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Original Research Article

Role of testicular elastography in the evaluation of male infertility: a comparative cross-sectional study

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ABSTRACT

Background: An estimated 70 million people worldwide are thought to be affected by some severity of infertility. Ultrasound, MRI, and invasive procedures like venography and vasography are the usual investigations taken for the evaluation of infertility. Ultrasound is the preferred initial modality due to its availability and non-invasive nature. In our study, we evaluated the usefulness of advanced ultrasound techniques like Doppler and Elastography and compared the results with biochemical parameters of semen analysis.

Methods: A comparative cross-sectional study was conducted over a period of one year, on men between the ages of 22 and 45, with normal or abnormal sperm analysis reports, who presented with inability to conceive. The testicular parenchyma resistive index, shear value and shear ratio were recorded. The mean values of the data and their standard deviations were assessed and compared by Student's t-test. The correlation of semen parameters with RI and shear wave indices was tested by One way ANOVA test, with a p value<0.05 considered statistically significant.

Results: Our study found that strain value and strain ratio were significantly elevated in the non-fertile group compared to the fertile group. The resistive index of the intraparenchymal arteries did not show any difference between infertile and fertile men.

Conclusions: Hence, we concluded that strain value and strain ratio are important investigative tools in the evaluation of male infertility. However, since our study was conducted on a small sample, larger large-scale studies are useful in establishing a concrete conclusion.

Keywords: Elastography, Infertility, Strain ratio, Male infertility

INTRODUCTION

An estimated 70 million people worldwide are thought to be affected by the common problem of infertility. According to estimates from the World Health Organization (WHO), 50% of the problems with infertility are caused by male factors, which affect 9% of couples globally. Humans have a lower fertility rate compared to many other species. After 12 months, around 90% of couples with proven fertility achieve pregnancy, increasing to 95% after 2 years.[1] In 40-50% of cases of infertility, a condition involving the male partner is a contributing factor.[2] Ultrasound, MRI, and invasive procedures like venography and vasography are the three primary imaging modalities utilised to examine the male reproductive system. Due to its non-invasive nature, safety, and accessibility as well as its capacity to identify various abnormalities pertinent to male infertility, ultrasound continues to be the cornerstone. Elastography, a new imaging technique that displays images of tissue stiffness, has been shown to be a promising tool for the structural and functional evaluation of testicular tissue.[3]

One of the most significant advancements in the arsenal of sonographic techniques in recent years has been the development of sonoelastography (SE), a more recent imaging technique used in conjunction with ultrasound. While not being utilised frequently in urology clinical practice, prior research has demonstrated its value in the evaluation of pathologies of other organs like breast and thyroid diseases, as well as its importance in diagnosing and staging acute appendicitis.[4]

METHODS

A comparative cross-sectional study was conducted at Fakhruddin Ali Ahmed Medical College and Hospital, Barpeta, Assam, over a period of one year, from February 2022 to February 2023. The study population consisted of 50 men, between the ages of 22 and 45, with normal or abnormal sperm analysis reports, who presented with inability to conceive, in spite of regular unprotected intercourse with their spouse for a duration of one year. Exclusion criteria included participants who had any procedure or treatment related to infertility, history of chemotherapy, congenital testicular anomalies, or obvious testicular lesions on grey scale ultrasound like hematoma, varicocele, rupture or mass in the testis. The patients were divided into two groups, fertile and infertile groups. The infertile group included patients who had abnormal semen analysis results. On the other hand, the fertile group consisted of men with normal semen analyses and the presenting infertility was either linked to their female partner or idiopathic. Basic patient data was collected using a standard questionnaire/proforma that included patient details and relevant history after obtaining informed consent. All the patients underwent sonographic evaluation of bilateral testis, on a Samsung RS80A ultrasound machine, using a 7-12 MHz linear probe. The ultrasound evaluation included grey-scale imaging for focal or diffuse testicular parenchymal lesions, followed by measurement of the resistive index (RI) of the testicular intraparenchymal arteries using spectral Doppler study in the supine position. (Figure 1). Next, strain elastography of the middle part of the testis was performed and the strain value (SV) of the testicular tissue was recorded. The strain ratio (SR) was calculated by assessing equal-sized ROI in testicular tissue (A) and scrotal subcutaneous tissue (B) (Figure 2). The SR value was calculated automatically by the ultrasound machine. The mean values of the data and their standard deviations were assessed and compared by Student's t test. The correlation of semen parameters with RI and shear wave indices was tested by One way ANOVA test, with a $p<0.05$ considered statistically significant. ROC curves were assessed for RI, SV and SR to determine the diagnostic performance.

