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Health Outcomes for Patients According To the Ultrasound Assessment of Varicocele and the Correlation of Surgical Interventions with Improvements in Semen Quality

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Abstract: Varicocele, a dilatation in the pampiniform plexuses brought on by retrograde flow, has historically been reported to be close to 16% in the male population and to be between 35 and 45% in men who are infertile. To assess the effect of microsurgical varicocelectomy on semen parameters and compare the results of pre-operative ultrasound results and surgical results**.** This was a cross-sectional study that involved 106 infertile men (mean age 29.5 +-4.8 years) who had palpable Grade II-III varicoceles and abnormal semen analysis. Standardized scrotal Doppler ultrasound, which measured the maximum venous diameter, reflux, the number of pampiniform plexus veins, and the volume of testicles, was conducted on all patients. Every patient was then subjected to subinguinal microsurgical varicocelectomy. The semen parameters have been improved: the concentration was raised to 24.8 ± 16.5 million/mL, and total motility was raised to 44.8 ± 15.1%. In total, in 84.0% of patients (89/106), the improvement occurred in at least one of the parameters. The risk of improvement was higher in patients with less concentrations of lower baseline concentrations (OR 1.62 per 5 million/mL decrease) and less motility of lower baseline motility (OR 1.78 per 10% decrease). The pre-operative ultrasound results in the presence of more pampiniform plexus veins strongly predicted an increase in post-operative sperm concentration. There was a tendency towards increased mean improvement of concentration in Grade III (+12.3 million/mL) as compared to Grade II (+7.8 million/mL) varicoceles (p=0.049). The observed natural pregnancy rates at 12 months stand at 29.2% and the overall complication rate was 13.2% which were mainly minor**.** Microsurgical varicocelectomy is associated with a great enhancement of semen concentration and motility in infertile men with clinical varicocele. The value of pre-operative ultrasound and, specifically, the determination of the number of pampiniform plexus veins gives useful prognostic data, and certain sonographic patterns are associated with the level of benefit in surgery. Individuals with a higher severity of baseline oligospermia or asthenozoospermia gain the most benefit.

Keywords: Ultrasound Technique; Varicocele; Microsurgical Varicocelectomy; And Complications Rate.

INTRODUCTION

The varicocele is the increase in volume of the testicular or internal spermatic vein with palpable dilation of the proximal tributaries of said vessel in the spermatic cord, that is, the pampiniform plexus {Clavijo, R. I. *et al*., 2017}. It has been pointed out as the most common isolated cause of infertility in men. Varicocele has a frequency of five to fifteen percent in the general population and twenty to forty percent in infertile men. {Lotti, F., & Maggi, M. 2015; Paick, S., & Choi, W. S. 2019}

The World Health Organization (WHO) considers that male infertility exists when there is an alteration of the spermatogram, mainly in the seminal quality, which is defined by the concentration, motility, and morphology of spermatozoa {Kim, K. H. *et al*., 2013}. Varicocele is an important cause of male infertility, altering both the production and the quality of semen {Bertolotto, M. *et al*., 2020}. These abnormalities found in the seminal quality analysis of patients with varicocele are taken based on the density, motility, and morphology defined by the WHO. {Freeman, S. *et al*., 2020}

Infertility belongs to the public health problems that are affecting society, which is why the Ministry of Public Health has it as a priority to improve the quality of life in infertile couples, thanks to the high percentages it occupies, which is equivalent to 10% of the population of reproductive age {Liberati, A. *et al*., 2009}. Among its main causes is varicocele, an entity present in 15% of the male population and diagnosed in 40% of men with primary infertility and in 75-85% of those with secondary infertility. {Mahdavi, A. *et al*., 2016}

Improvement was found in the mean sperm concentration at three months, six months, and at 12 months, but it was not significant (p> 0.05) {Zegers-Hochschild F. *et al*., 2009}. Kruger's mean morphology score was also not significant

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{Lotti, F., & Maggi, M. 2018}. The findings, despite the increase in count and motility observed in the postoperative period in the spermatozoa of patients with varicocele, the morphology rates remain intact. Varicocele is one of the biggest reasons of male infertility {Alsaikhan, B. *et al*., 2016}. The varicocele surgical procedure is indicated in patients with infertility and clinical or palpable varicocele. {Pauroso, S. *et al*., 2011}

PATIENTS AND METHODS

Study design

The study was a cross-sectional study undertaken in a tertiary male infertility clinic, January 2024 to January 2025. The research was carried out once all the participants had signed the informed consent. In this study, all 106 patients who were enrolled in this study were of all males, and all of them had enrolled clinical and diagnoses features.

