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Prioritizing Ultrasound Scrotum with Venous and Arterial Doppler as Primary Modality in Cases of Oligoasthenospermia

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ABSTRACT

Background: Oligoasthenospermia is a common contributor to male infertility and is frequently associated with varicocele and impaired testicular perfusion. Conventional semen analysis alone may not adequately identify underlying anatomical and vascular abnormalities.

Objective: To evaluate the association between sperm concentration and varicocele detected on Doppler ultrasonography among patients with oligoasthenospermia.

Methods: This cross-sectional study was conducted at SARF Hospital Islamabad from March 2024 to September 2024. Sixty male patients aged 20–32 years presenting with primary or secondary subfertility and diagnosed with oligoasthenospermia were included. Scrotal ultrasound with venous and arterial Doppler assessment was performed to identify varicocele characteristics. Semen analysis was carried out according to European Association of Urology guidelines. Data were analyzed using SPSS version 23.0. Correlation analysis was performed between sperm concentration and varicocele presence.

Results: Among 60 participants, 52 (86.7%) had primary subfertility and 8 (13.3%) had secondary subfertility. Varicocele was identified in 51 (85.0%) patients, with left-sided varicocele being the most common presentation (73.3%). Grade 3 varicocele was observed in 37 (61.7%) participants. Mean sperm concentration was significantly lower in primary subfertility cases compared to secondary subfertility cases (1.13 ± 0.34 vs 5.91 ± 4.08 million/mL). Correlation analysis demonstrated a weak positive but statistically non-significant association between sperm concentration and varicocele presence ($r = 0.205$).

Conclusion: Varicocele is highly prevalent among patients with oligoasthenospermia, particularly in primary subfertility. Doppler ultrasound provides valuable anatomical and vascular assessment and may serve as a useful adjunct in the evaluation of male infertility.

INTRODUCTION

Male infertility contributes to nearly 50% of infertility cases worldwide and represents a significant public health concern, particularly in low- and middle-income countries.[1] Oligoasthenospermia, characterized by reduced sperm concentration and impaired sperm motility, is among the leading causes of male subfertility.[2] The etiology of oligoasthenospermia is multifactorial and includes hormonal disturbances, genetic abnormalities, environmental exposures, lifestyle factors, and anatomical defects such as varicocele.[3] Varicocele is one of the most frequently identified correctable causes of male infertility and affects approximately 15% of the general male population and up to 40% of infertile men.[4] The proposed mechanisms through which varicocele impairs spermatogenesis include increased scrotal temperature, oxidative stress, hypoxia, and altered testicular blood flow.[5] Early diagnosis of varicocele and associated vascular abnormalities is therefore essential in the management of male infertility.Conventional semen analysis remains the cornerstone of infertility assessment; however, it provides limited information regarding underlying anatomical and vascular abnormalities.[6] Scrotal ultrasonography with venous and arterial Doppler evaluation has emerged as a valuable, non-invasive imaging modality for assessing testicular perfusion and detecting varicocele.[7] Despite its clinical utility, Doppler ultrasound remains underutilized in routine infertility workup in many healthcare settings.Several international studies have demonstrated the importance of Doppler ultrasound in identifying clinically significant varicocele and guiding management decisions.[8,9] However, local data regarding the relationship between oligoasthenospermia and Doppler ultrasound findings remain limited in Pakistan.Therefore, this study was conducted to determine the frequency of varicocele among patients with oligoasthenospermia and evaluate the association between sperm concentration and varicocele detected on Doppler ultrasonography.

MATERIALS AND METHODS

Study Design and Setting

This cross-sectional study was conducted at SARF Hospital Islamabad from March 2024 to September 2024.

Study Population

Male patients aged 20–32 years presenting with primary or secondary subfertility and diagnosed with oligoasthenospermia were included.

Sample Size

The sample size of 60 participants was calculated using OpenEpi version 3.01, assuming a varicocele prevalence of 85%, confidence level of 95%, and margin of error of 9%.