RESULTS

The clinical parameters recorded from our study are summarised in (Table 1). In our study, there was significant variation observed between the groups, with the infertile group exhibiting significantly higher mean SR compared to the fertile group.

Table 1: Demographic data and clinical characteristics of study population.

Parameters	Fertile group	Infertile group	P value
Number of patients (N)	25	25	-
Mean resistive indices	0.48±0.09	0.45±0.08	0.218
Mean strain values	4.40±2.27	5.82±2.34	0.002
Mean strain ratios	0.21±0.11	0.32±0.15	<0.001
Number of spermatozoa ($n\times10^6$/ml)	55.36±33.2	9.8±25.1	<0.001
Normal Morphology (%)	6.1±1.63	0.19±0.78	<0.001
Mean number of total motile sperm (%)	40.60±2.89	7.2±8.68	<0.001

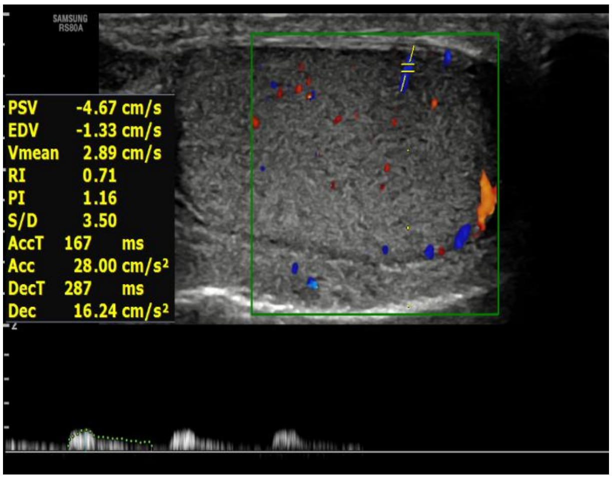

Figure 1: Trans-scrotal sonographic evaluation showing spectral doppler assessment of testicular parenchyma vessel.

Also, the mean SV of the infertile group was significantly higher compared to the non-fertile group. However, we did not find any significant difference between groups, while assessing the mean values of RI of testicular parenchymal vessels. Furthermore, an analysis of the ROC curve demonstrated that SR had the largest area under the curve (AUC) and displayed a significant difference between the two groups, as evidenced by a p value of less than 0.001. Additionally, we assessed several semen abnormality subgroups within the infertile group and found no significant distinctions in elastography scores among different sperm abnormalities.

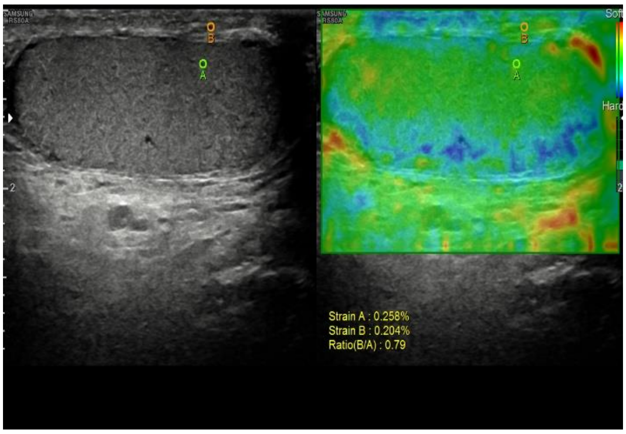

Figure 2: Trans-scrotal sonographic evaluation showing shear wave elastography of testicular parenchyma compared to scrotal subcutaneous fat.