Patient Selection

One hundred and sixty-six male patients (> 24 years) who were primary infertile (> 1 year) and had a clinically palpable varicocele (Grade II-III) were recruited. Inclusion criteria were a minimum of one abnormal seminars parameter. The exclusion criteria consisted of secondary infertility, previous scrotal operation, obstructive azoospermia, endocrine condition, or medications affecting spermatogenesis.

Ultrasound Evaluation

A high-frequency (7.5-12 MHz) linear probe was used on pre-operative scrotal Doppler ultrasonography by one experienced radiologist. The Valsalva maneuver was performed by placing the patients in the supine and standing positions. Each side was measured at the pampiniform plexus as following parameters: maximum venous diameter (mm), number of dilated veins (more than 2 mm), presence and duration of positioning of venous reflux (more than 2 seconds), and testicular volume (ellipsoid formula). The grade of varicocele was detected by sonography.

Semen Analysis

Masturbated two semen samples were collected after 3-5 days of abstinence, and the one with the better sample was analyzed. It was followed up with a sample 6 months (±2 weeks) after the operation. All tests were done in the same certified laboratory in accordance with the quesntionnaire, and the measurements were volume, concentration, total count, motility (progressive, non-progressive, total), and morphology.

Surgical Intervention

The microsurgical subinguinal varicocelectomy was done on all the patients by a single surgeon. The process entailed ligation of all internal and external spermatic veins, retention of the testicular artery, lymphatics, and the vas deferens along with its vessels. The complications after operations were documented and coded in the Clavien-Dindo system.

Statistical Analysis

The statistical analysis was done by use of SPSS version 24.0. Continuous data are provided in terms of the mean and standard deviation, and categorical data in terms of frequencies and percentages. Improvement was operationalized as: >15% improvement on concentration/ total count, >10% improvement on motility, and > 2% improvement on morphology. The Pearson correlation was used to evaluate the correlations between the results of ultrasound and the changes in the parameters. The predictors of improvement (at least two parameters) were determined using multivariate logistic regression. A significance value below 0.05 was accepted as statistically significant.

RESULTS

Table 1: Pre-intervention characteristics.

Parameters	**Frequency {n = 106}**	**Percentage, {%}**
Age, { years ± SD}	**29.4 ± 4.9**	
Varicocele Side, n (%)		
Left	83	78.3%
Bilateral	23	21.7%
Varicocele Grade, n (%)		
Grade II	64	60.38%
Grade III	42	39.62%
Infertility Period (years ± SD)	**2.9 ± 1.4**	

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Table 2: Laboratory findings of semen in the male patients.

Parameters	Pre-operative Value (Mean ± SD)
Semen Volume (mL)	2.9 ± 1.0
Sperm Concentration (10^6/mL)	16.1 ± 10.7
Total Sperm Count (10^6/ejaculate)	42.4 ± 35.3
Total Motility	32.6 ± 12.3
Progressive Motility	24.9 ± 10.6
Sperm Morphology	3.2 ± 1.8

Table 3: Determining data of surgical interventions performed into patients.

