Review Article

Doppler Ultrasonography in Subfertile Male

Md. Mofazzal Sharif [1], Omarandra Saha Sudipta[2], Md. Towhidur Rahman[3],
Mst. Monira Khatun[4], Khaleda Parvin Rekha[5].

Abstract

Imaging modality, especially Doppler Ultrasonography is a widely used and well tolerated modality for evaluation of pathologic conditions of the testes. Recent technical advances of US applications and post processing developments have enabled new aspects in the structural and functional analysis of testicular tissue and therefore male fertility. This review covers the most relevant approaches regarding Doppler ultrasonography of testis due to recent technical advances.

Key words: *Subfertility, Doppler, Ultrasonography.*

Date of received: *16.03.2020.*

KYAMC Journal.2020;11(2): 100-103.

Date of acceptance: *15.05.2020.*

DOI: https://doi.org/10.3329/kyamcj.v11i2.48424.

Introduction

The terms subfertility and infertility are often used interchangeably. Subfertility is a delay in conceiving. Infertility is the inability to conceive naturally after one year of trying. In subfertility, the possibility of conceiving naturally exists, but takes longer than average. In infertility, the likelihood of conceiving without medical intervention is unlikely. In advance of modern science, infertility is almost obsoleted as in vitro fertilization (IVF) can help those couples (who are declared infertile) to have child. Incidence of infertility occurs in 15-20% of couples. Male factor is involved in 50% of cases and is the sole cause of infertility in 30%.[1-3] In male subfertility can be diagnosed at laboratory by counting sperm in semen as well as observing motility. But laboratory findings cannot identify cause of subfertility. Imaging helps us to observe anatomic configuration of testis, pathway of sperm (or any blockage) and also blood flow of testis which is important for spermatogenesis.[3-6]

Imaging modalities

The three main imaging modalities used for investigation of the male reproductive system are ultrasound, MRI and invasive techniques such as venography and vasography. Ultrasound remains the mainstay as it is non-invasive, safe and widely available, and is able to define many of the abnormalities relevant to male infertility. MRI is useful in problem solving, and the invasive techniques are generally reserved for therapeutic intervention in previously defined abnormalities.[4,5]

Scrotal ultrasound

It is excellent for initial evaluation of the scrotum and can directly demonstrate abnormalities within the testis and the peritesticular structures, such as varicocoeles and epididymal abnormalities, as well as visualizing secondary changes caused by distal genital duct obstruction. The patient is examined in a supine position. The testes should be examined in orthogonal transverse and longitudinal planes, and colour Doppler evaluation and volume measurements should be performed routinely. Volume measurement is usually calculated as length×height×width×0.51. A total volume (both testes) of >30 ml and a single testicular volume of 12-15 ml is generally considered normal.[2,6,7]

1. Associate Professor of Radiology and Imaging, Thengamara Mohila Sabuj Sangha (TMSS) MC and RCH, Bogura, Bangladesh.
2. Medical Officer, Department of Radiology and Imaging, Sir Salimullah Medical College and Mitford Hospital, Dhaka, Bangladesh.
3. Associate Professor of Radiology and Imaging, BIRDEM General Hospital, Dhaka, Bangladesh.
4. Community Medicine, Thengamara Mohila Sabuj Sangha MC (TMSS) and RCH, Bogura, Bangladesh.
5. Assistant Professor, Khwaja Yunus Ali Medical College & Hospital, Enayetpur, Sirajganj, Bangladesh.

Correspondence: Dr. Md. Mofazzal Sharif, Associate Professor of Radiology and Imaging, Thengamara Mohila Sabuj Sangha Medical College and RCH, Bogura, Bangladesh. Email: mofazzal.sharif@gmail.com, Mobile: 8801717017552

Transrectal Ultrasound (TRUS)

It enables high-resolution imaging of the prostate, seminal vesicles and vas deferens and is the modality of choice in diagnosing congenital and acquired abnormalities implicated in the cause of obstructive azoospermia. The patient is positioned in a left lateral decubitus position. A high-frequency endorectal transducer should be used with a condom cover and evaluation of the terminal vas deferens, seminal vesicles, ejaculatory duct, prostate are carried out in axial and sagittal planes.[8,9]

