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A prospective study of the association between varicoceles and semen quality in men with infertility

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Abstract

Background Male infertility is a global problem, and varicoceles are a common and treatable cause of male infertility. This study prospectively evaluated the effects of varicoceles on the fertility status and potential among Nigerian men. The consequences of the presence, location, and grades of varicoceles on the fertility status of infertile men with varicoceles were determined using a Doppler scrotal ultrasound scan and their seminal fluid parameters.

Methods One hundred infertile males with clinical varicoceles (study group) and 100 infertile males without varicocele (control group) were recruited. Varicoceles were confirmed/excluded and graded with an ultrasound scan in each subject. They also all had a seminal fluid analysis to measure their fertility potential. The findings were compared and correlated in the two groups.

Results Most subjects in the study group (67%) had bilateral varicoceles, 31% had isolated left varicoceles, and only 2% had isolated right varicoceles. The majority of the participants (61%) in the study group had secondary infertility, while the majority (63%) in the control group had primary infertility ($p = 0.001$). There were significant increases in the prevalence of azoospermia ($p = 0.008$) and oligospermia ($p = 0.030$) with the higher grades of left varicoceles.

Conclusion Bilateral varicoceles were significantly present in males with infertility in the study group. Varicoceles were more common in males with secondary infertility, and higher grades of varicoceles were significantly more associated with azoospermia and severe oligospermia. We recommend the routine use of ultrasound scans to diagnose varicoceles for the optimal management of infertile male patients.

Keywords Varicoceles, Male infertility, Oligospermia, Azoospermia

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1 Background

Infertility is the inability of a couple to achieve a pregnancy after 12 or more months of cohabitation with regular unprotected sexual intercourse. About 8–12% of couples are affected globally by this problem, and the male partner is primarily or secondarily responsible for the cause of infertility in about 50% of such couples. The incidence and prevalence of infertility in sub-Saharan Africa and other developing countries may be much higher than the global average [1]. Recognized causes of male infertility include idiopathic testicular insufficiency, male accessory gland infection, acquired testicular damage, chromosomal abnormalities, obstruction of the vas deferens or ejaculatory duct, immunological causes, and commonly, varicoceles [2–4].

Varicocele is the abnormal dilatation and elongation of the network of testicular veins. It is the most common and most treatable scrotal abnormality found in men with infertility [3]. Varicocele is present in 15% of the general male population, in 35% of men with primary infertility, and up to 80% of men with secondary infertility [4, 5]. Unilateral varicoceles usually occur on the left side in 85% to 90% of cases. Unilateral right varicocele rarely presents in isolation in infertile men, but it occurs in about 10% of patients with bilateral varicoceles [6]. Studies have shown that varicoceles often induce bilateral testicular dysfunction due to collateral and retroperitoneal venous bypasses [7, 8]. Clinically palpable left varicocele may be associated with a sub-clinical right varicocele following an ultrasound scan, and it should be assumed to be a bilateral disease in such patients. Consequently, unilateral varicocelectomy in such patients may be an inadequate treatment [8]. The diagnosis of varicoceles by clinical evaluation is now frequently aided by an ultrasound scan as an adjunct to physical examination [9, 10].

The purpose of this study was to prospectively evaluate the impacts of varicoceles as an etiological factor in male infertility. We studied and compared infertile Nigerian male patients with and without clinical varicoceles using scrotal ultrasonography and seminal fluid analysis. We evaluated the effects of the presence, grade, and anatomical side of varicoceles on the seminal fluid parameters and the fertility status among aged-matched infertile men.

2 Materials and methods

The study complied with the Helsinki Declaration, and approval was obtained from the Research and Ethical Committee of the Hospital. The participants in this study all gave informed consent before their enrollment.

This study prospectively compared infertile male patients who had clinical varicoceles with age-matched infertile male patients without varicoceles as controls. The subjects were all recruited from the urology clinics of our hospital, a tertiary health facility. The study population was patients with a clinical diagnosis of infertility with two consecutive abnormal seminal fluid analyses (SFA) whose parameters fell below the reference limits prescribed by the World Health Organization (WHO) [11]. Two hundred consenting patients who met the inclusion criteria were enrolled consecutively. They consisted of 100 males for the study population and 100 males as the control group. Our exclusion criteria include patients with varicoceles and normal seminal fluid parameters, subjects who previously had varicocelectomy, and patients with other palpable intra-scrotal lesions.