Inclusion Criteria

- Male patients aged 20–32 years
- Primary or secondary subfertility
- Sperm concentration <15 million/mL
- Progressive sperm motility <32%

Exclusion Criteria

- Erectile dysfunction
- Premature ejaculation
- Known genetic abnormalities
- History of testicular surgery
- Right-sided renal masses
- Patients requiring karyotyping due to severe oligospermia

Data Collection Procedure

After obtaining informed consent, detailed demographic and clinical information was recorded. Semen analysis was performed according to European Association of Urology guidelines. Scrotal ultrasound with venous and arterial Doppler evaluation was performed to identify the presence, site, and grade of varicocele. Ethical approval was obtained from the Institutional Review Board of SARF Hospital (Ref No: 228/A0/641).

Statistical Analysis

Data were analyzed using SPSS version 23.0. Frequencies and percentages were calculated for categorical variables. Means and standard deviations were computed for quantitative variables. Correlation analysis was performed between sperm concentration and varicocele presence. A p-value <0.05 was considered statistically significant. Pearson correlation test was applied to assess the association between sperm concentration and varicocele presence. Independent samples t-test was used to compare mean sperm concentration between primary and secondary subfertility groups.

Results

A total of 60 participants were included in the study. Among them, 52 (86.7%) had primary subfertility and 8 (13.3%) had secondary subfertility. Varicocele was identified in 51 (85.0%) participants, while 9 (15.0%) participants had no evidence of varicocele. Left-sided varicocele was the most common finding, observed in 44 (73.3%) patients. Grade 3 varicocele was the most frequently observed grade, affecting 37 (61.7%) participants. Detailed distribution of subfertility status and varicocele characteristics is presented in Table 1. The mean sperm concentration among patients with primary subfertility was 1.13 ± 0.34 million/mL, whereas patients with secondary subfertility demonstrated a comparatively higher mean sperm concentration of 5.91 ± 4.08 million/mL. The difference in

mean sperm concentration between primary and secondary subfertility groups was statistically significant ($p<0.001$). Correlation analysis demonstrated a weak positive association between sperm concentration and varicocele presence ($r=0.205$), which did not reach statistical significance. The correlation analysis results are presented in Table 2.

Table 1: Distribution of Subfertility and Varicocele Characteristics

Variables	Frequency (n)	Percentage (%)
Primary subfertility	52	86.7
Secondary subfertility	8	13.3
Varicocele present	51	85.0
No varicocele	9	15.0
Left-sided varicocele	44	73.3
Bilateral varicocele	7	11.6
Grade 2 varicocele	9	15.0
Grade 3 varicocele	37	61.7
Grade 4 varicocele	5	8.3

Correlation analysis demonstrated a weak positive relationship between sperm concentration and varicocele presence ($r = 0.205$), which was statistically non-significant.

Table 2: Correlation Between Sperm Concentration and Varicocele Presence

Variables	Pearson r	P-value
Sperm concentration vs varicocele presence	0.205	0.116

Pearson correlation test was used to evaluate the association between sperm concentration and the presence of varicocele among patients with oligoasthenospermia. Correlation strength was interpreted according to the Pearson correlation coefficient (r), and statistical significance was considered at $p<0.05$.

