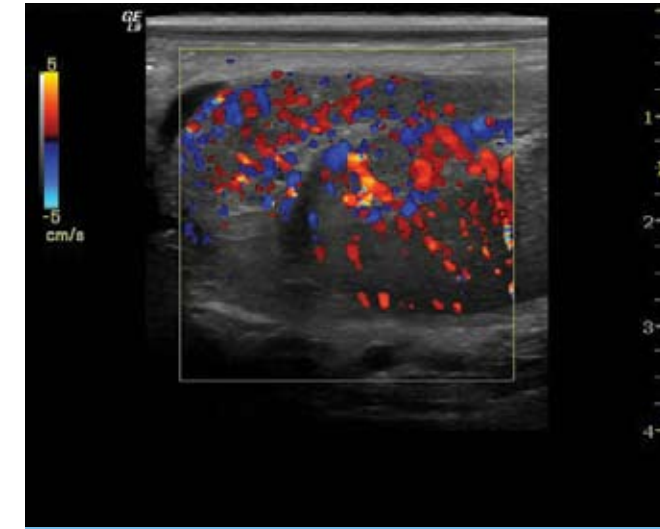
Tunica albuginea cysts in a 58 year old male with left scrotal pain. This transverse 2D image of the upper pole of the left testis (A) shows a smooth-walled, simple cyst adjacent to or within the anterior superior portion. A second cyst was also identified, but neither could be clearly confirmed as intra or extratesticular in location. A volume data set was obtained with the 4D16L probe and displayed in sectional planes with rendering of the cysts (B). The coronal plane (B-lower left) showed increased thickness of the wall surrounding the cysts. Deformation of the superior portion of the testis indicated mass effect upon the testis by the cysts. These findings helped to identify the structures as tunica albuginea cysts. The rendered view (B-lower right) confirms the smooth walls of the cysts and provides a more easily understood image of their extratesticular position. The 3D Visualization was changed to TUI with a slice distance of 1 mm (C). This image shows 8 parallel slices through the cysts and clearly demonstrates the thick wall separating the cysts from the testis.