Penile ultrasound

It is performed when evaluating physical causes of erectile dysfunction. These include structural penile abnormalities, problems with arterial inflow and malfunction of the venous occlusive mechanism. Greyscale ultrasound is initially performed to exclude structural abnormalities, including fibrotic plaque diseases, focal cavernosal fibrosis or calcification, and tunica albuginea disruption. Intracavernosal injection of prostaglandin E1 (PGE1) is then undertaken. The transducer is placed on the ventral surface of the base of the penis and the cavernosal artery is sampled with Doppler angle correction to allow for accurate velocity measurements.[10]

MRI

Imaging of the prostate for this purpose would include triplanar T_2 weighted spin echo [long repetition time (TR)/long echo time (TE)] and T_1 weighted turbo spin echo (short TR/short TE) triplanar high-resolution images (3-4 mm slice thickness) with a small field of view are useful for both detection and characterization of prostatic cysts detected on a TRUS and evaluation of the vas deferens, seminal vesicles and ejaculatory ducts.[10,11]

Vasography

This is an invasive procedure requiring either blind or ultrasound-guided puncture of the vas deferens and retrograde contrast injection with filling of the ducts and spill into the bladder confirming patency.[8,9]

The prerequisites for successful male fertility are normal spermatogenesis, successful epididymal maturation and storage of sperm, normal sperm transport and normal accessory gland function. The absence of both spermatozoa and spermatogenic cells in semen and post-ejaculate urine is termed azoospermia. This manifests because of blockage of sperm transport or abnormalities of the epididymis, vas deferens or ejaculatory duct. Non-obstructive azoospermia results from defective sperm production by the testicles. The importance in differentiating these entities and correctly identifying azoospermia is that the latter may be amenable to surgical correction.[5,7]

Hemodynamics of Testis

As with other solid organs, the testis has a low vascular resistance. Therefore, the testicular artery and all of its capsular and intratesticular branches are characterized by typical low resistance waveforms with relatively broad systolic peaks and high levels of diastolic flow. Conversely, the cremasteric and deferential arteries supply the high-resistance vascular beds of the epididymis and peritesticular tissues and therefore are characterized by narrower systolic peaks and lower levels of diastolic flow.[9] Because these latter vessels are often sampled in the spermatic cord, waveforms from the supratesticular region may be either low resistance (testicular) or high resistance (cremastenic and deferential). Vascular resistance in an artery can be estimated by using the resistive index (RI) defined as (peak systolic velocity - end diastolic velocity)/peak systolic velocity. Higher resistive indexes indicate more resistance to flow. In 30 normal testes, resistive indexes of supratesticular vessels were 0.63-1.00 (mean, 0.84). Resistive indexes from capsular vessels were 0.46-0.78 (mean, 0.66), and resistive indexes from intratesticular vessels (centripetal and recurrent rami) were 0.48-0.75 (mean, 0.62).[10-13]

Assessment of male infertility by Colour Doppler Ultrasonography

Testicular volume measured by B-mode ultrasound (US) correlated significantly with testicular function. Increased resistive index (Rl) and pulsatility index (PI) of capsular branches of testicular arteries on unenhanced color Doppler US examination may be an indicator of impaired testicular microcirculation in patients with clinical varicocele. FSH was inversely correlated with testicular volume and directly correlated with testicular vascularization, suggesting that ultrasonographic and color Doppler scanning of the testes may be used, if a sperm count is not available, to indirectly assess the gonadal function. Perfusion mapping, performed with the use of color Doppler ultrasound, has shown for the first time that in patients suffering from azoospermia, sperm quality and quantity depend on tissue perfusion within the testicle. Testicular arterial blood flow was found to be significantly decreased in men with varicocele. This may be a reflection of the impaired microcirculation. Following decreased testicular arterial blood flow, impaired spermatogenesis may result from defective energy metabolism in the microcirculatory bed. Contrast enhanced ultrasound imaging is potentially applicable to the investigation of vascular disorders of the testis. Pulse inversion (PI) US data can correctly determine relative testicular perfusion based on nonlinear curve fitting of the US backscatter intensity as a function of time and spectral analysis of the intensity time trace. PI imaging, compared with conventional Doppler US methods, provides superior assessment of perfusion in the setting of acute testicular ischemia. New contrast-enhanced US techniques like microvessel imaging and CPS allow for a better determination of tissue perfusion based on time intensity curves and an illustration of vessel distribution inside the testis. First results show a lower vessel density in atrophic testes and a difference in contrast dynamics in testis with impaired function. Realtime elastography, a method for illustration of tissue stiffness under real-time conditions, demonstrates different elasticity values dependent on testicular volume and function.[14-18]

