Asian Journal of Research and Reports in Urology

4(2): 8-18, 2021; Article no.AJRRU.67045

Pathological Scrotal Ultrasonic Findings in Infertile Men at a Tertiary Hospital in South South Nigeria

E. W. Ugboma[1*] and B. A. Manuel[1]

[1]Department of Radiology, University of Port Harcourt Teaching Hospital, Nigeria.

Authors' contributions

This work was carried out in collaboration between both authors. Authors BAM and EWU designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author BAM managed the analyses/ literature searches of the study. Both authors read and approved the final manuscript.

Article Information

Editor(s):
(1) Dr. Punit Bansal, RG Stone and Superspeciality Hospital, India.
Reviewers:
(1) Anna Maria Aloisi, University of Siena Via Aldo Moro 2 53100 Siena Italy.
(2) Mohammadreza Mohammadabadi, Shahid Bahonar University of Kerman, Iran.
Complete Peer review History: http://www.sdiarticle4.com/review-history/67045

Original Research Article

Received 30 January 2021
Accepted 01 April 2021
Published 16 April 2021

ABSTRACT

Background: The male factor in infertility is often underplayed especially in Africa however, it is known to contribute significantly to infertility. Various scrotal pathologies have been associated with infertility with ultrasound scan being a safe, cheap and none invasive method of evaluating these pathologies.
Aim: The purpose of this study was to detect, by ultrasound the spectrum and frequency of scrotal pathologies in infertile men in a tertiary hospital in southern Nigeria.
Methodology: One hundred infertile men were prospectively examined. All pathologies noted were recorded and analyzed using Statistical Package for the Social Sciences (SPSS) 20.0. Occupation (based on hours spent sitting down) and their relationship with different scrotal pathologies was assessed using Chi square and Fishers exact as appropriate.
Results: The age of the study population ranged from 27 – 48 years. Mean age was 38.16 ± 4.7 years. The most common scrotal ultrasound abnormal finding was varicocele (60%). No correlation was found between scrotal pathologies and the number of hours spent sitting down due to occupation.
Conclusion: This study found varicocele as the commonest abnormality in infertile men. No correlation between scrotal pathology and occupation was found.

**Corresponding author: Email: enighe.ugboma@uniport.edu.ng, eugboma@gmail.com;*

Keywords: Infertility; scrotal ultrasound; testicular volume; scrotal pathology.

1. INTRODUCTION

Infertility can be defined as the failure to conceive following 12 months of regular unprotected intercourse [1,2]. Infertility is an issue that affects 15-20% of couples worldwide [3,4]. Statistics in Nigeria put the prevalence of infertility at between 11-18.5% [5,6]. Infertility may be classified as primary or secondary. Primary infertility refers to a situation where the couple has never achieved conception, while secondary infertility is when there has been a previous pregnancy involving at least one individual in the couple [1,2].

Traditionally, especially in African societies, the sole blame for infertility is mostly placed on the female partner.[1] Various studies have however shown that the female factor in infertility is about 30%, the male factor contribution ranges from 30-50%, while combined male and female is about 30% and no identifiable cause in about 10% of couples [1,2].

Causes of male factor infertility include varicoceles, cryptorchidism, primary, ejaculatory duct obstruction, endocrine abnormalities, chromosomal abnormalities, as well as anabolic steroid and alcohol abuse. Infertility may even be idiopathic.

Scrotal ultrasound plays an invaluable role in the evaluation of the infertile man [6]. It is non-invasive and can detect abnormalities that can be corrected to improve the chances of conception. It may even reveal more harmful pathological conditions which could not be detected by clinical examination alone [1,2].

Various studies have been carried out in countries such as Japan, Germany, and the Middle-east documenting the high number of intrascrotal abnormalities in infertile men [1-4]. In Nigeria most studies carried out focused on the semen qualities of infertile men [7]. There is however a paucity of information concerning the pattern of intra-scrotal pathological findings detectable on ultrasound in infertile men in Nigeria. This study aims to detect the presence and pattern of abnormalities on scrotal ultrasound in infertile men and to correlate this with the hours spent sitting down due to their occupation.

2. MATERIALS AND METHODS

2.1 Study Approach

This study was a cross-sectional descriptive study and carried out over a period of 12 months.

2.2 Study Population and Setting

The study population comprised of men with infertility. This study was carried out in the Radiology department of the University of Port-Harcourt Teaching Hospital (UPTH) in Port Harcourt, Rivers State, a tertiary health facility located in the South-South geopolitical zone of Nigeria.

2.3 Sample Size Estimation

The study had a total of 100 males based on the calculation of sample size and the adjustment of 20% non-response rate based on a prevalence of 11.2% [5].

3. METHODOLOGY

All male patients being investigated for infertility referred to the department of radiology UPTH Port-Harcourt for scrotal ultrasound from the urology clinic who met the inclusion criteria and gave informed consent participated in the study.

