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Original Research Paper

Radio-Diagnosis

# ROLE OF SHEAR WAVE ELASTOGRAPHY IN EVALUATION OF NORMAL TESTES AND IN PATIENTS WITH VARICOCELE

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## ABSTRACT

**Background And Objectives:** Varicocele refers to the anomalous enlargement of the veins within the pampiniform plexus. Shear wave elastography (SWE) is an innovative, consistent, and non-invasive ultrasonographic imaging technique employed for assessing the stiffness and flexibility of diverse tissues. This study aimed to evaluate the effectiveness of SWE in detecting alterations in testicular stiffness among adult individuals diagnosed with varicocele.

**Aims And Objectives**

1. To evaluate ultrasound and color Doppler findings of testes in patients with varicocele.
2. To grade the varicocele based on color Doppler findings.
3. To evaluate the shear wave elastography findings of testes in patients with varicocele.
4. To correlate the elastography findings with varicocele grade.
5. To compare the elastography findings between the case and control study groups.

**Study Design:** Case control study **Setting:** Department of Radiodiagnosis at R. L. Jalappa Hospital and Research Centre attached to SDUMC, Kolar. **Materials And Methods:** This prospective comparative study, approved by the Institutional Review Board (IRB), included the enrollment of 60 patients with varicocele and an equal number of 60 control patients. All US examinations will be performed using Philips EPIQ 5 and Philips Affinity 70 system equipped with shear wave point quantification, ELASTPQ, using curvilinear broadband transducer C5-2. **Results:** The mean SWE values exhibited a notable difference between the two groups and in the comparisons within each group ($P < 0.05$). Additionally, a significant disparity was observed in mean testicular volumes between the case and control groups ($P < 0.0001$). The SWE values were significantly different when comparing the case and control groups. However, no significant correlation was found between testicular stiffness and volume in either group. **Conclusion:** It is recommended that further investigations involving larger patient populations be conducted to validate the efficacy of shear wave elastography (SWE) in predicting damage to testicular parenchyma.

**KEYWORDS :** Shear wave elastography, testicular stiffness, varicocele

## INTRODUCTION

Varicocele is characterized by scrotal enlargement, discomfort, and infertility. Because the left spermatic vein drains into the left renal vein at a perpendicular angle, most occurrences tend to occur on the left side. Physical examination is the gold standard for diagnosing and grading testicular varicocele.[1] The main way to diagnose varicoceles is with a physical examination, however scrotal Doppler ultrasound is a helpful adjunct. When the valves in the spermatic veins are either not there or are not functioning properly, the result is an enlarged and congested network of veins called the pampiniform plexus, which is the hallmark of varicocele.[2] Enlargement of the veins that drain the testicles is known as varicocele. Retrograde flow, in which blood flows backward through the veins, can cause a variety of issues, such as high body temperature, venous stasis (blood stagnation), testicular parenchymal damage (trauma to the testicular tissues), testicular atrophy (shrinkage of the testicle), and impaired testicular function.[3] Pathological examinations reveal that varicocele causes testicular damage in the form of peritubular fibrosis, Leydig cell atrophy, and a diminution in the diameter of the seminiferous tubules, which are the small tubes in the testicle responsible for sperm production.[4]

## NEED FOR STUDY

There is a dearth of research that has examined testicular elasticity and utilized SWE to assess testicular stiffness and damage in varicocele patients. One major development in ultrasonography recently is ultrasound-based elastography, which has greatly expanded ultrasonography's use in clinical practice.[5] Hasan Erdogan et al. state that SWE is a useful tool for evaluating varicocele testes, since it can detect parenchymal damage, anticipate interstitial fibrosis, and keep an eye on how bad it gets. Therefore, this study was conducted to evaluate the function of SWE in monitoring testicular stiffness changes in adult patients afflicted with varicocele". We compared the findings to those from the patients' healthy contralateral testes. Additionally, we looked at how varicocele correlated with shifts in testicular volume.[6]

### Method of Collection of Data:

All US examinations were performed using Philips EPIQ 5 system equipped with shear wave point quantification, ELASTPQ, using curvilinear broadband transducer C5-2. SWE images require no transducer pressure or external compression. Patient lies in supine position, and scrotum was supported with a rolled towel. Patient will be asked to lie relaxed without movement. An ideal longitudinal image of the testes is taken and three automated fixed 5 mm diameter circular region of interest (ROI) placed at upper, middle and lower poles of the testis. The measurement was repeated three

times, and the mean stiffness value was analyzed. Automatically calculated quantitative stiffness value was obtained in kilopascal.

