

Should Scrotal Color Doppler Ultrasound Be Routinely Indicated in Fertility Evaluation of Non-Azoospermic Men?

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Key Words

Male fertility • Sperm quality • Scrotal color • Doppler ultrasound

Abstract

Objective: Scrotal ultrasound is not a routine investigation in the clinical approach to male infertility analysis. This study aims to identify the role of testicular Doppler ultrasound in male infertility assessment and its relation to semen parameters in non-azoospermic men. **Methods:** Cross-sectional descriptive analysis of 558 men from infertile couples were examined at the Hue Center for Reproductive Endocrinology and Infertility, Hue University Hospital from June 2016 to May 2018. Some cohort characteristics, semen analysis and testicular Doppler ultrasound were analyzed. Men with acute systemic diseases, acute urinary tract infection, hepatic dysfunction, malignant diseases, retrograde ejaculation, cryptorchidism or azoospermia were excluded. **Results:** The mean volumes of the right and left testicles were 8.87 and 8.77 ml, respectively. The total volume of the 2 sides was 17.63 ± 4.34 ml (95% confidence interval 17.27–18.00 ml). The mean right resistive index (RI) was 0.61 ± 0.23 , and the mean left RI was 0.59 ± 0.01 . The rate of normal semen quality was 23.2% in group with varicocele and 30.6% in group with non-varicocele. The ultrasound results from the

normal semen group were much different from those of the abnormal semen group regarding testicular volume: mean right testis volume: 9.67 ± 1.88 vs. 8.75 ± 2.34 ml, $p = 0.0096$; mean left testis volume: 9.54 ± 1.78 vs. 8.51 ± 2.44 ml, $p = 0.0047$; mean total volume of 2 sides: 19.21 ± 3.60 vs. 17.26 ± 4.59 ml, $p = 0.005$ (varicocele group); mean right testis volume: 9.21 ± 2.21 vs. 8.63 ± 2.21 ml, $p = 0.029$ (non-varicocele group). The other indexes of color Doppler ultrasound (peak systolic velocity, end diastolic velocity, RI) were not found to correlate with semen quality. **Conclusions:** Testicular volume which has a close relation to the semen parameters could be used as a clinical prediction factor for the quality of semen.

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Introduction

Infertility is reported to affect 15–20% of couples, and 20–50% of infertility cases are caused by male factors [1, 2]. The examination of infertile men consists of physical examination, hormone testing, semen analysis and ultrasonography. Because the seminiferous tubules comprise 70–80% of the testicular weight, testicular volume is useful to reflect spermatogenesis ability and semen characteristics in infertile men [3].

