Imaging and angiography in male factor infertility

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Ultrasound imaging and angiography play a crucial role in the diagnosis and treatment of men with subfertility. The most commonly used imaging modality is ultrasound (US), which can be used for diagnostic purposes or to aid in treatment. Scrotal US can be used to document varicoceles in subfertile men in the context of difficult examination or for confirmation before treatment. Spectral Doppler, sonoelastography, and power Doppler have aided in the evaluation and treatment of azoospermia and oligospermia. They have proven useful in the detection of spermatogenesis and sperm retrieval. In the population with congenital Wolffian duct abnormalities, renal US can evaluate renal anomalies. In subfertile men with low ejaculate volume and oligospermia or azoospermia transrectal US can be used to evaluate and assist in treatment of ejaculatory duct obstruction. Non-US–based modalities are also commonly used in evaluating and treating men with subfertility. Magnetic resonance imaging (MRI) can be used for evaluation of pituitary adenomas in hypogonadism. More invasive imaging modalities used during treatment of subfertile men include vasography for vasal obstruction, venography and angioembolization for varicocele, and US-guided needle placement for testis-sparing surgery. Male subfertility is a complex problem and the use of imaging techniques is often essential in providing accurate diagnosis and appropriate treatment. (Fertil Steril® 2016;105:1432–42. ©2016 by American Society for Reproductive Medicine.)

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Ultrasound (US) was first introduced to the field of Urology by Takashi and Ouchi in 1963 as they attempted to perform a transrectal ultrasound (TRUS) of the prostate (1). It was not until Watanabe et al. (2), however, that a discernable image of the prostate was available and able to be used medically to roughly evaluate symmetry and echogenicity and help detect prostate cancer. In 1976 Perri et al. (3) began using Doppler US, their "Doppler stethoscope," in the scrotum to evaluate testicular blood flow in the acute scrotum. The first case series of ultrasound used in male fertility came in 1977 from Greenberg et al. (4) in their evaluation of men with subfertility and varicocele. They found in this study that men with varicocele, observed using their Doppler stethoscope, either before or after varicocelectomy, had abnormal semen parameters.

Imaging is a useful adjunct to clinical and laboratory examination in the diagnosis and treatment of male factor infertility. One of the most cost effective and minimally invasive imaging techniques used is US. Ultrasound of the scrotum can quantify varicocele size and confirm diagnosis of varicocele, especially when the examination is challenging due to a thickened scrotal wall or contracted scrotum (5). Various US techniques can be used in men with azoospermia to evaluate for obstructive azoospermia versus nonobstructive azoospermia (NOA), to evaluate regions of increased testicular blood flow and potential increased spermatogenesis, and renal abnormalities associated with genetic mutations (6–9). Ultrasound guidance can also be used for intervention, as it may help locate testicular tumors for biopsy or intervention, or seminal vesicle (SV), or utricular cyst aspiration (10, 11). Ultrasound, however, is not the only imaging technique used in male factor infertility. Various other imaging technologies can be used, such as magnetic resonance imaging (MRI), which is more expensive, as well as vasography and venography, with or without embolization, which are more invasive (12, 13). Our intent is to provide an overview of imaging techniques useful in the evaluation and treatment of the subfertile male.

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SCROTAL ULTRASOUND

Anatomy and Embryology

The scrotum is divided into two compartments, each of which contains a testicle, an epididymis, and a spermatic cord. The origin of the testicles begins

in the 3-week-old embryo where the primordial germ cells begin to migrate onto the urogenital ridge. The kidney precursors, gonads, and reproductive tract share a common embryology, also originating from the urogenital ridge. During the eighth week of gestation the Müllerian ducts regress and T from the Leydig cells stimulate mesonephric (Wolffian) development. The mesonephric ducts develop into epididymides, vas deferens, and ejaculatory ducts. The SVs form as an outpunching of these ducts. Vestigial remnants of the mesonephric duct include the appendix epididymis and paradidymis (5).

