Testes Parenchymal Shear Wave Elastography Findings in Varicocele

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ABSTRACT

Objective: To investigate the testicular parenchymal changes in patients with varicocele using shear wave elastography (SWE).
Study Design: Cross-sectional study.
Place and Duration of Study: Department of Radiology, Hatay Mustafa Kemal, School of Medicine, Hatay, Turkey, between June and August 2021.
Methodology: The study was conducted on 124 testes of 62 patients who had undergone scrotal ultrasonography. Using the SWE technique, the mean velocity and stiffness values of each testis were measured and recorded, and varicocele volume was calculated by measuring testis volume and the Pampiniform plexus (pp) vein diameter on Doppler examination. After the exclusion criteria, 55 (44.3%) testes with varicocele and 69 (55.6%) testes without varicocele were examined. The relationship between the SWE values of testis volume and the presence and volume of varicocele was evaluated statistically.
Results: The mean velocity value was 0.76 ± 0.08 m/s in the varicocele group and 0.85 ± 0.13 m/s in the without varicocele group; the mean stiffness value was 1.76 ± 0.37 KPa in the varicocele group and 2.25 ± 0.54 KPa in the without varicocele group. The SWE values were found to be significantly lower in testes with varicocele than in those without ($p<0.001$). The mean testis volume was 13.5 ± 4.6 in the varicocele group and 13.8 ± 4.4 in the without varicocele group. No statistically significant relationship was determined between the presence of varicocele and testis volume ($p=0.670$). A significant negative correlation was found between plexus pampiniform diameter and velocity ($rs=-0.405$, $p=0.002$) and stiffness ($rs=-0.399$, $p=0.003$) values.
Conclusion: SWE findings can provide information about testicular damage associated with varicocele. Furthermore comprehensive studies may be of importance in varicocele treatment.

Key Words: *Shearwave elastography (SWE), Testis, Varicocele, Parenchymal stiffness.*

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INTRODUCTION

Varicocele is a vascular anomaly characterised by expansion of the Pampiniform plexus (PP) veins. It is the most frequently seen andrological problem in adolescents and adult males, affecting approximately 15% of the general male population.[1] Varicocele is a well-known cause of reduced testicular function and has been reported to be seen at the rate of 40% in primary infertile patients and 75-81% in patients with secondary infertility.[2]

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The diagnosis of varicocele is essentially based on clinical suspicion. Although the gray-scale and Doppler ultrasonographic determination of varicocele are superior to clinical diagnosis, these methods cannot determine parenchymal damage and fibrosis.[3] In addition to information obtained with traditional gray-scale and Doppler ultrasonography techniques, sonoelastography is a method of evaluating tissue elasticity which has had increasingly widespread use in the last two decades.[4]

There are also studies in the literature that have researched the use of elastography in various testis pathologies such as microlithiasis, tumoral lesions, and hydrocele.[5] However, there is still a limited number of studies that have investigated the use of elastography in patients with varicocele. Shear wave elastography (SWE) is a sonoelastography technique that allows the qualitative and quantitative measurement of tissue elasticity, which has increasingly been used in recent years in both research and clinical practice.[4]

The aim of the present study was to evaluate the effect of varicocele on testicular volume and elasticity using ultrasound and SWE methods.

METHODOLOGY

After obtaining informed consent, this study was conducted at Hatay Mustafa Kemal, School of Medicine, Hatay, Turkey. One hundred and forty four testicles of 72 patients aged between 18-45 years who had secondary infertility despite being sexually active, were evaluated prospectively by scrotal ultrasonography between June and August 2021. Patients were excluded if they had undergone prior scrotal surgery (n = 3); 2) those who had a scrotal pathology other than varicocele (space-occupying lesion, sequelae of orchitis, history of infarctus, microlithiasis, congenital anomaly, n = 7). The gray-scale, Doppler USG, and elastography procedures were simultaneously applied using a LOGIQ E9 9L4 (7-9 MHz) probe, with the patient in a supine position. All procedures were performed by the same radiologist with 3 years of SWE experience. In the gray-scale examination, testis volume was calculated by measuring length, width, and anterior-posterior diameter. The plexus pampiniform (pp) vein diameter was measured by ultrasound. When taking the SWE measurements, the USG probe was placed perpendicular to the parenchyma so as not to apply any pressure eon the testis tissue. Using a region of interest (ROI) of mean 3 mm diameter for each testis in the SWE examination, 3 consecutive measurements were taken and the mean value was calculated for the analysis (Figure 1). The stiffness values were recorded as kiloPascal (kPa) and the velocity values as metre/scond (m/s).

