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AN OBSERVATIONAL STUDY OF SHEAR WAVE ULTRASOUND ELASTOGRAPHY FOR THE EVALUATION OF TESTICULAR VARICOCELE IN YOUNG ADULTS

Radio-Diagnosis

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ABSTRACT

Introduction: A varicocele is an abnormal dilation of scrotal veins, it often appears as a soft lump on the left scrotum and is graded based on visibility and palpation. Diagnosis is typically done with high-resolution color Doppler ultrasound, while shear wave elastography (SWE) is newer method that assesses testicular stiffness and may provide insights into varicocele severity and its effect on spermatogenesis. **Materials and Methods:** This hospital-based cross-sectional study was conducted at SMS Hospital, Jaipur, including 67 patients with varicocele. Patients were diagnosed based on physical examination and scrotal Doppler ultrasonography. Exclusion criteria included a history of significant medical conditions or testicular abnormalities. SWE was performed to measure testicular stiffness at rest and during the Valsalva maneuver, with varicocele graded from 1 to 3. Data were collected on demographic characteristics, varicocele grade, and sperm count. **Results** : Among the 67 patients, the majority were aged 26-30 years. Varicocele was predominantly left-sided (91.2%) and grade 3 (46.27%). SWE measurements showed increased testicular stiffness correlating with varicocele severity, particularly during the Valsalva maneuver. Higher stiffness was observed in patients with more severe varicocele grades, suggesting that SWE could help in assessing varicocele impact. A notable association between lower sperm count and higher varicocele severity was found, aligning with previous research indicating varicocele's detrimental effect on sperm production and testicular function. **Conclusion:** SWE provides valuable insights into testicular stiffness and varicocele severity, potentially improving the assessment of male infertility and guiding treatment strategies. Further research is needed to explore the relationship between varicocele severity and sperm count comprehensively.

KEYWORDS

Varicocele, Shear Wave Elastography (SWE), Testicular Stiffness, Infertility, Doppler Ultrasonography, Sperm Count

INTRODUCTION

A varicocele refers to an abnormal dilation and enlargement of the pampiniform plexus, a network of veins within the scrotum responsible for draining blood from each testicle.[1-4] Varicocele is detected in 15% of men without underlying health issues, and its occurrence rises to 35% in individuals with primary infertility and reaches up to 80% in those facing secondary infertility. Among adolescents aged 15 and above, one in seven is reported to have a varicocele.[5-7]

Anatomically, three theories explain varicocele development: failure of the antireflux valve, angulation at the junction of internal spermatic and left renal veins, and the "Nutcracker" effect involving entrapment or compression. Rare causes include deep vein thrombosis, renal arteriovenous malformations, and pampiniform plexus thrombosis.[2]

The physical manifestation of varicoceles includes soft lumps above the testicle, typically on the left side of the scrotum, resembling a "bag of worms" when large. While large varicoceles are easily identifiable through visual inspection, medium ones are detectable by palpation without patient-induced pressure, and small ones require a strong Valsalva maneuver for identification. Subclinical varicoceles, not clinically detectable, are revealed solely through ultrasound imaging.[2] Grading of the varicocoele is possible, with a Grade I varicocoele being impalpable (i.e. observed only on ultrasound), Grade II being palpable and Grade III being visible.[8,9]

Ultrasonography (US) is commonly used for varicocele diagnosis, with various grading systems based on grayscale and Doppler US proposed for objective assessment. High-resolution color-flow Doppler ultrasound confirms varicoceles by revealing pampiniform plexus vessel dilation, particularly when exceeding 3 mm in diameter.[10,11]

Routine imaging is unnecessary for clinically significant cases. Testicular strain elastography is under study for identifying patients requiring varicocele treatment.[12,13]

USG and Colour Doppler lack clinical relevance due to a weak correlation with abnormal semen parameters reflecting impaired spermatogenesis. They focus solely on the extent of dilated spermatic veins, neglecting testicular parenchymal changes. Recently, sonoelastographic methods, particularly shear-wave elastography (SWE), offer a non-invasive approach for assessing micro environmental parenchymal changes in solid organs.[11]