Detailed Scrotal Doppler ultrasound scans were performed on all the subjects to confirm the clinically diagnosed varicoceles, to identify sub-clinical varicoceles, and to grade them using the Sarteschi grading system [12]. Sonological examinations were performed by a dedicated radiologist using a real-time ultrasound scanner (Toshiba Nemio XG diagnostic Ultrasound System) using a 7.5–10 MHz linear transducer. Diagnosis of varicoceles was confirmed by visualizing the dilated pampiniform plexus of veins measuring greater than 2 mm in diameter. The largest diameters of dilated veins were identified and measured on each side in both supine and erect positions.

The data collected were analyzed using Standard Statistical Package for Statistical Package for Social Science (SPSS®) for Windows, version 20.0.0 17.0.1; 2011. The categorical and continuous variables in the case and control populations were compared using Chi-square and Student T test, respectively. Probability values of $p < 0.05$ were considered significant.

3 Results

3.1 Demography

A total of 200 subjects consisting of 100 infertile men with clinical varicocele (study group), and 100 infertile men without varicocele (control group) were enrolled for the study. The patients were age-matched with a mean age ± SD of the participants of 39.00 ± 6.63 years and 38.27 ± 5.63 years for the study and control groups, respectively ($p < 0.9$; $t = 0.103$, Table 1).

3.2 Frequency and grades of varicoceles

Of all the subjects in the study group, the majority 67(67%) had bilateral varicoceles, while 31(31%) had isolated left varicocele; only 2 persons had isolated right varicocele (Table 2). Sonographic grade 4 was the most frequent grade of varicoceles seen in 42 (42.0%) and 73

Table 1 Age distribution of participants

Age (years)	Controls *N* (%)	Cases: *N* (%)
20–29	4 (4.0)	6 (6.0)
30–39	45 (45.0)	43 (43.0)
≥ 40	51 (81.0)	51 (51.0)
Total	100	100
Mean ± SD (years)	38.27 ± 5.63	39.00 ± 6.63

$p = 0.8003$, $\chi^2 = 0.4455$

Table 2 Side distribution of varicocele among cases

Varicocele location	Frequency	Percent (%)
Unilateral	33	33.0
Bilateral	67	67.0
Right varicocele		
Present	69	69.0
Absent	31	31.0
Left varicocele		
Present	98.0	98.0
Absent	2.0	2.0

Table 3 Sonographic grading of varicoceles in the study group

Grade	Right-sided varicocele *N* (%)	Left-sided varicocele *N* (%)
0	30 (30.0)	2(2.0)
1	1 (1.0)	0 (0.0)
2	25 (25.0)	16 (16.0)
3	2 (2.0)	2 (2.0)
4	42 (42.0)	73 (73.0)
5	0 (0.0)	7 (7.0)
Total	100 (100.0)	100 (100.0)

cases (73.0%) on the right and left, respectively, in the study group (Table 3).

3.3 Pampiniform plexus diameters and testicular volumes

The mean diameters of the right and left pampiniform plexuses measured in the study group were significantly higher than those in the control group.

The mean volume of the left testis in the study group was lower than the same parameter in the control group. Conversely, the mean volume of the right testis in the study group was higher than that of the right testis in the control group (Table 4).

3.4 Fertility status and seminal fluid parameters of subjects

The majority of the participants in the study group had secondary infertility while most of the subjects in the control group had primary infertility (Table 5).

Table 5 Nature of infertility among participants

Types of infertility	Controls: *N* (%)	Case *N* (%)
Secondary infertility	37 (37.0)	61 (61.0)
Primary Infertility	63 (63.0)	39 (39.0)
Total	100 (100.0)	100 (100.0)

$\chi^2 = 11.525$, $p = 0.001$

The qualitative abnormalities seen in the seminal fluid parameters of the subjects in the study and control groups are shown and compared in Table 6. Statistically significant increases in the prevalence of azoospermia ($p = 0.008$, $\chi^2 = 13.785$) and oligospermia ($p = 0.030$, $\chi^2 = 19.592$) were observed with the higher grades of left varicocele (Table 7). However, the prevalence of azoospermia ($p = 0.34$, $\chi^2 = 8.701$) and oligospermia ($p = 0.133$, $\chi^2 = 5.597$) in subjects with higher grades of right varicocele was not significant (Table 8).

4 Discussion

Varicoceles are dilated and tortuous testicular veins. They are a well-established cause of male infertility worldwide with a higher prevalence in infertile males than in the general population. They can cause progressive testicular damage if left untreated, and they are the most surgically correctable etiology of male infertility [3–5, 13, 14].