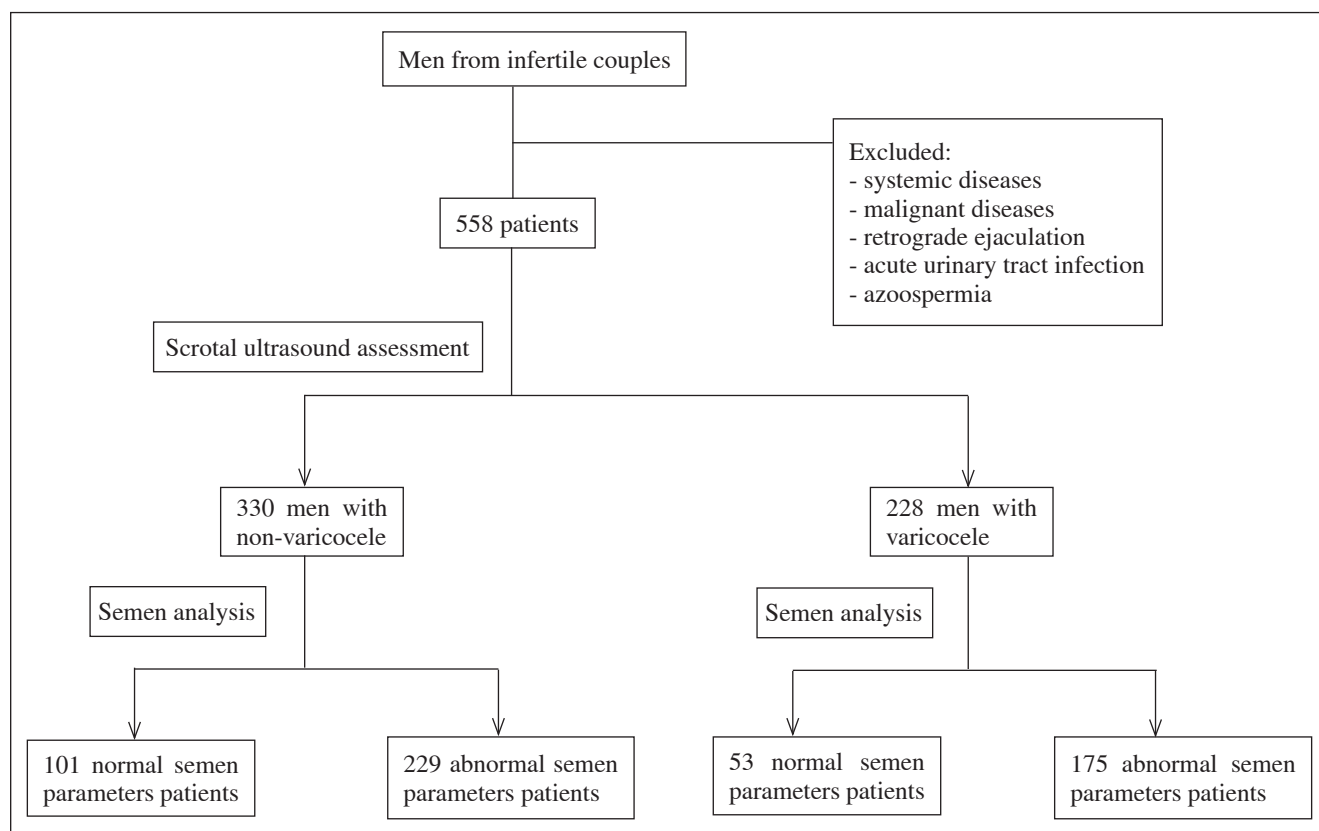


Fig. 1. Flow chart demonstrating recruitment of patients.

Routine semen analysis remains the basic standard for the evaluation of infertility [4]. The criteria of World Health Organization (WHO) 2010 for semen are as follows: 1.5 ml is the lower limit for semen volume; the lower reference limit for total motility (a + b) is 32%; the lower reference limit for sperm concentration is 15×10^6 /ml; the lower reference limit for total sperm number is 39×10^6 spermatozoa per ejaculate; the lower reference limit for sperm morphology is 4% [5].

Ultrasound is widely considered as a safe and efficient method with the ability to define pathology quickly, so that it has become the primary imaging modality for evaluating the testis and paratesticular structures. This noninvasive technique plays a very important role in both the evaluation and treatment of male-factor infertility. Scrotal abnormalities occur in 40–65% of infertile men; however, 60–70% of these cases were not defined clinically on physical examination [6, 7]. According to European Association of Urology Guidelines, on male infertility, the scrotal ultrasound may be helpful in finding signs of

obstruction or signs of testicular dysgenesis (testicular microlithiasis) [8]. Color flow Doppler also adds further value to increase the accuracy of scrotal ultrasonography, which is useful in cases of testicular ischemia, infectious testis, trauma [9]. Color Doppler is very helpful in acute painful conditions: it could differentiate testicular ischemia from inflammatory. Information from color Doppler can be used to assess vascularity in testicular malignancies. In terms of diagnosing varicoceles, color Doppler has high sensitivity and specificity [10]. Furthermore, varicoceles have clearly been a risk factor of male infertility according to a prospective study in 2007 [11]. Several previous studies have indicated that color Doppler sonography of the testis might be useful in the differential diagnosis of azoospermia [12, 13]. However, the value of scrotal ultrasound in fertility assessment in men with non-azoospermia from infertile couples is still a question in clinical practice. The principal objective of this study was to evaluate the relationship between scrotal Doppler ultrasound and semen parameters of non-azoospermia men.