A study observed fifty-eight infertile men by gray-scale and Color Doppler sonography for presence of varicocele, testicular volume and arterial resistance. Twenty-seven men had left-sided varicoceles (96% of which were subclinical) and 31 infertile men without varicoceles served as controls. Mean volumes of the right and left testes of study subjects were 14.8 ml and 14.6 ml, respectively, and in controls were 14.2 ml and 13.6 ml, respectively. Mean Rl values for the right and left testes of study subjects were 0.61 and 0.58, respectively and in controls were 0.61 and 0.58, respectively. There were no statistically significant differences in volume or Rl, either between the right and left testes within patient groups or between the control and study groups' combined mean values.[12]

While the mean intertesticular volume differences for the study and control groups were 2.2 ml and 3.4 ml, respectively, the mean intertesticular Rl differences were 0.04 and 0.07, respectively. These values also did not differ significantly between groups. Male infertility/ sub fertility was thought to be related with varicocele and the volume change of testis. For this, fourty-six healthy male volunteers and 178 infertile men with left varicocele were examined by high frequency sonography. The differences in spermatic vein diameter at rest, diameter at valsalva maneuver, the peak velocity of reflux, reflux time and testis volume between the right and the left sides were not stastistically significant in the control group and the left testis volume was smaller than the right one among valsalva maneuver groups and that of control group. It was concluded that high frequency ultrasound could provide the accurate internal spermatic vein diameter, hemodynamics and the testis volume to male infertility caused by varicocele.[19] Color Doppler was performed to detect intrascrotal abnormalities.[13] Findings were compared with those of physical examination. Intrascrotal abnormalities were detected by ultrasonography in 65.3% of patients. of 374 abnormalities, 58.3% were undetected by physical examination, left varicocele was found in 313 patients (57.4%); testicular microlithiasis in 30 (5.5%); epididymal cyst in 21 (3.9%); right varicocele in 4 (0.8%); and testicular cysts in 3 (0.6%). One occurrence each (0.2%) was found for testicular tumor, intrascrotal hemangioma, and hydrocele of the spermatic cord. Compared to ultrasonography, sensitivity in detecting left varicocele by physical examination was 58.4%; specificity, 79.3%; accuracy, 67.3%; and positive predictive value, 79.3%. Venous diameters in the pampiniform plexus were 3 mm or more in 61.5% of 130 subclinical left varicoceles. Of 30 patients with testicular microlithiasis, 14 had varicocele, 2 had epididymal cysts, 3 had a history of mumps orchitis, 1 had retractile testis, and 1 had a history of orchiectomy for contralateral testicular tumor. A study conducted to investigate the value of the RI of intratesticular arteries and to establish diagnostic criteria for normal and pathological sperm counts on the basis of quantitative Colour Doppler Ultrasonography (CDUS), as the assessment of the testicular Rl is widely used to measure intratesticular blood flow in 160 subjects. In all men (aged 22-43 years, 320 testicles) were prospectively investigated; 80 had a normal and 80 a pathological sperm count, the latter having mild oligoasthenozoospermia. The Rl was measured using a high-frequency Doppler Ultrasound probe (14 MHz), three times on each testicle at an intratesticular artery in the upper, middle and lower testicular pole. The testicular volume was also measured by US. The Rl values were compared between patients with normal and pathological sperm counts and were compared statistically with testicular volumes. They found that patients with normal sperm counts had a mean Rl of 0.54 (0.05) and a mean testicular volume of 18.7 (5.2) ml, the respective values in those with pathological sperm counts were 0.68 (0.06) and 16.8 (6.0) ml, with a significantly greater Rl in the latter ($P< 0.001$), but with no statistically significant difference in testicular volume between the groups ($P >0,05$) and concluded that an Rl of >0.6 might be suggestive of a pathological sperm count in andrological patients.[16]