The age range of 22 to 52 years for the participants in this study is very similar to those previously reported from our environment by Jeje et al.13 (26–54 years), Ibrahim et al. [15] (21 to 53 years), and Ahmed et al. [16] (18 to 56 years). However, the modal age group of ≥40 years observed was higher than what Ibrahim et al. [15] reported. The observed difference may be attributable to the sociocultural differences in behavior in the settings of the two studies. Marriages at earlier ages are more common in the north of Nigeria than in the South where our subjects are domiciled. However, Levinger et al. [17] reported an age-related prevalence of varicoceles with increases of about 10% for each decade of life.

Secondary infertility was significantly more preponderant type of male infertility in the varicocele group from our study. This finding is similar to that

Table 4 Mean diameters of pampiniform plexus and testicular volumes in the participants

Parameter	Controls (100)	Cases (100)	*t* test	*p* value
Right pampiniform Plexus diameter (mm)	1.31 ± 0.22	2.21 ± 0.68	−12.453	< 0.001
Left pampiniform Plexus diameter (mm)	1.49 ± 0.18	3.05 ± 0.70	−21.684	< 0.001
Mean Right testicular volume (cm^3)	11.55 ± 2.85	11.95 ± 4.31	−0.788	0.432
Mean Left testicular volume (cm^3)	11.11 ± 3.46	10.51 ± 4.16	1.088	0.278

Table 6 Abnormal parameters in the seminal fluid analyses of the groups

Qualitative abnormalities	Control: 100 (%)	Case: 100 (%)
Azoospermia		
Absent	53 (53.0)	81 (81.0)
Present	47 (47.0)	19 (33.0)
Test statistics: $\chi^2 = 17.730$, $p < 0.001$		
Oligospermia		
Absent	65 (65.0)	39 (39.0)
Present	35 (35.0)	61 (61.0)
Test statistics: $\chi^2 = 13.542$, $p < 0.001$		
Asthenozoospermia		
Absent	56 (56.0)	43 (43.0)
Present	44 (44.0)	57 (57.0)
Test statistics: $\chi^2 = 3.380$, $p = 0.066$		
Necrozoospermia		
Absent	94 (94.0)	96 (96.0)
Present	6 (6.0)	4 (4.0)
Test statistics: $\chi^2 = 0.421$, $p = 0.516$		
Teratozoospermia		
Absent	100 (100.0)	98 (98.0)
Present	0 (0.0)	2 (2.0)
Test statistics: $\chi^2 = 0.505$, $p = 0.477$		

of Witt and Lipshultz [5]; they also reported a higher frequency of varicoceles in men with secondary infertility than in men with primary infertility. This supports the opinion that varicoceles cause a progressive decline in male fertility over time if untreated [18]. Bilateral varicoceles had a higher frequency than isolated unilateral varicoceles in this study. Several other authors [13, 15, 19] have also previously observed and reported similar greater frequencies. Bilateral varicoceles often combine a clinically evident left varicocele with a sub-clinical right varicocele, usually diagnosed by ultrasonography [10]. Therefore, necessary consideration should be given to the possibility of a sub-clinical component when planning for unilateral varicocelectomy after only physical examination. Varicoceles were also significantly more on the left side, either as a unilateral left varicocele or as a component of bilateral varicoceles. This finding agrees with the previous reports that varicoceles occur more commonly on the left side [10, 13]. The right testicular vein usually drains directly into the inferior vena cava at an oblique angle, and the left testicular vein drains into the left renal vein at a right angle [20]. These anatomic differences in venous drainage between the left and right testicular veins cause higher hydrostatic pressure in the left testicular vein. This pressure is transferred to the pampiniform plexus and accounts for the predominance of left-sided varicoceles.

Table 7 Relationship between left varicocele grades and seminal fluid abnormalities

