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The Comparison of Resistance Index of Testicular Artery Using Color Doppler Ultrasound in Infertile Men Undergoing Varicocelectomy

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Abstract

Background: Varicocele is one of the leading causes of infertility in men. Resistance index (RI) in testis is a parameter indicating parenchymal perfusion and microvascular functions. Increased RI in the testis of patients with varicocele might be a sign of impairments in microvascularization and a significant decrease in testicular perfusion. In the present study, RI in capsular and intraparenchymal testicular arteries was evaluated in patients with varicocele who underwent varicocelectomy.

Methods: This prospective cohort study was performed in 2019-2020 in Guilan, Iran. Sixty-six patients were included. Semen analysis was also done before surgeries. Patients with at least one disorder in semen analysis entered the study. RI in testicular arteries was measured by an experienced radiologist before surgeries. Six months after varicocelectomy, all patients underwent the same semen analysis and ultrasound imaging. Data were analyzed using SPSS software. The tests for analysis included McNemar Test and Wilcoxon and $p<0.005$ was considered as the significance level.

Results: According to the results, 42 patients (63.6%) had positive changes in sperm analysis after surgeries. Sperm analysis showed a significant increase in number, concentration, morphology, and motility of sperm after surgeries ($p<0.001$). Further measurements of capsular and intratesticular RI in all patients also indicated a significant decrease ($p<0.001$).

Conclusion: Increased RI might be associated with impaired microperfusion in testis followed by impairments in semen. Moreover, mean capsular and intratesticular RI in patients decreased after surgeries and this decrease was significantly more in patients who had improvement in their semen parameters.

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Introduction

Varicocele is defined as dilated spermatic veins and also reticular veins. Studies indicated that the prevalence rate of varicocele is almost 15% in the general population (1). It has also been indicated that 35-44% of men with primary infertility and 45-81% of men with secondary infertility are later diagnosed with varicocele (2). There has been a direct relationship between varicocele and lower qualities of semen in men referring to infertility clinics (3, 4). Scrotal hyperthermia, changes in the bloodstream of the testis, increased venous pressure, hypoxia, hormonal dis-

orders, and accumulation of toxins are the most known factors for the effects of varicocele on the quality of semen (5-7).

The golden standard for diagnosis of varicocele is based on clinical examinations which are divided into 3 grades; grade 1 varicocele is touchable only during valsalva maneuver, grade 2 is easily touchable without valsalva maneuver, and grade 3 could be observed without any touching (8, 9). Imaging studies also play pivotal roles in the diagnosis and staging the varicocele. These studies include performing ultrasound, color Doppler ultrasound (CDUS) and phlebography (10).

With increased progress in ultrasound imaging modalities, structural and functional studies of the testis are available. These structural studies include evaluating parenchymal volume and echo and functional studies include macrovascular and microvascular evaluations which indicate perfusion characteristics of the testis (11). Testicular vascularization is performed by 3 main arteries. These include testicular artery (TA), cremasteric artery (CA), and deferential artery (DF). TA is also divided into capsular and intra-parenchymal branches (12). As mentioned above, CDUS studies could evaluate the perfusion of the testis. Resistance index (RI) is a parameter indicating parenchymal perfusion and microvascular functions of the testis (13). Increased RI in the testis of patients with varicocele might be a sign of impairments in microvascularization and also a significant decrease in testicular perfusion. Spermatogenesis is a sensitive process in which the perfusion of the testis could affect the process (14).

Varicocelectomy is performed using different surgical techniques (15). Changes in semen parameters are observed after varicocelectomy (16). Previous studies have evaluated such parameters in patients and these studies have reported variable results. In the present study, an attempt was made to evaluate and compare color Doppler indexes including RI in capsular and intraparenchymal testicular arteries in patients with varicocele who underwent varicocelectomy in Razi hospital in Rasht, Iran.

Methods

This prospective cohort study was performed in 2019-2020 in Razi hospital, Guilan, Iran. The current study was approved by the research committee of Guilan University of Medical Sciences and the ethics committee has confirmed it (Ethics code: IR.GUMS.REC.1398.390). In this study, infertile men referred to the urology and infertility clinic of Razi hospital were included. Our inclusion criteria were having at least one disorder in semen analysis, clinical diagnosis of varicocele and being a candidate for varicocelectomy. The exclusion criteria were having a systemic disease (Including hypertension or diabetes mellitus), history of undescended testis, history of hydrocele, history of surgeries on the testis, inguinal area or pelvis, history of testis torsion, testis radiotherapy, history of medications (Including gonadotropin and anabolic steroid), and smoking.