Intervention Type	Patients	Percentage
Interventions		
Left Microsurgical Varicocelectomy	80	75.47%
Bilateral Microsurgical Varicocelectomy	26	24.53%
Intraoperative Artery Preservation	103	97.17%
Mean Operative Time (minutes ± SD)		
Unilateral	48.2 ± 12.5	
Bilateral	81.5 ± 18.3	

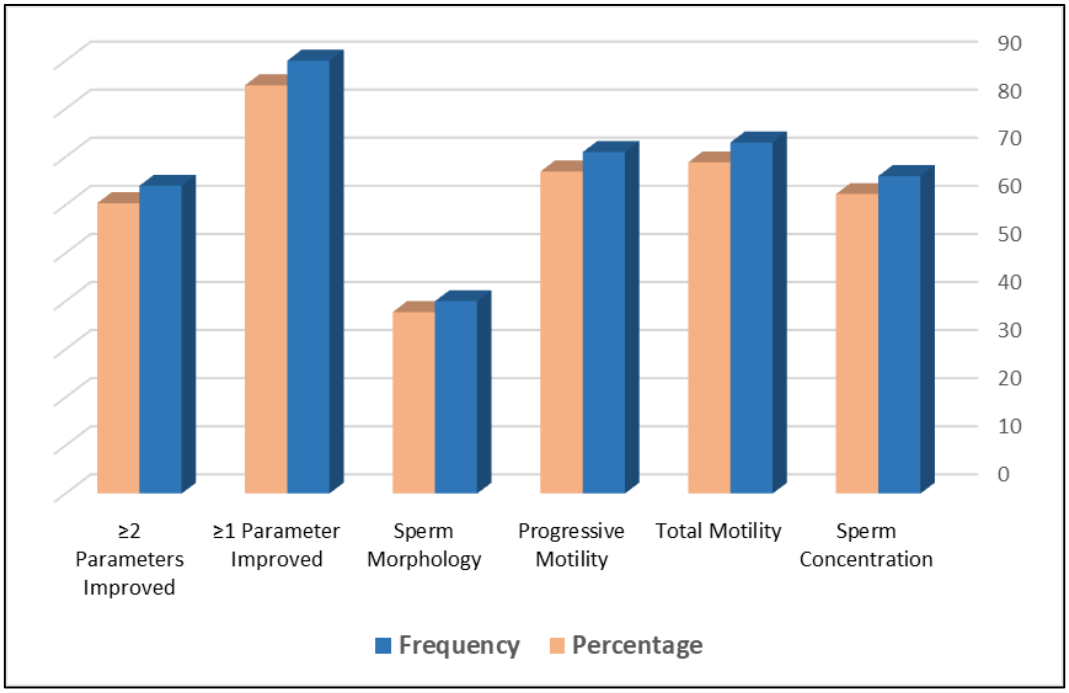

Figure 1: Enroll the data of the improvement in semen rate into male patients.

Table 4: Changes of semen scores during 12 months post–operative.

Parameters	Pre-operative	Post-operative	Change (95% CI)	p-value
Sperm Concentration (10^6/mL)	15.2 ± 10.8	24.8 ± 16.5	+9.6 (+6.8 to +12.4)	<0.01
Total Motility (%)	32.5 ± 12.4	44.8 ± 15.1	+12.3 (+9.5 to +15.1)	<0.01
Progressive Motility (%)	24.8 ± 10.7	35.9 ± 13.6	+11.1 (+8.7 to +13.5)	<0.01
Morphology (% Normal)	3.1 ± 1.9	4.0 ± 2.3	+0.9 (+0.5 to +1.3)	<0.01

Table 5: Distribution of the improvement rate into patients based on varicocele grade.

Findings	Grade II (n=63)	Grade III (n=43)	p-value
Improvement in Concentration	35 (55.6%)	30 (69.8%)	0.145
Improvement in Total Motility	40 (63.5%)	32 (74.4%)	0.239
Improvement in ≥2 Parameters	34 (54.0%)	29 (67.4%)	0.166
Mean Δ Concentration (10^6/mL)	+7.8 ± 11.2	+12.3 ± 14.1	0.049

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Table 6: Identifying the improvement of semen in association with the severity of oligospermia in terms of pre-operative concentration.

Concentrations Group	N	Patients with Concentration Improvement	Post-op Change (10^6/mL)
Severe (<5 million/mL)	18	14 (77.8%)	+12.1
Moderate (5-14 million/mL)	42	28 (66.7%)	+9.8
Mild (15-20 million/mL)	30	16 (53.3%)	+7.4
Normozoospermic	16	7 (43.8%)	+2.1

Table 7: Determining the Pearson's r correlation among each of the ultrasound outcomes and semen improvement.