Seminal fluid abnormalities	Grade 1 $N = 0$ (%)	Grade 2 $N = 16$ (%)	Grade 3 $N = 2$ (%)	Grade 4 $N = 73$ (%)	Grade 5 $N = 7$ (%)
Azoospermia					
Absent	2 (2.5)	13 (16.5)	2 (2.5)	60 (75.9)	2 (2.5)
Present	0 (0.0)	2 (10.5)	0 (0.0)	12 (63.2)	5 (26.3)
Test statistics: $\chi^2 = 13.785$, $p = 0.008$					
Oligospermia					
Absent	0 (0.0)	8 (20.5)	0 (0.0)	25 (64.1)	6 (15.4)
Present	2 (3.4)	7 (11.9)	2 (3.4)	47 (79.7)	1 (1.7)
Test statistics: $\chi^2 = 19.592$, $p = 0.030$					
Asthenozoospermia					
Absent	2 (4.7)	4 (9.3)	0 (0.0)	32 (74.4)	5 (11.6)
Present	0 (0.0)	11 (20.0)	2 (3.6)	40 (72.7)	2 (3.6)
Test statistics: $\chi^2 = 8.093$, $p = 0.088$					
Necrozoospermia					
Absent	2 (2.1)	15 (16.0)	2 (2.1)	68 (72.3)	7 (7.4)
Present	0 (0.0)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)
Test statistics: $\chi^2 = 1.506$, $p = 0.826$					
Teratozoospermia					
Absent	2 (2.1)	15 (15.6)	2 (2.1)	70 (72.9)	7 (7.3)
Present	0 (0.0)	0 (0.0)	0 (0.0)	2 (100.0)	0 (0.0)
Test statistics: $\chi^2 = 0.737$, $p = 0.947$					

Table 8 Relationship between right varicocele grades and seminal fluid abnormalities

Seminal fluid abnormalities	Grade 1 $N=1$ (%)	Grade 2 $N=25$ (%)	Grade 3 $N=2$ (%)	Grade 4 $N=42$ (%)	Grade 5 $N=0$ (%)
Azoospermia					
Absent	1 (1.7)	25 (42.4)	2 (3.4)	31 (52.5)	0 (0.0)
Present	0 (0.0)	0 (0.0)	0 (0.0)	11 (100.0)	0 (0.0)
Test statistics: $\chi^2=8.701$, $p=0.34$					
Oligospermia					
Absent	0 (0.0)	6 (23.1)	0 (0.0)	20 (76.9)	0 (0.0)
Present	1 (2.3)	19 (43.2)	2 (4.5)	22 (50.0)	0 (0.0)
Test statistics: $\chi^2=5.597$, $p=0.133$					
Asthenozoospermia					
Absent	0 (0.0)	11 (35.5)	0 (0.0)	20 (64.5)	0 (0.0)
Present	1 (2.6)	14 (35.9)	2 (5.1)	22 (56.4)	0 (0.0)
Test statistics: $\chi^2=2.575$, $p=0.462$					
Necrozoospermia					
Absent	1 (1.5)	24 (35.3)	2 (2.9)	41 (60.3)	0 (0.0)
Present	0 (0.0)	1 (50.0)	0 (0.0)	1 (50.0)	0 (0.0)
Test statistics: $\chi^2=0.240$, $p=0.971$					
Teratozoospermia					
Absent	1 (1.5)	25 (36.8)	2 (2.9)	40 (58.8)	0 (0.0)
Present	0(0.0)	0(0.0)	0(0.0)	2(100.0)	0(0.0)
Test Statistics: $\chi^2=1.373$, $p=0.712$					

The mean testicular volumes in our study group were lower than those in the control group with no statistical difference. Pasqualotto et al. [21] also reported that the testicles were of smaller volumes in their infertile patients with varicoceles than in fertile men without varicoceles. Varicoceles can result in the arrest of testicular growth and consequent reduction in testicular volume [21, 22].

The diagnosis of male infertility requires consistent abnormality of semen fluid analysis, but other factors may also contribute to sub-fertility/infertility when the semen analysis parameters are normal. The components of SFA that are of primary concern include semen volume, sperm concentration, sperm motility, and sperm morphology [11]. In our study, spermatozoa count was significantly more affected in the patients with left-sided varicoceles, resulting in severe oligospermia and azoospermia. The abnormal parameters were also more pronounced with the higher grades of the varicoceles. This finding indicates that the adverse effects of varicoceles on the seminal fluid parameters increase in severity with increasing grades. Tchovelidze et al. [23] observed disturbance of spermatogenesis in approximately 80% of infertile patients with bilateral varicoceles, with extreme oligospermia and azoospermia being the most common abnormalities. Villanueva-Diaz [24] et al. also reported that their patients with varicoceles had lower numbers of functional spermatozoa per ejaculate, but that this and other abnormalities were not related to the grades of varicoceles. Multiple hypotheses exist to explain the observed effects of varicoceles. These include elevated intratesticular temperature, retrograde flow of adrenal metabolites, Leydig cell dysfunction, elevated reactive oxygen species, depressed total antioxidant capacity levels, and reduced oxygen tension from venous stasis [7, 8]. No single theory can explain all the effects of varicoceles on male infertility, but oxidative stress acting through DNA damage and fragmentation seems to be a central mechanism [25, 26]. Therefore, the increasing advocacy for the use of adjuvant oral anti-oxidants to improve semen parameters in infertile men is also justifiable after varicocelectomy [27].