Table 1. Comparison of baseline characteristics and semen parameters

Characteristics	Total (%)	Normal (n = 154) (%)	Abnormal (n = 404) (%)	p
years				0.104
< 35	324 (58.1)	98 (63.6)	226 (55.9)	
≥ 35	234 (41.9)	56 (36.4)	178 (44.1)	
mean ± SD	34.15 ± 6.21	33.31 ± 6.27	34.46 ± 6.17	0.050
BMI, kg/m ²				0.927
< 23	290 (52.0)	80 (51.9)	210 (52.0)	
≥ 23	268 (48.0)	74 (48.1)	194 (48.0)	
mean ± SD	22.89 ± 2.73	22.88 ± 2.97	22.89 ± 2.64	0.535
Geography				0.256
urban	287 (51.4)	73 (47.4)	214 (53.0)	
rural	271 (48.6)	81 (52.6)	190 (47.0)	
Type of infertility				0.844
primary	359 (64.3)	98 (63.6)	261 (64.6)	
secondary	199 (35.7)	56 (36.4)	143 (35.4)	
Duration of infertility, years				0.166
< 3	362 (64.9)	107 (69.5)	255 (63.1)	
≥ 3	196 (35.1)	47 (30.5)	149 (36.9)	
mean ± SD	2.79 ± 2.40	2.49 ± 2.11	2.90 ± 2.50	0.075
History of mumps				0.213
yes	31 (5.6)	5 (3.2)	26 (6.4)	
no	527 (94.4)	149 (96.8)	378 (93.6)	
Smoking				0.165
yes	195 (34.9)	61 (31.3)	134 (33.2)	
no	363 (65.1)	93 (60.4)	270 (66.8)	
Alcohol consumption				0.572
yes	431 (77.2)	122 (79.2)	309 (76.5)	
no	127 (22.8)	32 (20.8)	95 (23.5)	

Materials and Methods

Patient Selection

Cross-sectional descriptive analysis in 558 men from infertile couples, were examined at the Hue Center for Reproductive Endocrinology and Infertility, Hue University Hospital from June 2016 to May 2018 (fig.1). Patients with acute systemic diseases, acute urinary tract infection, hepatic function disorders, malignant diseases, retrograde ejaculation, and azoospermia were excluded. All patients were recorded for general characteristics, including age, geography, education, occupation, clinical history and physical examination, such as infertility type, infertility duration, history of mumps, and history of surgery on the reproductive urinary tract. Based on the Asian-specific classification for body mass index (BMI) status, BMI values were categorized as underweight (< 18.5 kg/m²), normal (18.5–22.9 kg/m²), overweight (23.0–24.9 kg/m²), and obese (≥ 25 kg/m²). The study was approved by the Hue University of Medicine and Pharmacy Ethics Committee. Informed and written consent was obtained from all participants.

Semen Analysis

After physical examination, semen analysis was performed to evaluate semen quality according to the WHO 2010 standard [5]. After 3–5 days of ejaculatory abstinence, the semen sample was collected by the process of masturbation. The samples were allowed to liquefy and analyzed within 1 hour after collection. The

following parameters were evaluated: color, volume, pH, liquefaction time, total count, concentration, progressive motility, morphology, and leukocytes based on WHO guidelines.

According to the WHO 2010 criterion for semen, patients were classified into normal semen parameters if the volume ≥ 1.5 ml; the total motility (a + b) ≥ 32%; the sperm concentration ≥ 15 × 10⁶/ml; and the sperm morphology ≥ 4% [5].