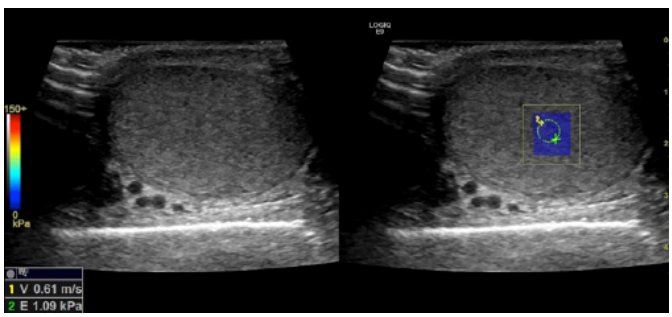

Figure 1: Measurement of the shear wave elastography values.

The diagnosis of varicocele was made based on clinical examination (grade 1= palpable during Valsalva maneuver, grade 2: palpable at rest, grade 3: visible veins). A total of 124 testes were evaluated by dividing them into two groups as those with and without varicocele. Testicular volumes and SWE values were compared between these two groups. In addition, the relationship between pp vein diameters and SWE was investigated in the testes with the varicocele group.

Data obtained in the study were analysed statistically using SPSS 23 and GraphPad prism software. Means and standard deviations were used to describe the continuous variables. Categorical variables were expressed as frequency and percentage. The conformity of continuous data to normal distribution was examined with the Shapiro Wilk test. In the comparisons of continuous variables between groups, the Independent Samples t-test was used. The correlation between PP vein diameters and SWE values was evaluated with Spearman's rank correlation test. A value of $p<0.050$ was accepted as statistically significant.

RESULTS

One hundred and twenty-four testes of 62 cases were finally included in the current study. The mean age was 33.6±6.9 years. Fifty-five (44.3%) testes with varicocele and 69 (55.6%) normal testes without varicocele were examined. Unilateral varicocele was detected in 39 (83%) of 47 varicocele patients, and bilateral varicocele in 8 (17%) of them. Among the patients with unilateral varicocele, 33 (70.2%) had left side varicocele and 6 (12.8%) had right side varicocele. In 15 (24.1%) cases, varicocele was not observed. There were 55 (44.3%) testes with varicocele and 69 (55.6%) normal testes (without varicocele). The mean testis volume was 13.5 ± 4.6 ml in the testes with the varicocele group and 13.8 ± 4.4 ml in the without the varicocele group. No significant difference was determined between testis volume and the presence of varicocele (p=0.670).

The mean velocity value was 0.76 ± 0.08 m/s in the testes with the varicocele group and 0.85 ± 0.13 m/s in the without varicocele group. The mean stiffness value was 1.76 ± 0.37 KPa in the varicocele group and 2.25 ± 0.54 KPa in the without varicocele group. The velocity and stiffness values were determined to be statistically significantly lower in the testes with varicocele compared to those without (p<0.001, Table I).

Table I: The volume, velocity, and stiffness values of testes with or without varicocele.

	Testes with varicocele (n:55)	Testes without varicocele (n:69)	p-value
Age (years)	32.7 ± 6.2	34.2 ± 7.4	0.228
Testes volume (cc)	13.5 ± 4.6	13.8 ± 4.4	0.670
Velocity (m/s)	0.76 ± 0.08	0.85 ± 0.13	<0.001
Stiffness (kPa)	1.76 ± 0.37	2.25 ± 0.54	<0.001

Independent Samples t-test results. Quantitative data were expressed a mean and standard deviation. SWE: shear wave elastography; m/s: meters/second; kPa: kilopascal.

In the testes with varicocele, as the pp vein diameter increased, there was observed to be a decrease in SWE values. A significant negative correlation was found between pp vein diameter and velocity (rs = -0.405, p = 0.002) and stiffness (rs = -0.399, p = 0.003) values (Figure 2).