Oligospermia was the most common seminal fluid abnormality in the varicocele group. Osifo et al. [28] also reported oligospermia as the most common seminal fluid abnormality in subfertile men with varicoceles. The deleterious effects of varicocele tend to be progressive in nature, resulting in testicular function decline and loss of previously established fertility [4–6]. The second most common seminal fluid abnormality in both groups was asthenozoospermia. Okeke et al. [29] noted that varicocelectomy in patients with preoperative oligospermia resulted in significant improvement in all the semen parameters except the sperm morphology. However, they observed no improvement of significance in the semen parameters when varicocele patients with preoperative normospermia associated with asthenospermia or teratospermia or those with azoospermia had the surgery done [29]. Overall, evidence suggests a beneficial effect of varicocelectomy on semen quality in patients with varicoceles [30].

5 Conclusion

Bilateral varicoceles are significantly present in males with infertility. The varicoceles are commoner in males with secondary infertility, and higher grades of varicoceles are significantly associated with abnormal seminal fluid parameters.

6 Recommendations

Routine use of ultrasound scans to confirm isolated clinical varicoceles and to diagnose sub-clinical varicoceles is recommended for the optimal management of infertile male patients.

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Author contributions
MAO: contributed to the concept and research resign, data analysis and interpretation, drafting, and critical review of the manuscript. OAA: contributed to concept and research design, data acquisition, analysis and interpretation, drafting, and critical review of the manuscript. EAJ: critical review of the manuscript. RWO: contributed to data acquisition and critical review of the manuscript. RAA: contributed to concept and research design, data acquisition, and critical review of the manuscript. All authors read and approved the final manuscript.

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

Declarations

Ethics approval and consent to participate
This work was reviewed and approved by the Health Research and Ethics Committee of the Lagos University Teaching Hospital (Approval No: ADM/DCST/HREC/APP/683). The participants in this study all gave informed consent before their enrollment.

Consent for publication
Not applicable.

Competing interests
The authors declare no conflicts of interest.