## Epididymo-orchitis

Figure 5

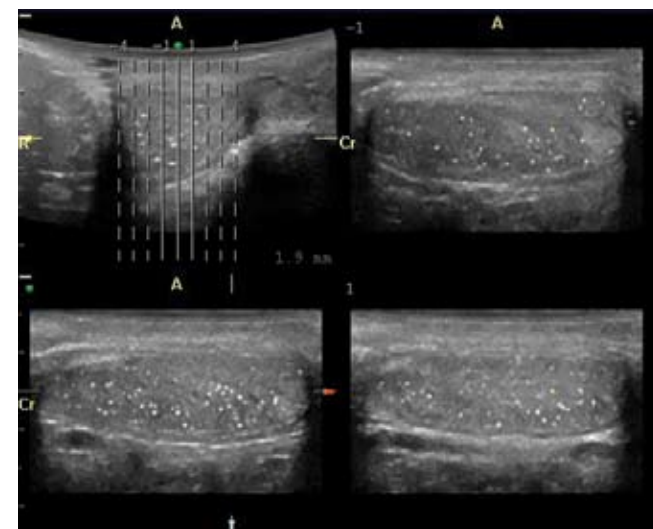
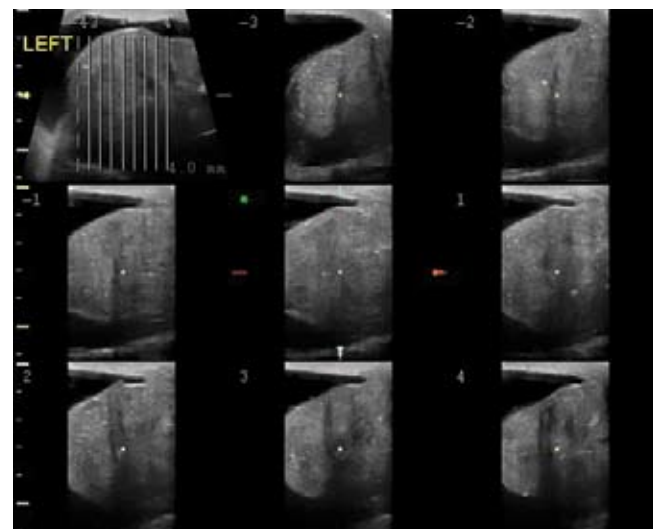
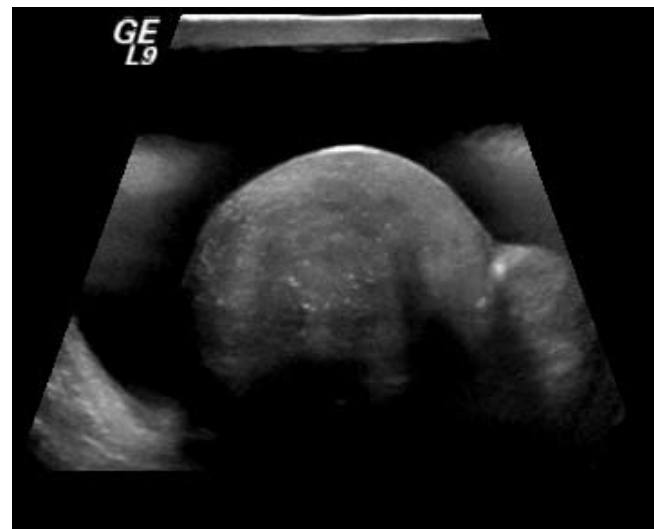
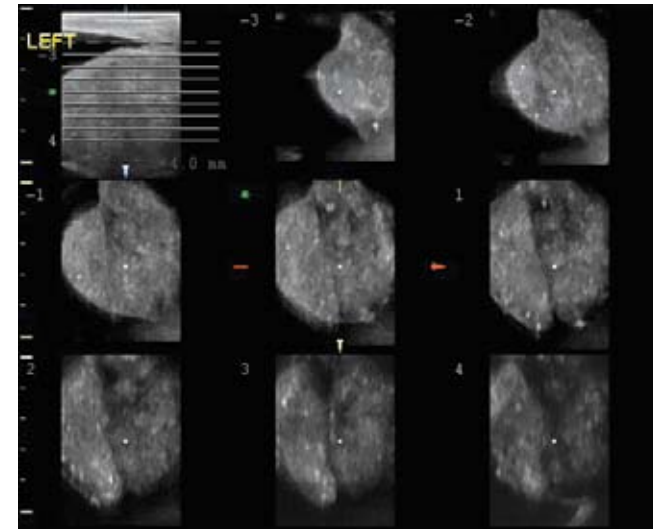
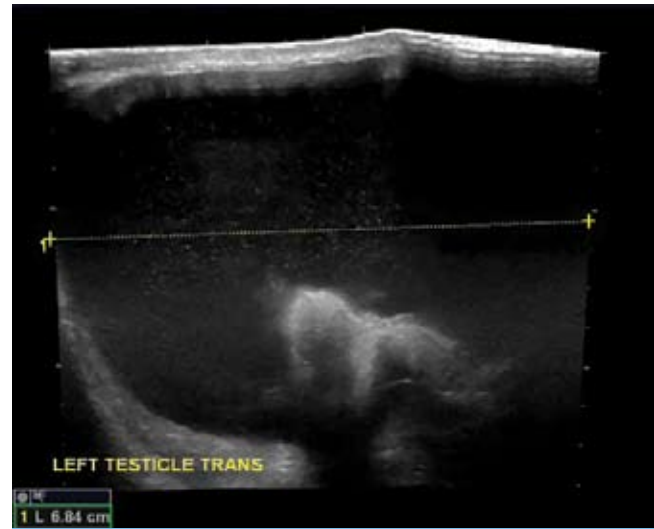
Right epididymitis in a 25 year old male with right testicular pain. Color Doppler imaging demonstrated hyperemic flow within the epididymis and testis consistent with epididymo-orchitis (A). Standard 2D imaging was not performed. Volume Ultrasound was performed with the 4D16L transducer. Sectional planes on the right show enlargement of the right epididymis throughout its length (B). The rendered image clearly demonstrates the enlarged epididymis, testis and surrounding hydrocele (C). The dataset was then manipulated to better demonstrate the tail of the epididymis and Visualization was changed to TUI in the coronal plane (slightly off axis of the coronal plane). Multiple slices through the inferior aspect of the hemiscrotum show the enlarged epididymal tail (globus minor). (D) The globus minor is often difficult to identify sonographically, however the volume dataset can be manipulated by adjusting the X, Y and Z planes to lay out the epididymis as it curves around the inferior aspect of the testis and then slice through the volume until the desired image is obtained.