DISCUSSION

The present study evaluated the frequency of varicocele and its association with oligoasthenospermia among male patients presenting with subfertility. A substantial proportion of participants demonstrated evidence of varicocele on Doppler ultrasonography, particularly among patients with primary subfertility. These findings reinforce the growing evidence that vascular and anatomical abnormalities play an important role in male infertility and impaired spermatogenesis [13]. In the current study, varicocele was identified in 85% of participants, with left-sided varicocele being the predominant finding. Similar observations have been reported in previous studies where left-sided varicocele was more common because of the anatomical drainage of the left testicular vein into the left renal vein at a perpendicular angle, resulting in increased venous pressure and venous reflux [10,15,16]. The mean sperm concentration observed among patients with primary subfertility was markedly lower than that observed in secondary subfertility cases. This finding is consistent with previous evidence suggesting that prolonged venous stasis, oxidative stress, testicular hyperthermia, and impaired microcirculation may negatively affect spermatogenesis and sperm motility in men with varicocele [17,18]. Liang et al. demonstrated that oxidative stress pathways and ferroptosis contribute significantly to impaired sperm quality in oligoasthenospermia, supporting the pathophysiological basis observed in our study [14]. Although the present study demonstrated only a weak positive correlation between sperm concentration and varicocele presence, previous literature has reported inconsistent associations between varicocele severity and semen abnormalities. Some investigators observed progressive deterioration in semen quality with increasing varicocele grade, whereas others suggested that hormonal factors, genetic susceptibility, and environmental influences may also contribute to impaired fertility outcomes [19,20]. This variability highlights the multifactorial nature of oligoasthenospermia and indicates that varicocele alone may not fully explain the severity of semen abnormalities.Doppler ultrasonography has emerged as a valuable, non-invasive imaging modality for the evaluation of male infertility. It provides detailed assessment of venous reflux, testicular blood flow, and vascular anatomy, thereby improving the detection of clinically significant varicocele [21,22]. Recent studies have emphasized the importance of integrating Doppler imaging into infertility assessment protocols to improve diagnostic accuracy and individualized patient management [23]. The findings of the present study further support the use of venous and arterial Doppler ultrasonography as an adjunctive diagnostic modality in patients presenting with oligoasthenospermia. Several recent therapeutic and experimental studies have also focused on improving sperm quality among patients with oligoasthenospermia. Investigators have explored antioxidant therapies, metabolic regulators, and non-pharmacological interventions aimed at reducing oxidative stress and improving spermatogenesis [24]. In addition, systematic reviews and meta-analyses have demonstrated that early identification and management of varicocele may contribute to improved reproductive outcomes and semen quality among infertile males [25]. The present study has several strengths, including the use of standardized semen analysis and Doppler ultrasound evaluation performed in a tertiary care setting. However, certain limitations should

be acknowledged. The study was conducted at a single center with a relatively small sample size, limiting the generalizability of findings. Hormonal profiles, genetic analyses, and long-term fertility outcomes were not assessed. Future multicenter studies with larger populations and longitudinal follow-up are recommended to further clarify the relationship between Doppler ultrasound findings and reproductive outcomes in men with oligoasthenospermia.

Strengths

The strengths of this study include standardized semen analysis, Doppler ultrasound assessment performed in a specialized tertiary care setting, and evaluation of both anatomical and vascular parameters among patients with oligoasthenospermia.

Limitations

This study had several limitations. First, it was conducted at a single tertiary care center with a relatively small sample size, which may limit the generalizability of the findings to the wider population. Second, hormonal profiles, genetic testing, and oxidative stress markers were not evaluated, which could have provided a more comprehensive assessment of factors contributing to oligoasthenospermia. Third, long-term fertility outcomes following intervention or follow-up were not assessed. Additionally, the absence of a control group limited comparative evaluation between fertile and infertile individuals. Future multicenter studies with larger sample sizes and long-term follow-up are recommended to further validate these findings.

Conclusion

Varicocele was highly prevalent among patients with oligoasthenospermia, particularly among those with primary subfertility. A weak positive association was observed between sperm concentration and the presence of varicocele. Scrotal ultrasonography with venous and arterial Doppler provides valuable anatomical and vascular information and may serve as a useful adjunct in the evaluation of male infertility. Further multicenter studies with larger sample sizes are warranted to validate these findings and better define the role of Doppler ultrasonography in the assessment of oligoasthenospermia.

Ethical Approval Statement

Ethical approval for this study was obtained from the Institutional Review Board of SARF Hospital Islamabad (Ref No:SHI/ERB/228/08/2023).

Informed Consent

Written informed consent was obtained from all participants prior to enrollment in the study.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this study.

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Data Availability Statement

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

AI-Assisted Technology Disclosure

During the preparation of this manuscript, the authors used artificial intelligence (AI)-assisted tools to improve language quality, grammar, and manuscript organization. The authors critically reviewed and edited all AI-generated content and assume full responsibility for the final version of the manuscript. AI tools were not used to generate study data, perform statistical analyses, interpret findings, or formulate scientific conclusions.

Authors' Contributions

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Critical Review and Final Approval

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All authors read and approved the final version of the manuscript.

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