Shear wave elastography represents an evolving form of ultrasound imaging. While akin to strain elastography in principle, it diverges by employing a more intense pulse to generate shear waves, which propagate laterally from the insonated structure. In contrast to strain elastography, where transducer pressure measures shift in an ultrasound A-line to gauge strain changes, shear wave elastography tracks shear waves with low-intensity pulses to determine shear velocity. This velocity is subsequently correlated with Young's modulus, providing valuable information about the elastic properties of the tissue under examination.[14]

Over the last two decades, sonoelastography has become increasingly utilized for assessing soft-tissue elasticity, complementing information obtained through conventional ultrasonographic techniques. Shear-wave elastography (SWE) is considered more objective and quantitative. SWE employs an acoustic radiation force pulse sequence to generate shear waves, providing a measure of tissue elasticity. Shear-wave velocities correlate with the tissue's shear modulus, offering absolute elastic property information.[15,16]

SWE provides quantitative data for organs like the testis, and its diagnostic utility has been explored in undescended testis, testicular microlithiasis, scrotal hydrocele, testicular torsion, and malignant tumours. [17-21] Several studies indicate that varicocele alters testicular stiffness measured by elastography.[22-25] So, our study aimed to evaluate the testicular stiffness in patients with varicocele measured by shear wave ultrasound elastography (SWE) with correlation of total sperm count and varicocele grade.

MATERIALS AND METHODS

This hospital-based cross-sectional study was conducted at the Department of Radiodiagnosis, SMS Hospital, Jaipur, Rajasthan, after obtaining institutional research board approval. The study population included married males referred for scrotal Doppler ultrasonography and diagnosed with varicocele. Participants were men unable to conceive with their partners within one year without contraception. Exclusion criteria included history of surgery, trauma, malignancy, radiation, chromosomal abnormalities, chronic diseases, testicular abnormalities, abnormal hormonal profiles, or refusal to participate. The sample size of 67 was calculated with 80% power and a 0.05 alpha error, assuming a 48% prevalence of grade-3 varicocele based on a

prior study. Baseline data were collected using a pre-designed proforma, including demographics and ultrasound findings. Shear-wave elastography measured testicular stiffness at rest and during the Valsalva maneuver with no transducer pressure, and stiffness was averaged from measurements at the upper, mid, and lower testicular poles. Varicocele grading was based on reflux patterns, with grades 1-3 defined by varying levels of spontaneous or Valsalva-induced reflux.

RESULTS

In our study, among the 67 patients comprising the study group, the highest proportion fell within the age bracket of 26-30 years, constituting 29 cases (43.28%).

Table.1 Baseline characteristics of study subjects

Age Group		
	No of cases (n=67)	Percentage (%)
26-30	29	43.2
31-35	24	35.8
36-40	14	20.8
Type of infertility		
Primary	21	31.3
Secondary	46	68.6
BMI		
BMI below 18.5	12	17.9
18.5–24.9	28	41.7
25.0–29.9	27	40.2
Varicocele Characteristics (Side affected)		
Left	61	91.05
Bilateral	6	8.95
Grade of Varicocele		
(Left) Grade 1	10	14.92
Grade 2	26	38.81
Grade 3	31	46.27
(Right) Grade 1	6	8.95

Our study included cases of infertility with diagnosed varicocele during physical examination. In our study out of 67 patients 21 patients (31.43%) had primary infertility and 46 patients (68.66%) had secondary infertility (Table 1). Varicocele prevalence in the context of male infertility ranges from 25% to 35%, escalating to 50% to 80% in cases of secondary infertility. Out of 67 patients, 28 had a normal BMI, 27 were overweight, and 12 were underweight. Increased intra-abdominal fat in obese men might reduce the impact of the "nutcracker" phenomenon, which compresses the spermatic vein.[31-32]

Approximately half of the testicles with clinical grade 2 or 3 varicocele exhibited significantly increased stiffness during the Valsalva maneuver, compared to one testis classified as grade 0. These results imply that the severity of testicular parenchymal congestion may show individual variations even among cases of the same clinical grade. They recommended that comparative analysis of clinical grade and SWE changes, which are more closely related to prognosis, is needed in future studies investigating clinical and histologic features and semen test results.