Disorders in sperm analysis were regarded as less than 15 million sperm per milliliter, less than 1.5 milliliters of volume, less than 4% normality in morphology and less than 40% motility after one hour of ejaculation.

Patients entered the study based on inclusion and exclusion criteria. Physical examinations were performed on each patient using the valsalva maneuver by an experienced urologist for grading the varicocele. Semen analysis was also done before surgeries for each patient using self-masturbation after 3-4 days of having no intercourse. CDUS of testicular arteries and scrotal CDUS were also performed by an experienced radiologist for each patient in supine and relaxing position before surgeries. GE Voluson E6 ultrasound was used with high-resolution transducers. RI in testicular arteries was measured for each patient before surgeries.

Surgical procedures were performed using traditional methods with an inguinal approach under general anesthesia. Six months after surgeries, all patients underwent the same semen analysis and ultrasound imaging. Data were collected and compared using SPSS software version 25. The tests for analysis included McNemar Test and Wilcoxon and $p<0.005$ was considered as the significance level.

Results

The present study was performed on 66 infertile men who had disorders in their sperm and who were candidates for varicocelectomy. The mean age of patients was 29.57±3.84 years (Range of 22-36 years). Our primary analysis showed that 37 patients (56.1%) had grade I varicocele, 22 patients (33.3%) had grade II and 7 patients (10.6%) had grade III varicocele.

Data analysis indicated that a total number of 42 patients (63.6%) had positive changes in semen analysis and 24 patients (36.4%) did not respond

to varicocelectomy. Analysis of patients with positive effects of varicocelectomy on sperm analysis showed that four measured factors (Number, concentration, morphology and motility) significantly increased after surgeries (p<0.001). These data are indicated in table 1.

Further measurements of capsular and intratesticular RI in all patients also indicated a significant decrease (p<0.001). Mean capsular RI was 0.58±0.03 before surgeries and after interventions which decreased to 0.54±0.04 (Table 2).

Our data also showed that in patients with positive effects of varicocelectomy on sperm analysis, the mean capsular and intratesticular RI was significantly lower than patients who did not have improvement in sperm parameters (Table 3).

Discussion

In the current study, sperm analysis and capsular and intratesticular RI were evaluated among 66 infertile men who underwent varicocelectomy and it was indicated that 42 patients had significant improvement in their sperm parameters. This improvement was observed in all of the measured items (Number, concentration, morphology, and motility). Furthermore, it was shown that mean capsular and intratesticular RI in patients decreased after surgeries and this decrease was significantly more in patients who had improvement in their sperm parameters. These data emphasize the important role of varicocele as an etiologic factor for infertility and also the importance of RI as a possible affecting factor in patients with infertility. The significant decrease in capsular and intratesticular RI along with improvement in sperm parameters indicated that testicular CDUS is an effective and non-invasive tool for diagnosis and follow-up of patients with varicocele.

As mentioned above, varicocele is a common urologic problem in juveniles which could nega-

Table 1. Sperm analysis of patients before and after surgeries

Variables	Before surgeries		After surgeries		Amelioration (%)	p-value
	N	%	N	%		
Number						
Abnormal	36	54.5	16	24.2	55.5	<0.001
Normal	30	45.5	50	75.8		
Concentration						
Abnormal	35	53	15	22.7	55.5	<0.001
Normal	31	47	51	77.3		
Morphology						
Abnormal	37	56.1	15	22.7	33.3	<0.001
Normal	39	43.9	51	77.3		
Motility						
Abnormal	42	63.6	16	24.2	39.4	<0.001
Normal	24	36.4	50	75.8		

Table 2. Comparison of capsular and intratesticular RI of patients

Variables	Before surgeries			After surgeries			p-value
	Median±IQR	Min	Max	Median±IQR	Min	Max	
Intratesticular RI	0.56±0.03	0.52	0.64	0.52±0.03	0.50	0.60	<0.001
Capsular RI	0.58±0.03	0.53	0.66	0.54±0.04	0.51	0.63	<0.001