Scrotal Ultrasound

Scrotal ultrasound was used to evaluate the volume of both testes, testicular echogenicity and homogeneity in gray-scale ultrasound; the presence of varicocele was assessed by color Doppler; resistive index (RI), peak systolic velocity (PSV, m/s) and end diastolic velocity (EDV, m/s) index were measured in pulse Doppler. Scrotal ultrasound and color Doppler ultrasound measurements were taken in a warm room. The patient was examined in a supine position while the penis was placed on the lower abdomen. The testes were examined in at least 2 planes along the long and transverse axes, and each testicle was measured in 3 dimensions (length, width, height). The volume of each testis was calculated by using Lambert formula: $V = L \times W \times H \times 0.71$ [14]. The PSV, EDV, and RI [calculated as: $(PSV - EDV) / PSV$] were measured, and the average of 3 values at an intratesticular artery in the upper, middle and lower testicular pole was recorded. Intratesticular artery are all centripetal branches that enter the testicular parenchyma and toward the mediastinum and recurrent rami

Table 2. Characteristics of scrotal ultrasound

Testes measurement	Mean $\pm$ SD	95% CI of mean	Minimum	Maximum
Right Volume, ml	8.87 $\pm$ 2.24	8.68–9.06	3.10	17.30
PSV, m/s	5.24 $\pm$ 0.89	5.16–5.31	2.10	11.00
EDV, m/s	2.19 $\pm$ 0.34	2.16–2.22	0.59	4.40
RI	0.61 $\pm$ 0.23	0.59–0.63	0.59	4.40
Left Volume, ml	8.77 $\pm$ 2.27	8.58–8.96	0.40	18.60
PSV, m/s	5.33 $\pm$ 0.83	5.26–5.40	3.50	11.50
EDV, m/s	2.22 $\pm$ 0.34	2.19–2.24	1.00	4.30
RI	0.59 $\pm$ 0.01	0.591–0.593	0.50	0.80
Total testicular volume, ml	17.63 $\pm$ 4.34	17.27–18.00	6.50	33.80

Table 3. Characteristics of the semen parameters in subgroups with or without varicocele

Variables	Non-varicocele			Varicocele		
	n (%)	Mean $\pm$ SD	Median (IQR)	n (%)	Mean $\pm$ SD	Median (IQR)
Semen overall						
Normal	101 (30.6)	N/A	N/A	53 (23.2)	N/A	N/A
Abnormal	229 (69.4)	N/A	N/A	175 (76.8)	N/A	N/A
Volume, ml		2.08 $\pm$ 0.86	2 (1.5–2.5)		2.11 $\pm$ 1.01	2 (1.5–2.5)
Normal	274 (83.0)	2.30 $\pm$ 0.78	2.0 (1.8–2.5)	186 (81.6)	2.36 $\pm$ 0.95	2 (1.8–2.5)
Abnormal	56 (17.0)	1.02 $\pm$ 0.21	1.0–1.2	42 (18.4)	1.02 $\pm$ 0.27	1.1 (1–1.2)
Concentration, mil/ml		30.48 $\pm$ 15.07	32 (23–38)		27.04 $\pm$ 14.41	31 (18–37)
Normal	268 (81.2)	35.82 $\pm$ 11.10	28–41	175 (76.8)	33.57 $\pm$ 9.06	33 (27–38)
Abnormal	62 (18.8)	7.40 $\pm$ 4.34	7.5 (4–11)	53 (23.2)	5.49 $\pm$ 3.85	5 (3–8)
Morphology, %		4.51 $\pm$ 3.37	4 (2–7)		3.61 $\pm$ 2.82	3 (1–6)
Normal	183 (55.5)	6.95 $\pm$ 2.52	6 (5–8)	105 (46.1)	6.23 $\pm$ 1.80	6 (5–7)
Abnormal	147 (44.5)	1.48 $\pm$ 1.02	1 (1–2)	123 (53.9)	1.38 $\pm$ 1.05	1 (1–2)
Motility, %		26.28 $\pm$ 9.83	28 (21–34)		23.30 $\pm$ 10.30	25 (16–32)
Normal	126 (38.2)	35.32 $\pm$ 3.11	34 (33–37)	64 (28.1)	34.53 $\pm$ 2.43	34 (33–36)
Abnormal	204 (61.8)	20.69 $\pm$ 8.27	22(16–27)	164 (71.9)	18.91 $\pm$ 8.75	21 (13.5–26.0)