DISCUSSION

Infertility is a common issue that affects millions of men worldwide, affecting approximately 70 million people world-wide.[5] While the causes of infertility are multifactorial, abnormalities in testicular function are a major contributing factor. Testicular dysfunction can result from a variety of conditions, including genetic abnormalities, immunological, drug-related, malignancies, infections, varicocele, and exposure to toxins or radiation.[6] Diagnosis of the underlying cause of infertility is essential for appropriate management and treatment. There are two primary approaches to evaluating stiffness: strain elastography and shear-wave elastography. Strain elastography gauges stiffness based on the level of strain caused by manual compression, but its effectiveness is hindered by the operator's ability to consistently apply sufficient compression. To address this issue, shear-wave elastography (SWE) was developed as a more reliable alternative. SWE is a more reproducible method for assessing stiffness.[7]

In recent years, SWE has emerged as a promising non-invasive technique for evaluating testicular function in both clinical and research settings. Several studies have revealed that by assessing the elasticity of testicular tissue, SWE elastography can provide valuable insights into the parenchymal damage that can contribute to an abnormality in sperm quantity.[8] The objective of our study is to emphasize the significance of shear wave elastography in the evaluation of male infertility. Recent technological developments have established ultrasound (US) as the primary choice for male genital tract examination. B-mode and colour Doppler US, in conjunction with strain and shear wave elastography, have been recognized as effective tools for investigating testicular tissues and spermatogenesis.[9] Shear wave elastography (SWE) is a newer technique that combines B-mode image with colour-coded US generating a quantitative image of the tissue stiffness (kPa) in real-time conditions.[10]

The strain elastogram's colour map for a healthy testicle shows a green colour in the centre of the parenchyma with blue edges, and red bands surrounding it. This characteristic pattern is referred to as a 3-ring structure.[11] In our study, the mean resistive index of the intraparenchymal arteries did not show any significant difference between infertile and fertile men. However, the strain values and strain ratios were significantly higher in infertile men with abnormal semen parameters compared to those with a normal semen analysis. A study by Küçükdurmaz et al. also found similar results.[12] Studies by Pinggera et al and Khani et al however, found that patients with abnormal sperm features had increased vascular resistance.[13,14] Additionally, the elasticity of testicular tissue was found to be negatively correlated with sperm concentration and total motile sperm count, with higher strain ratio values observed in patients with abnormal semen parameters. Moreover, in our study, the strain ratio of patients with decreased sperm count was high, and hence elastography may be a useful tool in such cases.

These findings suggest that strain elastography is a promising non-invasive and cost-effective imaging modality for the evaluation of male infertility, particularly in cases where invasive procedures may not be feasible or appropriate. Our study underscores the potential of elastography as a valuable tool in the evaluation of male infertility, providing clinicians with additional information for the management and treatment of patients with fertility issues. However, our study is not without limitations. The sample size of patients was low in our study. Also, doppler indices like RI and Shear wave indices like SV and SR are operator dependent and also depend on the optimisation of image acquisition. Hence further large-scale studies with multiple readings on the same patient are warranted before the conclusion of a concrete conclusion.

CONCLUSION

Current research found that infertile men with abnormal semen parameters had higher strain values and ratios than those with a normal semen analysis. Furthermore, the strain elastography results showed significant differences in patients with abnormal sperm counts. This indicates that this technique is a useful tool for evaluating male infertility. However, larger studies are necessary to fully understand the value of this imaging method in assessing male infertility.

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