## Tumor

**Figure 6**

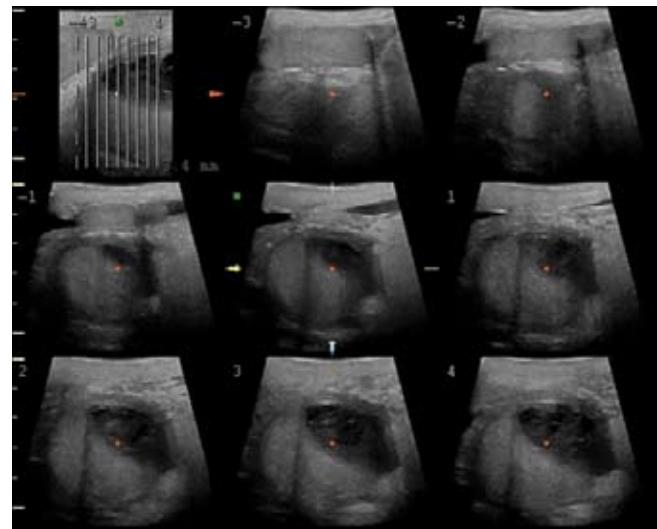
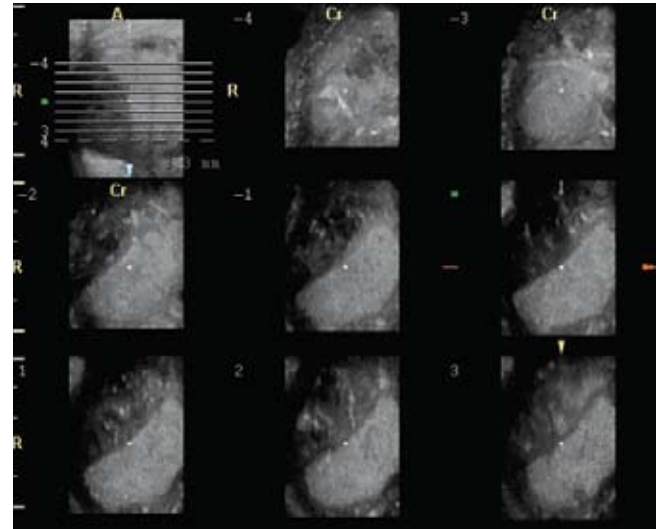
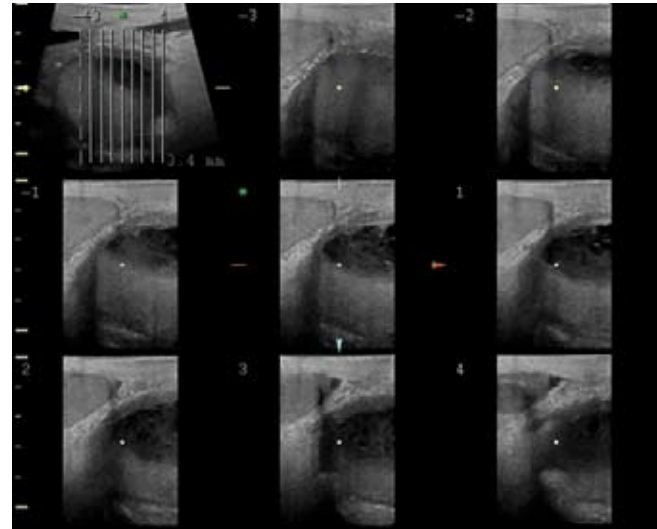
28 year old male with left testicular pain and swelling for several months. Conventional 2D ultrasound exam was performed after regular office hours during a holiday call-back. The exam was difficult to perform due to massive swelling of the left hemiscrotum. The right testicle was not identified. A large hydrocele was seen on the left (A). The left testicle was not well visualized, but appeared to be enlarged and heterogeneous (B). A preliminary diagnosis of suspected left epididymo-orchitis was given. The patient was recalled for further evaluation and Volume Ultrasound imaging was performed with the 4D10L transducer. TUI display was used to carefully evaluate the left testis in all 3 planes- transverse (C), sagittal (D), and coronal (E). Microcalcifications and a heterogeneous appearance highly suspicious for testicular malignancy were detected. The right testis was identified (F) and also evaluated with TUI in all three imaging planes. The right testis was significantly smaller in size, however microlithiasis was present. Additionally, a mildly heterogeneous echo texture was detected and involvement with malignancy could not be excluded. The patient underwent surgery and pathology revealed mixed germ cell tumor with the vast majority of the tumor being embryonal carcinoma with a small focus of seminomas.