## RESULTS:

Out of a sample size of 120, 60 were varicocele patients and 60 were normal. Among the total cases, the highest number of patients were in the 30-40 age group, whereas the fewest patients were in the 10-20 age group. Similarly, in the control group, the maximum number of patients was found in the 30-40 age group, while the lowest number was observed in the 10-20 age group.

### Testicular Volume

The mean testicular volume was 9.97±.843 ml in the varicocele (cases) group as compared to 14.88±1.748 ml in the control group. The median value of testicular volume was also lower in the varicocele (cases) group as compared to the control group. Testicular volume was significantly low in some cases, which indicates statistical significance ($p<0.001$). The mean testicular volume in grade I was 10.37 ± 0.833, slightly higher compared to other grades. The mean testicular volume was almost the same in patients with grade II, III, and IV varicoceles.

### SWE

Mean SWE values were 13.85±.988 and 7.01±1.078 among the diseased and control groups. The median values were also higher in the varicocele (cases) group as compared to the control group. SWE was significantly higher in cases, which was statistically significant ($p < 0.001$). The average SWE was observed to be higher in grade IV.

### Side

Out of 60 cases, 17 (28.3%) had bilateral varicoceles, 25 (41.7%) had varicoceles on the left side, and 18 (30%) had varicoceles on the right side. The highest number of varicoceles was observed on the left side.

### Correlation Between SWE And Testicular Volume

No significant correlation was observed between the SWE and testicular volume in patients with varicocele (p-value = 0.204).

## DISCUSSION

Elastography has been used to evaluate a variety of pathologic entities in the testis, such as malignancies, infertility, varicocele, undescended testis, testicular torsion and infarction, and testicular microlithiasis[7,8] When evaluating testicles, qualitative methods like strain elastography were first employed. By using these methods, data on the strain-deformation ratio following the application of external tissue pressure may be collected. Generally speaking, pathogenic tissues have high elasticity and limited compression capability, whereas healthy tissues have low elasticity.[9] A picture with a mode B overlay color scale can be used to illustrate these findings. RTE (Real-Time Elastography) has a range of sensitivity and specificity for distinguishing benign from malignant lesions: 59% to 89% and 25% to 38%, respectively. However, the technique's wide range of variability and the challenge of achieving consistent compression in the testicular parenchyma have restricted its application in clinical settings.[10] Testicular stiffness has been measurable thanks to quantitative methods like SWE, which measures the wave's speed of propagation through tissue. This displays anatomical pictures in real time, together with color scale maps and elasticity modules of the targeted areas.[11] The speed of wave propagation (m/s) and tissue elasticity (kilopascals, kPa) can be measured using this easy-to-use, non-invasive, and highly reproducible technique. While it has been applied to other anatomical areas, scrotal pathology is a relatively new area of application, with little research on the subject. A technique for assessing tissue elasticity that has become more popular over the past 20 years is sonoelastography, which provides information beyond that which can be acquired using conventional grayscale and Doppler ultrasonography methods.[12,13] The data on tissue elasticity published by Ozturker C et al. documented variations in testicular stiffness due to topography. The testicle's poles had stiffness values that were greater than its center (1.15 m/s versus 0.90 m/s, respectively).[14]

## LIMITATIONS:

Shear wave elastography (SWE) is a relatively new ultrasound technique that measures tissue stiffness and elasticity. It is increasingly being used in various medical fields, including the assessment of varicoceles. However, there are certain limitations and challenges associated with using SWE for varicocele evaluation:

1. **Technical Limitations:** SWE requires high-quality imaging and the accuracy of the measurements can be influenced by the skill of the operator and the quality of the ultrasound machine.
2. **Patient Variability:** Factors such as patient body habitus, the presence of subcutaneous
fat, and anatomical variations can affect the accuracy of SWE measurements.
3. **Reproducibility**: Although SWE is generally reproducible, there can be inter- and intra-observer.
variability. Consistency in measurements can be challenging to achieve.
4. **Depth And Size Limitations:** The depth and size of the varicocele can affect the quality
of the elastography readings. Deeper or smaller varicoceles may be more difficult to
assess accurately.
5. **Accessibility:** Advanced ultrasound techniques like SWE may not be available in all clinical settings due to their cost and the need for specialized equipment.