DISCUSSION

The mechanism by which varicocele creates damage in the testicular parenchyma is not yet fully understood.[2] According to the proposed mechanism, It reduces arterial blood flow by causing impaired venous drainage, venous stasis, and increased venous pressure. Hypoxia resulting from disruption of microperfusion causes disruption in mitochondrial energy metabolism.[6] In addition, apoptosis is thought to be triggered by

oxidative stress caused by reactive oxygen products occurring because of increased testicular heat due to venous stasis.[6]

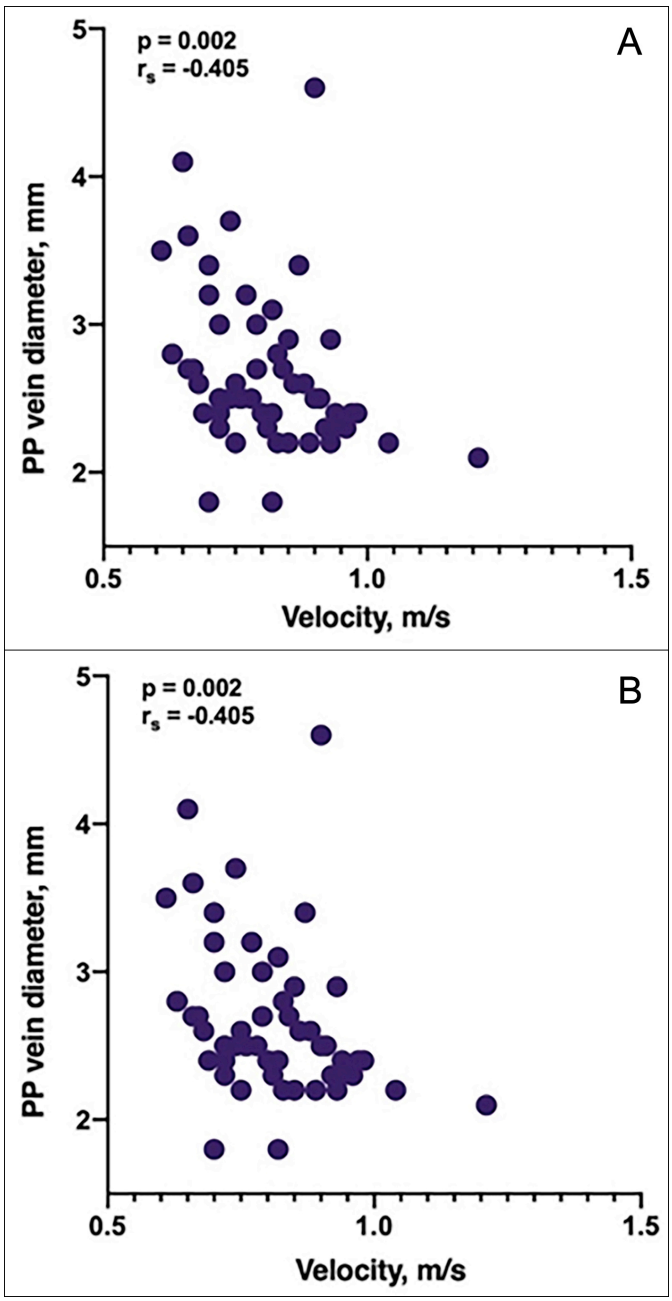

Figure 2: Correlation between PP vein diameter and SWE values. (A) Velocity, (B) Stifness.

Currently, histopathological sampling is not recommended in patients with varicocele. Nevertheless, there are some previous studies that have investigated the histopathological changes in patients with varicocele. The changes defined in those studies are peritubular sclerosis occurring because of collagen deposits formed by fibromyocytes in the peritubular sheath, thickening in the tubular basal membrane, sclerosis in small vessels, reduced spermatogenesis, germ cell atrophy, and an increase in interstitial fibrous tissue.[7]

It is thought that as a result of all these mechanisms there will be hypotrophy in the affected testis. In the literature, there are several studies that have investigated the relationship between testis volume and varicocele. In the majority of those studies, the testis volume on the side with varicocele in infertile patients has been found to be lower than that of the contralateral side without varicocele.[8-10] In a study of fertile and infertile patient groups, although testis volume was found to be lower on the side with varicocele, no significant difference was observed between testis volumes in patients with subclinical varicocele.[11]

There is a limited number of studies in the literature which have aimed to determine the changes made by varicocele in testis parenchyma with elastographic examinations. In some of these studies, SWE was used, as in the current study, and in some, the strain elastography technique was used. The strain elastography method is based on the movement of tissues with compression applied by the probe, and semiquantitative data are obtained about stiffness with this method.[12] As the severity of compression can vary from person to person, there are disadvantages such as high operator dependence and that semiquantitative data are obtained. SWE is an objective, quantitative, easily repeatable method based on the fact that the velocity of shear waves is different in different tissues.[12] As SWE does not require compression, it has the advantages of lower operator dependence and that stiffness and velocity values can be calculated quantitatively.