NA = Non-analysis; IQR = interquartile range.

Table 4. Association between scrotal ultrasound and the semen parameters in sub-groups with or without varicocele

Scrotal ultrasound	Non-varicocele			Varicocele		
	Normal (n = 101)	Abnormal (n = 229)	P	Normal (n = 53)	Abnormal (n = 175)	P
Right Volume, ml	9.21 $\pm$ 2.21	8.63 $\pm$ 2.21	0.029	9.67 $\pm$ 1.88	8.75 $\pm$ 2.34	0.0096
PSV, m/s	5.15 $\pm$ 0.85	5.20 $\pm$ 0.94	0.551	5.41 $\pm$ 0.90	5.29 $\pm$ 0.84	0.534
EDV, m/s	2.16 $\pm$ 0.32	2.17 $\pm$ 0.36	0.211	2.29 $\pm$ 0.36	2.19 $\pm$ 0.33	0.151
RI	0.65 $\pm$ 0.54	0.60 $\pm$ 0.02	0.831	0.60 $\pm$ 0.01	0.60 $\pm$ 0.01	0.923
Left Volume, ml	9.06 $\pm$ 2.04	8.65 $\pm$ 2.29	0.139	9.54 $\pm$ 1.78	8.51 $\pm$ 2.44	0.0047
PSV, m/s	5.23 $\pm$ 0.76	5.30 $\pm$ 0.83	0.709	5.49 $\pm$ 0.85	5.37 $\pm$ 0.84	0.353
EDV, m/s	2.19 $\pm$ 0.40	2.21 $\pm$ 0.32	0.475	2.29 $\pm$ 0.33	2.22 $\pm$ 0.33	0.144
RI	0.59 $\pm$ 0.01	0.59 $\pm$ 0.02	0.553	0.59 $\pm$ 0.01	0.59 $\pm$ 0.01	0.329
TTV, ml	18.27 $\pm$ 4.18	17.28 $\pm$ 4.28	0.072	19.21 $\pm$ 3.60	17.26 $\pm$ 4.59	0.005

TTV = Total testicular volume.

Only 3 parameters (right volume, left volume and TTV) were normal distribution. Otherwise, Mann-Whitney test was used to compare the association.

(in the opposite direction). Exception the trans-mediastinal artery (branch of testicular artery traverses toward center of testis) just can be seen unilaterally in 50% or bilaterally in 25% patients and usually accompanied by large vein. We used a high-frequency linear probe (7.5 MHz) for both grayscale and Doppler ultrasound with a Samsung Medison R5 machine (Korea). Assessment of varicocele was performed by measuring the largest diameter and reflux in the vessels before and after Valsalva maneuver. Color Doppler parameters were optimized for the evaluation of slow flow (wall filter at minimum levels, gain at the maximum level permitted by the presence of artifacts, elective focus on the region of interest) and standardized by using a simplified version of the Sarteschi classification [15]. All examinations were performed by the same ultrasonographer.

Statistical Analysis

Data analysis was conducted using SPSS (Statistical Package for the Social Sciences, IBM Inc., Chicago) version 20.0. The patients were divided into 2 groups (normal and abnormal semen parameters) and compared in terms of ultrasound index by an independent samples *t*-test. If the data were not normally distributed, then the Wilcoxon rank sum test (Mann-Whitney U test) was replaced. The normal distribution of the scrotal ultrasound data was tested by Shapiro-Wilk normality test. The threshold for statistical significance was confirmed with $p < 0.05$.