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References

1. Vander Borght M, Wyns C (2018) Fertility and infertility: definition and epidemiology. Clin Biochem 62:2–10. https://doi.org/10.1016/j.clinbiochem.2018.03.012. (**Epub 2018 Mar 16**)
2. Agarwal A, Baskaran S, Parekh N, Cho CL, Henkel R, Vij S, Arafa M, Panner Selvam MK, Shah R (2021) Male infertility. Lancet 397(10271):319–333. https://doi.org/10.1016/S0140-6736(20)32667-2. (**Epub 2020 Dec 10**)
3. Masson P, Brannigan RE (2014) The varicocele. Urol Clin North Am 41(1):129–144. https://doi.org/10.1016/j.ucl.2013.08.001
4. Damsgaard J, Joensen UN, Carlsen E, Erenpreiss J, Jensen MB, Matulevicius V et al (2016) Varicocele is associated with impaired semen quality and reproductive hormone levels: a study of 7035 healthy young men from six European countries. Eur Urol 70(6):1019–1029. https://doi.org/10.1016/j.eururo.2016.06.044. (**Epub 2016 Jul 14**)
5. Witt MA, Lipshultz LI (1993) Varicocele: a progressive or static lesion? Urology 42(5):541–543
6. Chung JM, Lee SD (2018) Current issues in adolescent varicocele: pediatric urological perspectives. World J Mens Health 36(2):123–131
7. Jarow JP (2001) Effects of varicocele on male fertility. Hum Reprod update 7:59–64
8. Razi M, Tavalaee M, Sarrafzadeh-Rezaei F et al (2021) Varicocoele and oxidative stress: new perspectives from animal and human studies. Andrology 9:546–558
9. Ibrahim MZ, Tabari AM, Igashi JB, Lawal S, Ahmed M (2016) Scrotal Doppler ultrasound evaluation in Zaria, Nigeria. Niger J Basic Clin Sci 13:89–93
10. Sakamoto H, Saito K, Shichizyo T, Ishikawa K, Igarashi A, Yoshida H (2006) Color Doppler ultrasonography as a routine clinical examination in male infertility. Int J Urol 13:1073–1078
11. Wang C, Mbizvo M, Festin MP, Björndahl L, Toskin I et al (2022) Evolution of the WHO "Semen" processing manual from the first (1980) to the sixth edition (2021). Fertil Steril 117(2):237–245
12. Namdev R, Molinari A, Knipe H, et al. Varicocele grading on color Doppler. Reference article, Radiopaedia.org (Accessed on 24 Jul 2024) https://doi.org/10.53347/rID-26661
13. Jeje EA, Alabi TO, Ojewola RW, Ogunjimi MA, Osunkoya SA (2016) Male infertility: an audit of 70 cases in a single centre. Afr J Urol 22(3):223–226
14. Okonofua FE, Ntoimo LFC, Omonkhua A, Ayodeji O, Olafusi C, Unuabonah E et al (2022) Causes and risk factors for male infertility: a scoping review of published studies. Int J Gen Med 15:5985–5997
15. Ibrahim AG, Aliyu S, Ali N, Lawan AM (2014) Varicocele associated infertility in maiduguri North Eastern Nigeria. Int J Curr Res 7(5):17432–17434
16. Ahmed A, Bello A, Mbibu NH, Maitama HY (2010) Kalayi GD Epidemiological and aetiological factors of male infertility in northern Nigeria. Niger J Clin Pract 13(2):205–209
17. Levinger U, Gornish M, Gat Y, Bachar GN (2007) Is varicocele prevalence increasing with age? Andrologia 39:77–80
18. Gorelick JI et al (1993) Loss of fertility in men with varicocele. Fertil Steril 59(3):613–616
19. Gat Y, Bachar GN, Zukerman Z, Belenky A, Gornish M (2004) Varicocele: a bilateral disease. Fertil Steril 81(2):424–429
20. Gupta R, Gupta A, Aggarwal N (2015) Variations of gonadal veins: embryological prospective and clinical significance. J Clin Diagn Res 9(2):AC08-10. https://doi.org/10.7860/JCDR/2015/9493.5578. (**Epub 2015 Feb 1**)
21. Pasqualotto FF, Lucon AM, de Góes PM, Sobreiro BP, Hallak J, Pasqualotto EB, Arap S (2005) Semen profile, testicular volume, and hormonal levels in infertile patients with varicoceles compared with fertile men with and without varicoceles. Fertil Steril 83(1):74–77
22. Sayfan J, Siplovich L, Koltun L, Benyamin N (1997) Varicocele treatment in pubertal boys prevents testicular growth arrest. J Urol 157:1456–1457
23. Tchovelidze C, Sibony M, Callard P, Guetta T, Lababidi H, Arvis G (2004) The testicular biopsy and spermatogenesis disturbance of infertile patients with bilateral varicocele. Arkh Patol 66(2):40–45
24. Villanueva-Diaz CA, Vega-Hernandez EA, Diaz-Perez MA, Echavarria-Sanchez M, Karchmer-Krivitsky S (1999) Sperm dysfunction in subfertile patients with varicocele and marginal semen analysis. Andrologia 31(5):263–267
25. Saleh RA, Agarwal A, Sharma RK, Said TM, Sikka SC, Thomas AJ (2003) Jr Evaluation of nuclear DNA damage in spermatozoa from infertile men with varicocele. Fertil Steril 80:1431–1436
26. Jensen CFS, Østergren P, Dupree JM, Ohl DA, Sønksen J, Fode M (2017) Varicocele and male infertility. Nat Rev Urol 14:523–533

27. Li K, Yang X, Wu T (2022) The effect of antioxidants on sperm quality parameters and pregnancy rates for idiopathic male infertility: a network meta-analysis of randomized controlled trials. Front Endocrinol 13:810242. https://doi.org/10.3389/fendo.2022.810242
28. Osifo OD, Agbugui JO (2008) Male infertility secondary to varicocele: a study of the management of 45 patients. Afr J Reprod Health 12(1):54–59
29. Okeke L, Ikuerowo O, Chiekwe I, Etukakpan B, Shittu O, Olapade-Olaopa O (2007) Is varicocelectomy indicated in subfertile men with clinical varicoceles who have asthenospermia or teratospermia and normal sperm density? Int J Urol 14(8):729–732
30. Franco A, Proietti F, Palombi V, Savarese G, Guidotti M, Leonardo C, Ferro F, Manna C, Franco G (2023) Varicocele: to treat or not to treat? J Clin Med 12(12):4062. https://doi.org/10.3390/jcm12124062