Table 2 Elastographic parameters of Grade 1, 2, and 3 testicular varicoceles

	Grade 1	**Grade 2**	**Grade 3**	**Spearman corelation**	**P value**
At rest					
E_{mean} (kPa)	2.84 ±.30	2.54± .231	3.23± .53	.404	.000
Valsalva manoeuvre					
E_{mean} (kPa)	2.98 ±.29	3.18 ±.36	4.23 ±.66	.779	.000
Change in elasticity					
Absolute change in E_{mean} (kPa)	.141± .08	.63± .43	1.00± .60	.610	.000
Percentage change in E_{mean} (%)	5.11± 3.14	25.76 ±19.04	33.04 ±22.80	.544	.000

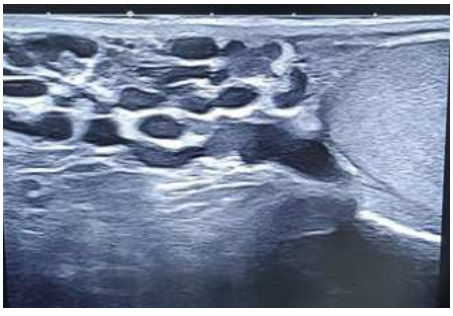
We found a notable association between sperm count and varicocele severity. Notably, individuals with higher sperm counts tended to have varying degrees of varicocele severity, with more severe cases observed in those with lower sperm counts. Specifically, among individuals with sperm counts exceeding 20 million per milliliter, there was considerable variability in varicocele severity, with left grade 3 varicocele being the most common. Conversely, those with lower sperm counts, particularly below 10 million per milliliter, exhibited more severe varicocele grades, including bilateral varicocele. This suggests a potential correlation between varicocele severity and sperm count, highlighting the importance of considering varicocele in the assessment of male infertility.

These findings underscore the need for further research to elucidate the precise relationship between varicocele severity and sperm count, potentially informing treatment strategies for individuals with varicocele-related infertility. **Damsgaard et al.[34] 2019** also reported that the severity of varicocele showed a consistent association with decreased semen quality, even among those with grade 1 varicocele. Notably, in grade 3 varicocele cases, sperm concentration was found to be less than half compared to individuals without varicocele. **Yavuz et al.[24] 2018** demonstrated significant negative correlations between mean testicular shear wave velocity values and sperm counts or testis volumes. They established cutoff values for mean testicular shear wave velocity to distinguish normal sperm count from azoospermia and oligozoospermia, providing valuable insights into the predictive capability of SWE in assessing male fertility potential.

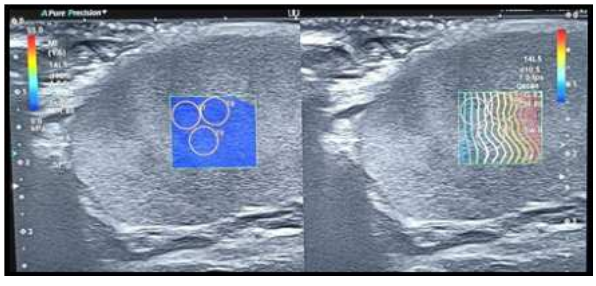
CONCLUSION

The potential of SWE as a valuable tool in predicting and assessing varicocele and male fertility potential, and evaluating testicular tissue characteristics. SWE demonstrates promise in enhancing diagnostic accuracy in male infertility with varicocele. Utilizing a dynamic provocation test may offer greater advantages compared to a static evaluation in diagnosing varicocele. Performing Shear Wave Elastography (SWE) assessments during both regular breathing and the Valsalva maneuver could be advantageous for evaluating varicoceles in adults males with varicocele. However, further research is warranted to validate these findings and optimize the clinical utility of SWE in this context.

Clinical Images



Pic.1 Left grade 3 varicocele, mean stiffness 7.8 kpa



Pic 2 left grade 2 varicocele mean stiffness 3.3 kpa

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