Conclusion

The implication is that the anatomical patterns of testicular arteries were related to spermatogenesis, thus confirming that spectral Colour Doppler Rl traces from the intratesticular artery could be considered as markers of spermatogenesis.

Acknowledgement

The authors are grateful to the library authority of BIRDEM, BANSDOC for continuous support.

References

1. Simpson WL, Rausch DR. Imaging of Male Infertility: Pictorial Review. AJR. 2009; 192: S98-S107.

2. Parsons RB, Fisher AM, Bar-Chama N, Mitty HA. MR imaging in male infertility. RadioGraphics 1997; 17: 627-637.

3. Spitz A, Kim ED, Lipshultz LI. Contemporary approach to the male infertility evaluation. Obstet Gynecol Clin North Am 2000; 27:487-516.

4. Ammar T, Sidhu PS, Wlkins CJ. Male infertility: the role of imaging in diagnosis and management. Br J Radiol 2012; 85(1): 59-68.

5. Jose-Miller AB, Boyden JW, Frey KA. Infertility. Am Fam Physician 2007; 75:849-856.

6. Sidhu PS. Diseases of the testis and epididymis. In: Baxter GM, Sidhu PS, eds. Ultrasound of the urogenital system. Stuttgart, Germany: Thieme; 2006; 153-180.

7. Skakkebaek NE, Jorgensen N. Testicular dysgenesis and fertility. Andrologia 2005; 37:217-218.

8. Edey AJ, Sidhu PS. Male infertility: role of imaging in the diagnosis and management. Imaging 2008; 20:139-146.

9. Halls J, Bydawell G, Patel U. Erectile dysfunction: the role of penile Doppler ultrasound in diagnosis. Abdom Imaging 2009; 34(6):712-725.

10. Engin G, Kadio?lu A, Orhan I, Akdöl S, Rozanes I. Transrectal US and endorectal MR imaging in partial and complete obstruction of the seminal duct system. A comparative study. Acta Radiol 2000; 41(3):288-295.

11. Moon MH, Kim SH, Cho JY, Seo JT, Chun YK. Scrotal US for evaluation of infertile men with azoospermia. Radiology 2006; 239(1):168-173.

12. Akcar N, Turgut M, Adapinar B, Ozkan IR. Intratesticular arterial resistance and testicular volume in infertile men with subclinical varicooele. J Clin Ultrasound 2004; 32(8):389-393.

13. Matthias AS. The role of ultrasound in assessment of male fertility, Eu J Repro 2009; 144: 192-198.

14. Middleton WD, Thome DA, Meison GL. Color Doppler ultrasound of the normal testis. AJR 1989; 152: 293-297.

15. Male infertility and subfertility: Guidelines for managrment. Human reproduction 1994; 9, 1260-1264.

16. Pinggera GM, Mitterberger M, Bartsch G, Strasser H, Gradl J, Aigner F, et al. Assessment of the intratesticular resistive index by colour Doppler ultrasonography measurements as a predictor of spermatogenesis. BJU Int 2008; 101(6): 206-209.

17. Schuster A, Frauscher F, Strasser H et al. Power Doppler ultrasound imaging for quantification of urinary bladder neck blood flow changes. Ultrasound Med Biol 2004; 30: 1379-1384.

18. Balasch J. Investigation of the infertile couple: investigation of the infertile couple in the era of assisted reproductive technology: a time for reappraisal. Hum Reprod 2000; 15: 2251-2257.

19. Qi-gen D, Dan-dan YU, Yang W. Application of Color Doppler Ultrasound in Make Infertility with Varicocele; J Cli Ul in Med 2004; 2: 5-9.