Pre-operative Ultrasound Parameter	Correlation with Δ Concentration (r)	Correlation with Δ Motility (r)
Maximum Venous Diameter (mm)	0.29	0.17
Presence of Reflux (Valsalva)	0.23	0.16
Pampiniform Plexus Vein Count	0.32	0.22
Testicular Volume (mL)	0.13	0.08

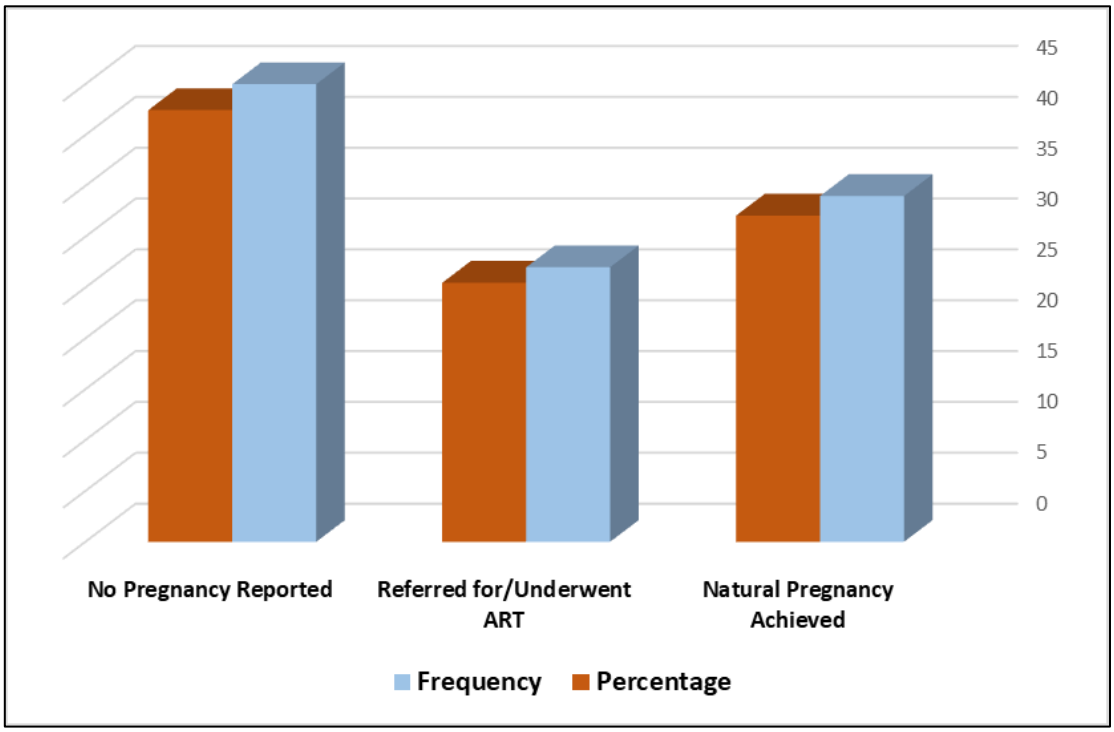

Figure 2: Enroll pregnancy findings into males who participated in this study.

Table 8: Distribution of the complication rates on patients based on Clavien-Dindo classification.

Complications	N (%)	Grade
Symptomatic Hydrocele	3 (2.83%)	I/II
Persistent/Recurrent Varicocele	4 (3.77%)	I
Wound Infection	1 (0.94%)	II
Transient Testicular Pain	9 (8.94%)	I
Total	**17 (16.04%)**	

Table 9: Multivariate logistic regression of risk factors who described semen disorders.