## Abscess

Figure 7

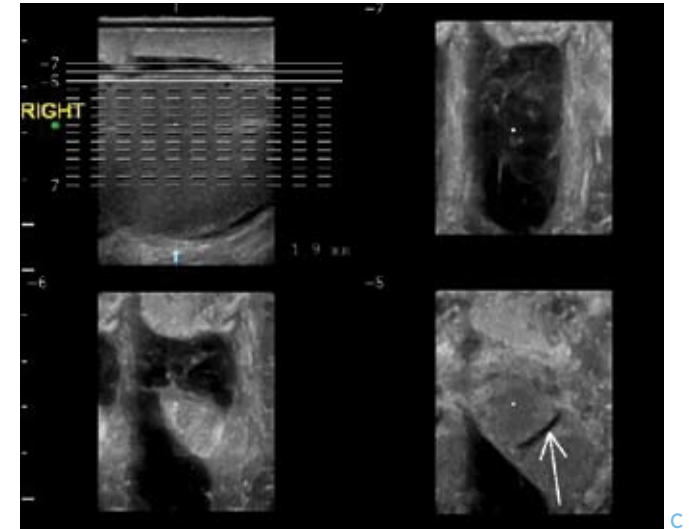
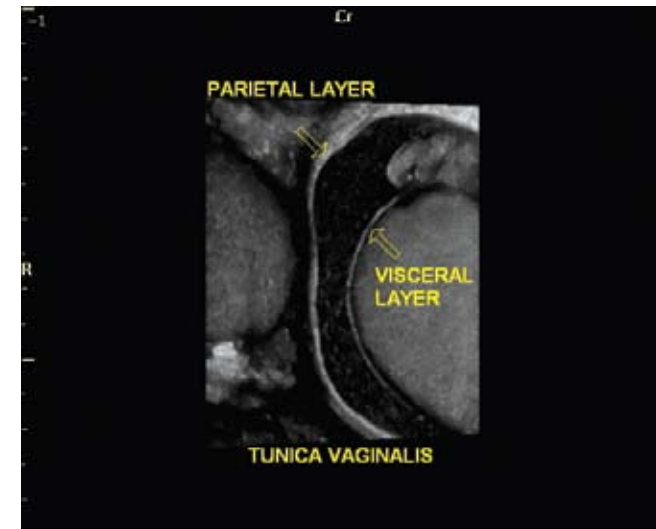
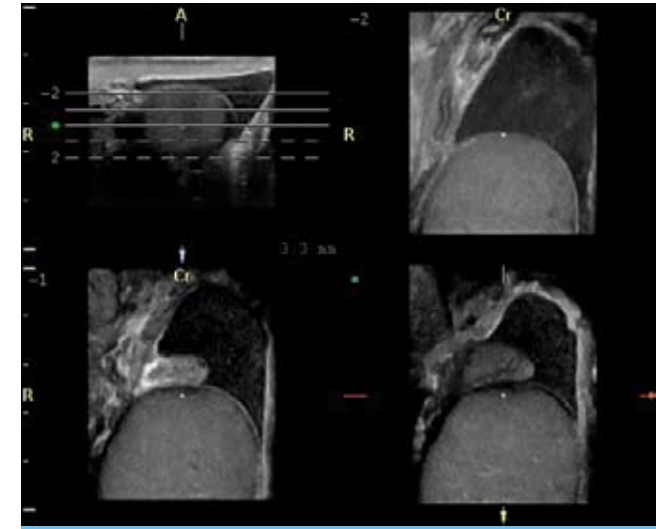
62 year old male with testicular pain and a previous history of a wound to the testis. Volume Ultrasound imaging was performed with the 4D10L transducer with Visualization in TUI. The transverse (A) and sagittal (B) images demonstrated a normal appearing right testis (partially shown) and a complex fluid collection medial and anterior to the left testis. The C plane images (C) clearly depicted mass effect of the fluid collection upon the anterior surface of the left testis. The diagnosis of abscess formation was given and confirmed at surgery.



## Hydrocele

Figure 8

Volume Ultrasound imaging in the C plane in three patients with hydrocele. The coronal plane is not routinely imaged with conventional 2D ultrasound due to anatomic restrictions. However, this plane is readily reconstructed with Volume 3D imaging and provides additional diagnostic information. Image A demonstrates the relationship of the epididymal head to the superior portion of the testis when surrounded by the fluid hydrocele. In Image B, the layers of the tunica vaginalis are clearly visualized when separated by the hydrocele and demonstrated in the coronal plane. A complex hydrocele in a patient with orchitis is shown in Image C. Three slices are depicted at 1.9 mm increments anterior to the testis. Multiple septations are visible in the top slices (top right, bottom left). A dilated capsular artery (arrow) due to hyperemic testicular flow is seen just posterior to the complex hydrocele (lower right).



## Conclusion

Volume Ultrasound imaging of the scrotum proves itself an excellent diagnostic tool. The reconstructed coronal plane adds an important new view of anatomic relationships. Tomographic Ultrasound Imaging increases diagnostic confidence by ensuring complete imaging throughout the entire testis/epididymis. Sectional plane imaging is a valuable visualization tool to image an abnormal area in three orthogonal planes. The images obtained in the Render view approximate anatomical drawings and are very helpful when discussing the pathology with the patient and referring physician.

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