Table 3. Comparison of capsular and intratesticular RI in improved and non-improved sperm parameters

Variables	Improved sperm parameters (n= 42)			Non-improved sperm parameters (n= 24)			p-value
	Median±IQR	Min	Max	Median±IQR	Min	Max	
Intratesticular RI	0.51±0.02	0.50	0.58	0.54±03	0.50	0.60	<0.001
Capsular RI	0.53±0.03	0.51	0.59	0.56±0.03	0.51	0.62	<0.001

tively affect their fertility. Measurements of parenchymal perfusion and microvascular functions of the testis through RI by CDUS have been recently studied in different surveys. In a study by Ünsal et al. in 2007, 15 patients with varicocele and 34 healthy controls were evaluated. RI and microvascular measurements in these patients showed that increased RI and PI of capsular branches of testicular arteries on spectral Doppler ultrasound may be an indicator of impaired testicular microcirculation in patients with clinical varicocele (17). In another study by Akcar et al., 27 men with varicocele and 31 infertile controls were evaluated. They indicated that the RI and testicular volume of cases and controls were not significantly different (18). These results are in line with the findings of our study. They emphasized on this issue that no significant differences could be observed between testicular RI of infertile men and men with varicocele and also suggested that RI measurements could be an important diagnostic method for men with subclinical varicocele. A study was conducted by Tarhan et al. in 2009 in Turkey on 62 patients with a clinical diagnosis of left varicocele. They showed that testicular microvascularization is an important factor in males' infertility. Furthermore, they declared that testicular blood flow decreased in varicocele which might have responded to therapeutic surgeries (19). In this study, the patients who underwent varicocelectomy had decreased capsular and intratesticular RI in comparison to their condition before the surgeries which is similar to above findings of previous studies.

Different lines of evidence have evaluated microvascular characteristics of testis in infertile men with varicocele and showed increased capsular and intratesticular RI among them (20, 21) but very few studies have evaluated the effects of varicocelectomy on these parameters. Ener et al. compared the results of semen analysis and also CDUS parameters before and after varicocelectomy among 30 men. They showed that the results of semen analysis significantly improved after varicocelectomy. They also showed that the resistance parameters, RI and PI, decreased significantly in patients after surgeries and no statistically significant difference in vascular parameters was seen between the patients with improved and unimproved semen parameters (22). These results are somehow in line with the findings of our study. Along with significant improvements in patients' semen and also decreased capsular and intratesticular RI, lower RI indexes were seen in patients which were not in line with the findings of Ener et al. These differences could be due to the study population and also the grade of varicocele in patients. Balci et al. also emphasized the importance of RI measurements in patients with varicocele using CDUS and showed that a significant improvement occurred in testicular blood flow and sperm parameters after surgical varicocele repair (23). Significantly decreased RI and improved sperm indexes resulted from varicocelectomy which are in line with the findings of our study.

In another study by Akand et al. in 2017, 33 patients with varicocele were evaluated for vascularization and sperm parameters before and after varicocelectomy. Along with the significant decrease in pain score in patients, both intratesticular and capsular RI decreased significantly after surgeries. These changes were also associated with improvements in sperm parameters. Similar to our study, they also declared that RI is a useful parameter for detecting changes in testicular microhemodynamics after varicocelectomy (24). A key point of our study was that RI decreased more in patients with improved semen indexes compared with other patients. On the other hand, Semiz et al. showed that RI, PI, and EDV values of capsular and intraparenchymal branches of testicular arteries may not be used as indicators of deterioration of semen parameters. These results were obtained after evaluation of 50 patients with clinically diagnosed varicocele (25). It seems that such differences could be due to clinical conditions of patients or differences in the number and population characteristics of the patients.

Conclusion

Taken together, it was shown that increased RI might be associated with impaired microperfusion in testis followed by impairments in semen. Mean capsular and intratesticular RI in patients decreased after surgeries and this decrease was significantly more in patients who had improvement in their sperm parameters. These data suggest that RI measurements could be an important diagnostic and follow up tool for patients and physicians should pay much attention to this method.

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Conflict of Interest

None.

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