Studies that have investigated the relationship between varicocele and testis tissue elasticity have obtained different results. In some studies, the stiffness values in testes with varicocele have been found to be higher than the values in testes without varicocele, and this has been explained by fibrosis occurring in these testes and increased stiffness is a well-known sonoelastographic characteristic of fibrosis.[13-18] In contrast to those studies, Dede *et al.* and Bitkin *et al*. reported lower stiffness values in testes with varicocele.[19,20] It is noteworthy that in studies that have reported higher stiffness values in testes with varicocele there has also been observed to be a decrease in testis volume.[14-17] In a study by Jedrejewski *et al*. SWE values were found to be higher in testes with >20% volume loss of the testis with varicocele, and no significant difference was found between the SWE values of testes with varicocele where volume loss was <20% and normal testes.[13] In another study which determined a negative correlation between the SWE values of testes with varicocele and normal testes, no significant difference was determined between the volume of testes with varicocele and normal testes.[20] In the current study, the SWE values were found to be lower in testes with varicocele compared to those without, and no significant difference was determined in respect of testis volume. When evaluated together with studies in the literature, this finding suggests that increased stiffness values in patients with varicocele develop in parallel with a decrease in volume. Previous studies investigating the relationship between varicocele and testicular elasticity are summarised in Table II.

Table II: The relationship between varicocele and testes stiffness and testes volume in the literature.

Study	Elastography technique	Varicocele-testes Stiffness correlation	Varicocele- testes volume correlation
Dede *et al.*	ARFI (m/sn)	Negative	Not evaluated
Turna *et al.*	SWE (kPa)	Positive	Negative
Salama *et al*.	Strain elastography	Positive	Negative
Bitkin *et al.*	Strain elastography	Negative	No correlation
Jedrzejewski *et al.*	SWE (kPa)	Volume reduction >20% group positive correlation Volume reduction <20% group no correlation	Negative
Erdogan *et al*.	SWE (m/s), (kPa)	Positive	Negative
Camoglio *et al.*	Strain elastography	Positive	Negative
Present study	SWE (m/s), (kPa)	Negative	No correlation

ARFI: Acoustic radiation force impulse, SWE: Shear wave elastography.

Although the histopathological examination was not made in the current study, it can be thought that the lower SWE values found in the testes with varicocele were detected at an earlier stage before the occurrence of irreversible changes which increase tissue stiffness such as interstitial fibrosis, which has been reported in previous studies. This opinion is supported by the fact that in the current study of patients, there was no decrease observed in volume, which is a long-term finding of varicocele.

In a study that investigated the reliability of SWE in the estimation of fertility potential, a negative correlation was determined between sperm parameters and SWE values, and no significant relationship was found between the presence of varicocele and SWE values.[21]

Surgery or percutaneous embolisation is applied in the treatment of varicocele. Although they have reported an increase in testis volume and sperm quality with varicocele treatment, the benefit to fertility is a matter of debate.[10] In a study by Onozova *et al*. which reported the long-term results of varicocele surgery, the pregnancy rates of the group applied with surgery were determined to be much higher than those of patients applied with a conservative approach.[22] In another multicentre study, no statistically significant difference was determined in the pregnancy rates between the group applied with varicocele surgery and the group followed up conservatively.[23] In patients with varicocele SWE findings may provide information about whether or not there are irreversible changes such as fibrosis, and consequently, it can be predicted that varicocele surgery or percutaneous treatment is of benefit for fertility. However, to be able to confirm this hypothesis, there is a need for further comprehensive studies including SWE measurements before and after varicocele interventions and the birth rates after treatment.

There were some limitations to this study, primarily the relatively low number of patients and that the spermiograms and hormone levels of the cases were not examined. Furthermore, a histopathological examination was not made in this study.

CONCLUSION

In conclusion, the results of this study demonstrated that the SWE values in testes with varicocele were lower than those of normal testes. We also found a negative correlation between pp vein diameter and velocity and stiffness. With the support of more comprehensive studies to be done, it can be thought that SWE examination will be more guiding in the diagnosis and follow-up of varicocele patients.

ETHICAL APPROVAL:

This study was approved by the ethics committee of Hatay Mustafa Kemal University on 24.06.2021 with the Approval No. 2021/80.

PATIENT'S CONSENT:

Informed consent was obtained from all individual participants included in the study.

COMPETING INTEREST:

The authors declared no competing interest.

AUTHORS' CONTRIBUTION:

KA: Conceptualisation, data curation, investigation, methodology writing-review and editing.
SA: Conceptualisation, methodology, visualisation, writing-review and editing.
TU: Data curation, methodology.
GKH, GS: Investigation, methodology.
All authors approved the final version of the manuscript to be published.

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