Despite these limitations, SWE holds promise as a non-invasive tool for evaluating varicoceles and other scrotal pathologies. Further studies and technological advancements are likely to address some of these challenges and improve the utility of SWE in clinical practice.

## CONCLUSION

Testicular assessment by using ultrasound and shear wave elastography can be utilized in the early identification of varicocele in order to facilitate early intervention and prevent complications. Shear wave elastography provides insights into testicular elasticity and stiffness, with varicocele patients demonstrating increased values. Early assessment of these parameters using SWE can therefore facilitate tailored management, potentially mitigating the risk of infertility.

## SUMMARY

In the present study, age did not show a significant association with varicocele. Lower testicular volume was observed in varicocele patients compared to non-varicocele individuals, while their SWE values were notably higher. No significant difference was observed in testicular volume or SWE among the grades. It suggests that the severity of varicocele, as indicated by the grades, does not have a discernible impact on testicular volume or elasticity as measured by SWE. The value of dilation of the pampiniform plexus was significantly raised in concordance with the grade. Hence, it is prudent to expect that as the grade of varicocele increases, there will be a corresponding increase in the dilation of the pampiniform plexus.

| Study Variable | Study Group | N | Mean | Median (IQR) | P-Value |
|---|---|---|---|---|---|
| Testicular Volume | Varicocele | 60 | 9.97± .843 | 10 (9.25-10) | P<0.001 |
| | Control | 60 | 14.88±1.748 | 15 (14-16) | |

**Table 1: Comparison of Testicular Volume between the Diseased and Control Groups**

| Study Variable | Study Group | N | Mean | Median (IQR) | P-Value |
|---|---|---|---|---|---|
| SWE | Varicocele | 60 | 13.85±.988 | 14 (13-14.75) | P<0.001 |
| | Control | 60 | 7.01±1.078 | 6.75 (6.40-7.90) | |

*Table 2: Comparison of SWE between the Diseased and Normal Group*

| Study Variables | Frequency | % |
|---|---|---|
| Bilateral | 17 | 28.3 |
| Left-Sided | 25 | 41.7 |
| Right-Sided | 18 | 30 |
| Total | 60 | 100 |

**Table 3: Distribution of Varicoceles According to Sides**

| | Frequency | Percentage (%) |
|---|---|---|
| Grade I | 18 | 30.0% |
| Grade II | 18 | 30.0% |
| Grade III | 12 | 20.0% |
| Grade IV | 12 | 20.0% |
| Total | 60 | 100.0% |

*Table 4: Grade Wise Distribution of Varicocele Cases*

| | Grade | N | Mean ±SD | 95% Confidence Interval for Mean | | Minimum | Maximum | P-Value |
|---|---|---|---|---|---|---|---|---|
| | | | | Lower Bound | Upper Bound | | | |
| Testicular Volume | I | 18 | 10.37 ±0.83 | 9.9580 | 10.7865 | 9.70 | 12.00 | 0.083 |
| | II | 18 | 9.70± 0.713 | 9.3451 | 10.0549 | 8.50 | 11.00 | |
| | III | 12 | 9.90± 0.768 | 9.4116 | 10.3884 | 8.80 | 11.40 | |
| | IV | 12 | 9.93± 0.808 | 9.4116 | 10.4384 | 8.50 | 11.20 | |
| | Total | 60 | 9.99± 0.807 | 9.7782 | 10.1952 | 8.50 | 12.00 | |