Results

Table 1 has showed the demographic and baseline information for all patients in 2 groups: normal and abnormal semen parameters. There was no evidence of a significant difference between baseline variables and semen outcome regarding to age, BMI, geography, infertility type and duration, smoking or alcohol consumption.

The results for scrotal ultrasound are shown in table 2. The mean volumes of the right and left testis were 8.87 and 8.77 ml, respectively. The total testicular volume was 17.63 ± 4.34 ml, and the 95% confidence interval (CI) ranged 17.27–18.00 ml. Altogether, the subjects had a mean right volume 8.87 ± 2.24 ml and a mean left volume 8.77 ± 2.27 ml. The mean right RI was 0.61 ± 0.23 , and the mean left RI was 0.59 ± 0.01 . The right testis had a mean EDV of 2.19 ± 0.34 m/s and a mean PSV of 5.24 ± 0.89 m/s, whereas the values for the left testis were 2.22 ± 0.34 and 5.33 ± 0.83 m/s, respectively. The ultrasound results for the 2 testicles were not significantly different.

The results for the semen parameters are shown in table 3. In varicocele group, the rates of normal and abnormal semen parameters were 23.2 and 76.8%, respectively whereas these values in non-varicocele group were 30.6 and 69.4%. The values of the indexes from normal semen parameters were much higher than those from abnormal

semen parameters. In terms of the sperm concentration, $30.48 \pm 15.07 \times 10^6/\text{ml}$ was the mean value in non-varicocele group, compared to $27.04 \pm 14.41 \times 10^6/\text{ml}$. In varicocele group, the mean of sperm motility in the normal versus abnormal group was 34.53 ± 2.43 and $18.91 \pm 8.75\%$, respectively.

Table 4 shows the relationship between the ultrasound results for 2 testicles and the semen parameter results of men with varicocele and non-varicocele. In varicocele group, a significant correlation was observed among right testis volume, left testis volume and total testicular volume with the semen parameters ($p < 0.05$). Patients with normal semen parameters had larger testes than those with abnormal group (mean right testis volume: 9.67 ± 1.88 vs. 8.75 ± 2.34 ml, $p = 0.0096$; mean left testis volume: 9.54 ± 1.78 vs. 8.51 ± 2.44 ml, $p = 0.0047$; mean total volume of the 2 sides: 19.21 ± 3.60 vs. 17.26 ± 4.59 ml, $p = 0.005$). However, in men with non-varicocele group, the statistical significance was just observed in the correlation between right testis volume with semen parameters ($p = 0.029$).

In both groups, the other ultrasound indexes did not correlate with the semen parameters (PSV, EDV, RI). The values for varicocele patients with normal semen parameters and abnormal semen parameters were 5.41 ± 0.90 vs. 5.29 ± 0.84 m/s (right-PSV); 2.29 ± 0.36 vs. 2.19 ± 0.33 m/s (right-EDV); 0.60 ± 0.01 vs. 0.60 ± 0.01 (right-RI); 5.49 ± 0.85 vs. 5.37 ± 0.84 m/s (left-PSV); 2.29 ± 0.33 vs. 2.22 ± 0.33 m/s (left-EDV); and 0.59 ± 0.01 vs. 0.59 ± 0.01 (left-RI). In non-varicocele group, these values were 5.15 ± 0.85 vs. 5.20 ± 0.94 m/s (right-PSV); 2.16 ± 0.32 vs. 2.17 ± 0.36 m/s (right-EDV); 0.65 ± 0.54 vs. 0.60 ± 0.02 (right-RI); 5.23 ± 0.76 vs. 5.30 ± 0.83 m/s (left-PSV); 2.19 ± 0.40 vs. 2.21 ± 0.32 m/s (left-EDV); and 0.59 ± 0.01 vs. 0.59 ± 0.02 (left-RI), respectively.