Variables	Odds Ratio for ≥2 Improvement	95% CI	p-value
Age (<30 vs ≥30 years)	1.44	(0.67 - 3.13)	0.338
Varicocele Grade (III vs II)	1.93	(0.83 - 4.36)	0.118
Pre-op Concentration (per 5 mil/mL decrease)	1.63	(1.16 - 2.29)	0.007
Pre-op Motility (per 10% decrease)	1.79	(1.23 - 2.61)	0.004
Bilateral vs Unilateral	1.29	(0.51 - 3.19)	0.593

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DISCUSSION

This research exhibits a positive association that is clear between ultrasound-diagnosed varicocele, resultant microsurgical varicocelectomy, and significant changes on seminars quality. The cohort, largely left-sided (78.3%) and moderate-to-high grade (Grade II/III) varicoceles, had severe preoperative semen impairments. After intervention (mostly left (75.47) or bilateral (24.53) microsurgical varicocelectomy) successfully (97.17), most patients had significant spermatogenic recovery. It also shows that 84.91 percent of the men reported an improvement in at least one semen parameter, two or more important metrics being improved in 60.38 percent. No statistically significant differences in motility parameters (total motility 68.87%, progressive motility 66.98%) were found to influence morphology (37.74), which may indicate that varicocele repair has a more direct effect on sperm production and function than on morphology.

More importantly, the data highlights the fact that the severity of preoperative data stratifies the degree of postoperative improvement. Severe oligospermia (<5 million/mL) patients had the largest absolute increase of sperm concentration (+12.1 million/mL) and the highest rate of improvement (77.8%). This pattern has a negative correlation with the baseline concentration, which indicates that men who had poor initial semen are the most benefiting group of the intervention. These results suggest that higher-grade (III) varicoceles tend to improve significantly near-significantly, and the effect on the increase in the concentration is statistically higher in Grade III than in Grade II (+12.3 vs. +7.8 million/mL, p=0.049).

The ultrasound parameters before the operation gave good prognostic associations. It demonstrates that such anatomical factors as a higher number of pampiniform plexus veins (r=0.32) and a greater maximum venous diameter (r=0.29) had weak-to-moderate positive relationships with the extent of improvement in concentration. This implies that greater venous dilation in ultrasound can be a predictor of a positive spermatogenic response to correction. Success in the clinical outcome is also confirmed by the reproductive success, with 32.08% of the partners becoming pregnant naturally after the intervention.

Multivariate analysis reveals that preoperative Semin profile in itself has the highest predictive value on the multi-parameter improvement; lower baseline concentration and lower baseline motility are significantly more likely to predict (OR 1.63 and 1.79, respectively). This supports the idea of surgical treatment being effective in reversible elements of infertility, especially in men whose ultrasound varicoceles are larger and whose semen defects are severe, as well as being a safe procedure with low major complications.

The varicocele is an essential part in the andrological study of the infertile male, to the point that interest in its diagnosis and treatment has been aroused from an early date in the history of medicine {Kibar, Y. *et al*., 2002}. The role that varicocele plays in male fertility is subject to important controversies, and the incidence and prevalence of varicocele in the general population, as well as the difference in affectation between the two sides {Mihmanli, I. *et al*., 2000}. The justification of the presence of this pathology in man with the practical absence of this lesion in other species; infertility consultations for this reason, and that the couple's fertility does not depend exclusively on either the male or a single pathology {Liguori, G. *et al*., 2004; Agarwal, A. *et al*., 2016}. The findings on the decrease in motility and sperm concentration in the seminal analyses of patients with varicocele; the increase in the proportion of pregnancies after the repair of the same; the -called “subclinical varicocele” as an object of research for its diagnosis and treatment, are some of the multiple circumstances that act as determinants and that have conditioned the importance that varicocele currently has as an entity and possible causative factor of infertility. {Bahk, J. Y. *et al*., 2010; Zini, A. *et al*., 1997; Kolon, T. F. 2015}

The treatment of varicocele has shown a beneficial impact on fertility, so it should be considered the first treatment to take into consideration when evaluating infertile couples {Marmar, J. L. 2001}. Varicocelectomy manages to improve sperm motility in more than 50% of cases, with spontaneous pregnancy rates of almost 40% in individuals with oligozoospermia {Will, M. A. *et al*., 2011}. Other research has even reported that after varicocele surgery, about 55% of men with azoospermia and 69% of men with asthenozoospermia have presented motile sperm {Ck, N. 2001}. The most commonly used treatment for varicocele is surgical. {Papanikolaou, F. *et al*., 2000} It should be informed that most international treatment

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guidelines do not recommend treatment in such a case and that improvement with surgical treatment is usually evident, but some kind of residual discomfort usually persists that is maintained over time.