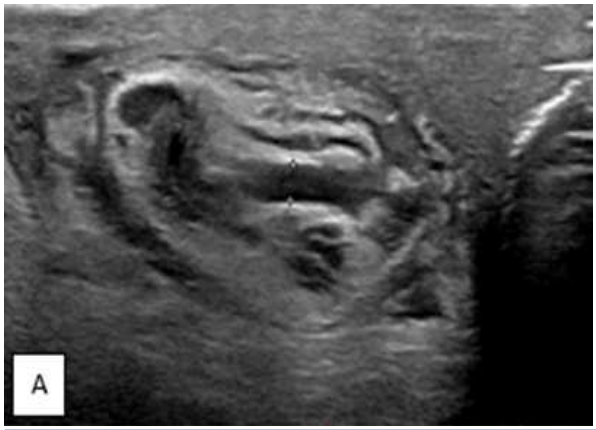
**Table 5: Comparison of Testicular Volume by Grade in Varicocele Cases**

***ANOVA applied**

| | Grade | N | Mean ±SD | 95% Confidence Interval for Mean | | Minimum | Maximum | P-Value |
|---|---|---|---|---|---|---|---|---|
| | | | | Lower Bound | Upper Bound | | | |
| SWE | I | 18 | 11.50± 0.218 | 11.3970 | 11.6141 | 11.20 | 11.90 | P<0.001 |
| | II | 18 | 12.54± 0.188 | 12.4452 | 12.6325 | 12.20 | 12.90 | |
| | III | 12 | 13.56± 0.156 | 13.4589 | 13.6577 | 13.30 | 13.70 | |
| | VI | 12 | 14.75± 0.124 | 14.6710 | 14.8290 | 14.50 | 14.90 | |
| | Total | 60 | 12.88± 1.203 | 12.5641 | 13.1859 | 11.20 | 14.90 | |

**Table 6: Comparison of Mean SWE by Grade in Varicocele Cases**

***ANOVA applied**



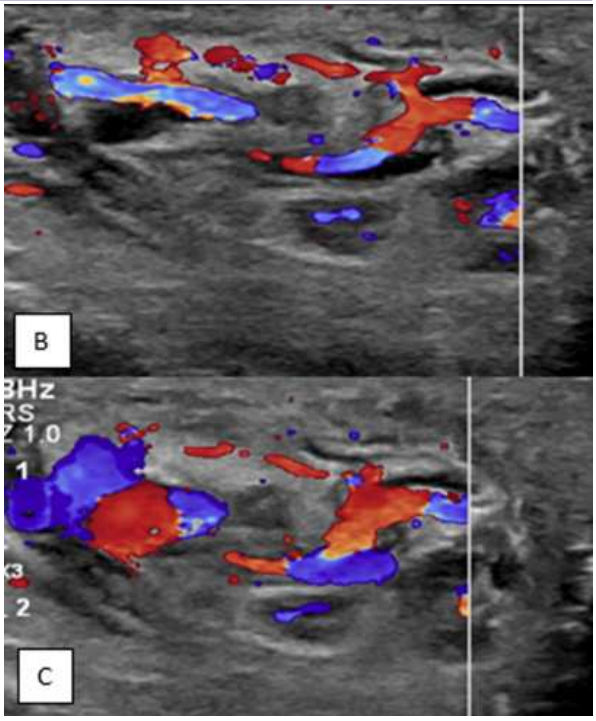




**Figure 1:** Grade II Varicocele
A) Grey Scale Ultrasound Image Showing few Dilated Serpiginous Vessels Superior to the Upper Pole of the Right Testicle.
B) Colour Doppler Imaging Showing Doppler Flow within Dilated Pampiniform Plexus.
C) Colour Doppler Showing Reflux in Upper Pole Veins during Valsalva Maneuver.