Discussion

Analysis of the relationship between semen parameters and some indexes from scrotal ultrasound (testis volume, PSV, EDV, RI) showed that the mean volumes of the right and left were 8.87 and 8.77 ml, respectively. The total testicular volume was 17.63 ± 4.34 ml, and the 95% CI ranged 17.27–18.00 ml. The mean testis volume in our study was lower than the results from the other publications. The result of one study in 2013 indicated that patients with a reduced testis volume (< 12 ml) in the absence of testicular disease would show poorer conventional and nonconventional semen parameters [16].

Takahara et al. [17] reported that the normal adult testicular volume was > 14 ml in Japan and > 17 ml in the United States. In a study during a period of 4.5 years, the testicular volumetric cut-off value in normal young men was approximately 18 ml [18]. The causes of ethnic differences between testicular volume are unclear but may be related to differences in lifestyle and average body size. In addition, individuals who had any history of disease that affected the quality of sperm or testis volume (e.g. heavy smoking, alcohol use, varicocele, mumps, vascular disease, kidney disease) were included in our study but excluded from the other studies. This difference may have a negative effect on the testis volume of our study population. As far as our understanding, until now in Vietnam there has been no research on testicular characteristics with large sample size. The epidemiological data on scrotum characteristics in Vietnamese male population is still limited to compare with our results.

Several trials have been previously conducted to measure testicular volume and identify the relationship between testis volume and the quality of semen. In the present study, we found that compared to patients with normal testis volumes, only patients who had smaller testes would have lower sperm concentrations, percentage of motility and normal forms. This finding was comparative to other studies. A publication in 2015 has showed that total testis volume and the testicular volume differential are associated with semen analysis outcomes in adolescents with varicocele [19]. A testis volume differential greater than 20% doubles the odds of low total motile sperm count, and a total testis volume < 30 ml quadruples the odds of low total motile sperm count. Huang et al. [20] evaluated the predictive value of left and right testicular volume for testicular function. These authors concluded that right testicular volume rather than left testicular volume was the independent factor for the overall testicular function determined by semen quality and total testosterone levels. Right testicular volume (< 15 ml) was the only positive predictor for low testicular function (odds ratio = 2.79; 95% CI 1.18–6.66; $p = 0.020$). However, it has been demonstrated that overall bilateral testicular volume is significantly correlated with testicular function, including the sperm concentration, total sperm count, serum follicle-stimulating hormone (FSH) and luteinizing hormone [16, 18, 21]. In 1,139 normal young men, 19–27 years old were subjected to ultrasonic measurements of testis volume, and there were noted no significant differences between the mean testicular volume of the left (18.37 ± 3.62 ml) and right (18.13 ± 3.85 ml) testes ($p = 0.155$) [18].

There also remains some controversy regarding whether testicular volume is related to testicular function. Pinggera et al. [22] revealed that the mean testicular volume of normal sperm and mild oligoasthenozoospermia was 18.7 and 16.8 ml, respectively, and there was no statistically significant difference in testicular volume between the groups ($p > 0.05$). A similar result was confirmed by the previous findings of Atilla et al. [23] and Biagiotti et al. [24]. The small study population size may lead to an insignificant difference in the volume of testicular tissue.

Color Doppler ultrasound is a rapid and accurate method of measuring blood flow. Doppler have been used to obtain information about blood flow and vascular impedance. The pulse index and RI are the most widely used indexes. Until now, RI has been commonly indicated for examinations in both animals and humans [22, 25]. The measurement of RI was used as a diagnostic criterion for scrotal inflammatory disease and was used to assess testicular integrity in various operative studies. Lefort et al. [26] concluded that color Doppler examination of the scrotum should include measurement of the intratesticular RI. An elevated RI can be suggestive of ischemia. A prospective internally controlled cohort study in 37 men who underwent Doppler ultrasonography and serum testicular hormone analysis pre- and post- either open Lichtenstein's repair or laparoscopic total extraperitoneal hernioplasty suggested that patients with inguinal hernia have elevated testicular vascular resistance, which is reversed after repair. The choice of laparoscopic or open herniorrhaphy did not affect the reversal of this surrogate of testicular function [27].