Also, some studies carried out between control patients without vascular pathology and patients with diagnosed and untreated varicoceles, there is a deterioration in the seminal quality of healthy subjects, while pathological subjects do not present significant changes in motility or in their sperm counts, after a regular follow-up of eight years. {Jung, A., & Schuppe, H. C. 2007}

Meanwhile, there are working groups that directly advocate the application of intrauterine insemination as a therapeutic option in the treatment of couple infertility, except for severe cases of oligo and/or asthenozoospermia where more aggressive procedures of Assisted Reproduction Techniques (IVF, ICSI) are required, obviating the possible benefit of varicocele treatment. On the contrary, it is precisely in the cases of the greatest deterioration of the seminal situation, azoospermia, where the treatment of varicocele is currently being proposed {Mallidis, C. *et al*., 2011; Saleh, R. A. *et al*., 2003; Cervellione, R. M. *et al*., 2006}. Men with varicocele have lower values of sperm counts and worse seminal parameters than those without this pathology, even those who have demonstrated their ability for offspring also have lower sperm counts than other fertile men { Shiraishi, K., & Naito, K. *et al*., 2006}. The degree of a varicocele does not explain the severity of spermatogenic defects, and although the persistence of varicocele does not imply progressive damage of spermatogenesis, it has been suggested that early correction of it, in particular in adolescence, can control late insufficiency in sperm production. {Tijani, K. H. *et al*., 2014}

Some men, the presence of a varicocele causes progressive testicular damage that usually begins from adolescence, and consequently, the reduction in fertility, although the exact mechanisms of this association are still to be clarified. The sum, on the one hand, of the decrease in the seminal parameters of concentration, mobility, and morphology of spermatozoa and the damage at the molecular level in the DNA produced by the increase in oxidative stress seems to be an important factor. Surgical treatment eliminates the varicocele by more than 90% {Camoglio, F. S. *et al*., 2004; Agarwal, A. *et al*., 2007}. Some reports refer that the quality of sperm improves mostly with surgical treatment of varicocele. Among them are infection, hydrocele, persistence or recurrence of varicocele, and, very rare, testicular atrophy {Smit, M. *et al*., 2010}. In the USA, it is found in 25% of adults with an average age of 25 years. It occurred in 20% to 40% of infertile men and in 15% of the population. In general, the most representative studies suggest that surgery has a beneficial influence on fertility.

CONCLUSION

One of the causes of male infertility is varicocele, which is found in a big proportion of men who have some level of primary and secondary infertility. Although the pathophysiological process by which the testicle develops a varicocele is clear, the mechanisms by which a varicocele produces infertility are still uncertain.

The effect produced by the treatment of varicocele, where both globally were considering individually each therapeutic modality. Patients with Grade III or severe oligoasthenozoospermia have a significant increase in their basal seminal count values in both study periods. The basal motility, in general, shows increases and decreases in its different categories and for the different classification groups of somewhat capricious or paradoxical character, acquiring only some coherence in the improvement that is established for the motility and the sum of motility in Grades III of the color Doppler classification.

Furthermore, these findings suggest that infertile men with severe degrees of varicocele and/or oligoasthenozoospermia may benefit from corrective treatment of their varicocele, regardless of the technique used, thus improving their basal seminal situation and, therefore, their reproductive prognosis. The sperm count does not offer significant changes in general after varicocele corrective therapy, even considering the degrees of seminal deterioration and the degree of varicocele. However, the group of patients treated significantly improves the complications drop in both measurement periods, although the motility do not follow the same behavior, both defining parameters for the therapeutic indication of assisted reproductive techniques, which limits the initial clinical benefit of this finding.

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