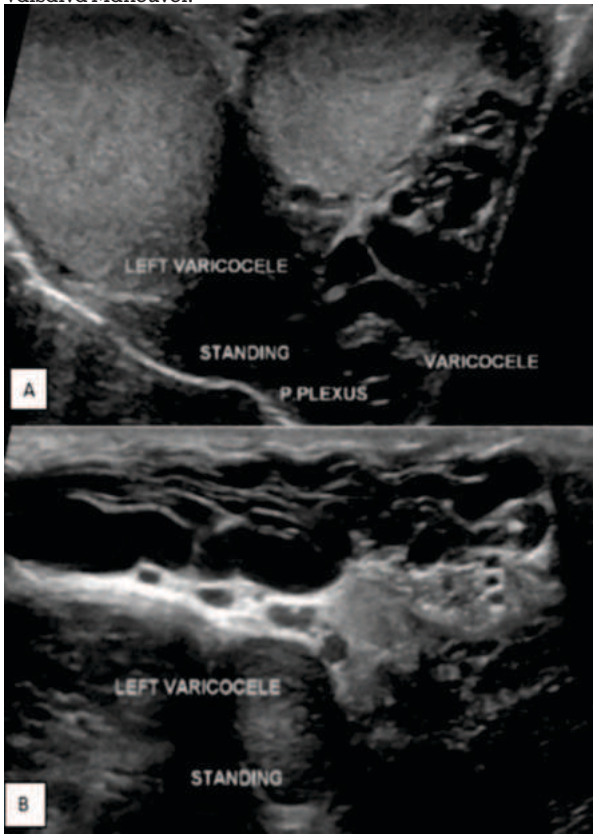



**Figure 2:** Grade III Varicocele
Figure A and B: Ultrasound Grey Scale Image of Testis Showing Dilated Veins upto Lower Pole of Testis, seen only in Standing Position

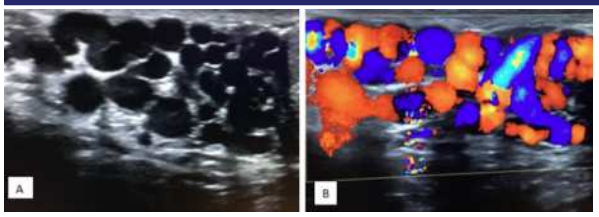


**Figure 3:** Grade IV Varicocele
A) Grey Scale Ultrasound Image Showing Multiple Dilated Serpiginous Vessels Superior to the Upper Pole of the Left Testicle. These Measure upto 4 mm even in the Supine Position.
B) Colour Doppler Imaging Showing Avid Doppler Flow within Dilated Pampiniform Plexus. The Appearances are Exaggerated during Standing and the Valsala Maneuver, No Flow Reversal


**Figure 4:** Ultrasound Image of Testis
A) Elastography measurement taken from Region of Interest, the Measurement was Repeated and Mean Stiffness Value was Analysed.
Mean Tissue Stiffness Measured in Case of Varicocele

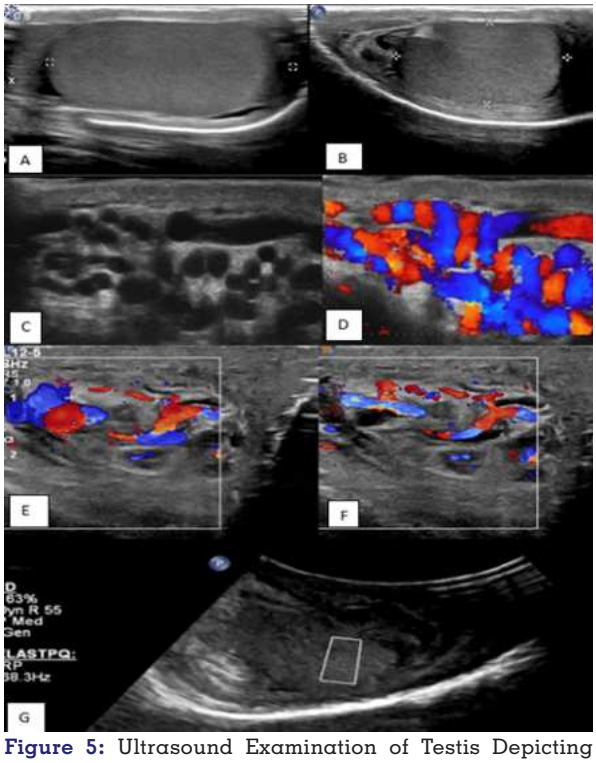


**Figure 5:** Ultrasound Examination of Testis Depicting Varicocele and Elastography
A and B) Longitudinal and Traverse Image of Testis: Testis Appear Normal in Size, Shape and Echotexture.
C) Grey Scale Ultrasound Image Showing Dilation of Pampiniform Plexus.
D) Colour Doppler Image Showing Reversal of Flow in Dilated Pampiniform Plexus
E) Colour Doppler Image Showing Reflux after Valsalva Maneuver
F) Colour Doppler Image Showing No Reflux before Valsalva Maneuver.
G) Region of Interest for Shear Wave Elastography of Testis

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