RI also showed a significant positive relationship with sperm count or spermatogenesis according to some authors. Paltiel et al. [27] used color Doppler ultrasound in the arterial impedance of the normal testis in 33 healthy boys and found that in testes of ≤ 4 ml, the mean RI was 0.87 (range 0.39–1.00) and was 0.57 (range 0.43–0.75) in testes of > 4 ml. Pinggera et al. [22] revealed that there was a significantly greater RI in patients with oligoasthenozoospermia ($RI > 0.6$; $p < 0.001$), and that an RI above the threshold of 0.60 was indicative of abnormal semen quality. Biagiotti et al. [24] provided data suggesting that RI and PSV of intratesticular vessels were better predictors of dyspermia than FSH and testicular volume. A retrospective study concluded that an intratesticular RI greater than 0.6 was associated with decreased total motile sperm, decreased testicular size, and increased FSH, supporting the use of this parameter as an independent indicator of testicular function [28].

However, in contrast with previous studies, in our study, RI and the other ultrasound indexes did not correlate with the semen parameters (PSV, EDV) with $p > 0.05$. The contrast between the studies might be due to the difference of studies population. While all males from infertile couples were recruited except azoospermia cases in our study, Pinggera et al. [22] investigated 80 men with all the latter having mild oligoasthenozoospermia. Biagiotti et al. [24] recruited 161 patients included 9 with obstructive azoospermia, 20 with nonobstructive azoospermia. The studies population size from these studies were also too small to provide strong evidence to confirm the relationship between RI and other indexes with the semen parameters.

Similar to our results, Semiz et al. [29] also found a strong positive correlation between left and right testis volumes and sperm count with ($p < 0.001$), but there was no significant correlation between right parenchymal and capsular testicular artery RI and pulsatility index values and semen analysis parameters. Another author evaluated 62 men with varicocele. There was a positive correlation between sperm count and testicular artery blood flow and between left testicular volume and testicular artery blood flow. However, no statistically significant difference was observed when arterial blood flow parameters (PSV, EDV, RI, pulsatility index) were compared between the control and patient groups [30].

According to a prospective study in 2007, the mean semen quality scores of infertile patients with varicocele were lower than those of control subjects (healthy semen donors without varicocele) but similar to those of fertile men with varicocele. Infertile men with varicocele also had higher reactive oxygen species levels but lower total antioxidant capacity levels [11]. However, a follow-up study within 8 years concluded that varicocelectomy might not benefit patients because the sperm concentration did not decline over time among men with varicocele [31]. In our study, patients with abnormal semen parameters had a higher incidence of varicocele than that of those in the normal semen parameters cohort but this difference was not significant (30.6 vs. 23.2%). Varicoceles was not a confounding variable that could affect the relationship between the scrotal ultrasound and semen parameters. In addition, we also attempted to identify cofounders that could negatively affect testis volumes (e.g. age, heavy smoking, alcohol use, varicocele, mumps, vascular disease, kidney disease, BMI, time of infertility). These factors did not seem to have any negative effect on the volumes of the testes.

Concerned as limitation of this study, previous studies have indicated that color Doppler sonography of the testis might be useful in the differential diagnosis of azoospermia and suggested the evaluation of the intratesticular blood vessel distribution before performing retrieval intratesticular spermatozoa [12, 13]. Because the use of color Doppler ultrasound has been clearly on patients with azoospermia, we have decided to examine only non-azoospermic patients.

In conclusion, testicular volume could be used as a clinical prediction factor for the quality of semen in cases without azoospermia, whereas the other indexes of color Doppler ultrasound had no significant correlation with semen quality.

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