The spermatic cord contains the ductus deferens, testicular artery, and the pampiniform plexus of testicular veins. The arterial blood supply of the scrotum includes the testicular artery, the cremasteric artery, and the deferential artery. The testicular venous drainage exits the testis as the mediastinum and joins the epididymal veins to form the pampiniform plexus. Cremasteric veins form a separate plexus posteriorly. The right testicular vein drains into the inferior vena cava, whereas the left testicular vein is significantly longer and drains into the left renal vein. These veins typically have valves to promote blood flow in the antegrade fashion. Backflow into dilated veins in the pampiniform plexus can be seen as a varicocele. Also, the increased length and right angle insertion of the left testicular vein is thought to contribute to increased varicocele formation on this side (14–17).

The testis is 3–5 cm long × 2–4 cm wide × 3 cm in the anteroposterior direction. The size correlates strongly with spermatogenesis as 85% of its volume is involved in reproduction. The testis is smooth and homogeneous, which allows sonographers to identify pathology (5, 13, 18, 19).

Ultrasound Technique

Using a consistent protocol for examination will provide similar and consistent results. The patient should be in the supine position with the scrotum supported. The choice of frequency used is a balance of depth of penetration and image resolution. A high frequency (7.5–18 MHz) and linear array transducer is most commonly used. Broad bandwidth transducers allow for multiple focal zones. A lower frequency (3.5–5 MHz) curved array probe is helpful in comparing echogenicity of testes when in a markedly thickened scrotal wall, as occurs in scrotal edema. The highest frequency probe as well as color flow and spectral Doppler should be used for improved resolution and for testicular and paratesticular blood flow detection. The scan should begin with a longitudinal view of the testis and scan from medial to lateral to examine the entire testis and paratesticular structures. The transverse view is obtained by rotating the transducer 90 degrees. The superior portion is surveyed first, followed by the inferior portion. At least one image should be obtained with both testes. The spermatic cord can be found superior and posterolateral to the testis (5, 18, 20).

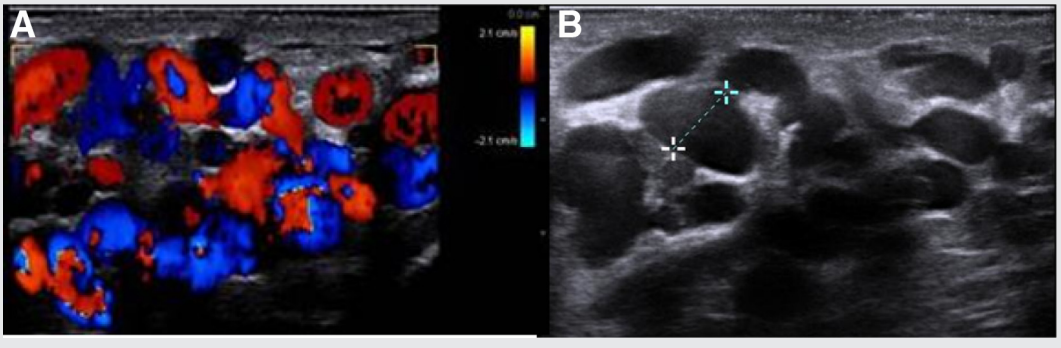
INDICATIONS IN MALE FACTOR INFERTILITY

Varicocele

Varicocele is the dilation of the spermatic vein and pampiniform plexus of veins in the spermatic cord. Left-sided varicocele is more common than the right as it is longer and inserts into the left renal vein; however, they have been shown to be bilateral in up to 80% of cases in some series. They are thought to be the result of incompetent or congenitally absent venous valves allowing for retrograde blood flow (19–24). The US findings include multiple anechoic tubular structures >2 mm superior and posterolateral to the testis. Color flow should be used to demonstrate reversing of flow during valsalva. For best visualization of the spermatic cord US should be completed superior and posterolateral to the testis (19, 25, 26). The American Urological Association (AUA) guidelines state that US should be used in any patient with a difficult or inadequate examination. These situations might include obese patients, a thickened scrotal wall, or a contracted scrotum (27) (Fig. 1).

Varicocele is present in >30% of men with primary subfertility and >80% in secondary subfertility, making it one of the most common causes in both cases (28). Clinically significant varicoceles are associated with impaired sperm count, sperm motility, and abnormal sperm morphology. The exact

FIGURE 1



Bilateral varicocele. (**A**) Doppler color flow study of dilated veins superior to the testis. (**B**) Doppler color flow study showing bilateral varicoceles. Note that the inner diameter of the varicocele is best measured on a *gray* scale (B-mode) image (5).

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