3.1 Inclusion Criteria

1. Patients must be either be managed or investigated as a case of infertility.
2. Patients must be between 25 and 65 years old.

3.2 Exclusion Criteria

1. Patients being managed for hypertension.
2. Patients being managed for diabetes mellitus.
3. Patients being managed for kidney disease or kidney failure.
4. Patients being managed for any form of extratesticular malignancy such as leukemia, stomach cancer, lung cancer etc.

Informed consent was sought with signatures on a form and confidentiality maintained. Demographic data such as age, level of

education and how many hours a day were spent sitting due to occupation were obtained using a questionnaire. Other information obtained with the questionnaire included type of infertility (whether primary or secondary), history of recurrent urinary tract infection, sexually transmitted disease, orchitis, cryptorchidism, alcohol and drug ingestion, smoking and history of genitourinary surgery or trauma. All scrotal ultrasound scans were carried out under the supervision of a Consultant Radiologist with a Mindray DC-8 diagnostic ultrasound system using a 7.4MHz transducer in the presence of a male chaperone. Patients were placed in the supine position with their trousers and underwear pulled down to the mid-thigh level. A folded towel was positioned between the patient's legs to support the scrotum with the penis positioned over the patients suprapubic region and draped with a second towel. Both scrotal sacs were examined in both longitudinal and transverse planes after a generous amount of coupling gel was applied. The scrotal sacs were examined to detect the testicular volume, intratesticular and extratesticular abnormalities including varicocele, hydrocoele, epididymal cyst, testicular microlithiasis and testicular tumours. Small testis was defined as any testis with a volume less than10.3cm^3 [8].

Colour Doppler was performed to detect varicoceles which was diagnosed when two or more dilated tortuous veins of greater than two millimetre (>2 mm) are seen in the pampiniform plexus [9]. Testicular microlithiasis was said to be present if five or more non-shadowing echogenic foci of 3 mm or less in size were seen on a single ultrasound image [10]. Epididymal cysts were defined as presence of well circumscribed hypoechoic lesions with posterior acoustic enhancement in the epididymis [11]. Epididymal enlargement was taken as a diameter of greater than 12 mm at the head of the epididymis [12]. The presence of an abnormal accumulation of clear fluid in the tunica vaginalis was taken as evidence of a hydrocele [13].

A testicular tumour was said to be present when a focal hypoechoic lesion was detected in the testicular parenchyma [14].

4. METHOD OF DATA ANALYSIS

Data was recorded in a patient data sheet and entered into a computer spread sheet. Data analysis was carried out using Statistical Package for the Social Sciences (SPSS) version 20.0. Socio-demographic variables and characteristics were presented in tabular form. The mean and standard deviation were calculated for quantitative variables. The spectrum and frequency of scrotal ultrasound findings were presented in a chart.

Occupation was grouped into two broad categories based on time spent sitting during working hours. One group were occupations that spent long hours sitting which was taken as sitting for ≥ 6 hours at work and the other group were occupations that did not spend long hours sitting(i.e. less than 6 hours sitting down at work). Chi square and Fishers exact was used to analyze the relationship between these occupation groups and intra scrotal pathologies as appropriate.

5. RESULTS

5.1 Socio-Demographic Characteristics of Patients

A total number of 100 men were evaluated during the study period. Their ages ranged from 27 - 48 years with a mean age of 38.16 $\pm$ 4.7 years. The modal age group was 36 - 40 years (39 or 39%) while the age group with the lowest frequency was 26-30 years (4 or 4%) (Table 1).

Table 1. Age distribution of subjects

Age (years)	Frequency	Percent (%)
26-30	4	4
31-35	27	27
36-40	39	39
41-45	21	21
46-50	9	9
Total	100	100

5.2 Clinical Characteristics of Patients

The mean duration of infertility was 3.3 ± 2.2 years with a range of 1-11 years. Primary infertility was commoner comprising 66(66%) subjects of the study population and secondary infertility making up 34(34%) (Table 2).

The clinical history obtained from the patients revealed that 22 (22%) of them had a history of urinary tract infection (UTI), 4 (4%) had a history of scrotal/groin surgery and 2 (2%) had a history of trauma to the scrotum.

5.3 Ultrasound Findings in Study Subjects

Scrotal ultrasound examination of the subjects revealed that 17(17%) of them had normal ultrasound findings while 83(83%) had abnormal findings. The abnormal findings detected included varicocele, microlithiasis, hydrocele, epididymal cyst, small testis and absent testis (Fig. 1).

Varicocele (Fig. 2) was the most frequent finding observed in 60(60%) study subjects. Bilateral varicoceles were seen in 30(30%) study subjects while unilateral left sided varicoceles were seen in 30(30%) of the study subjects. No unilateral right sided varicoceles were detected. epididymal cysts(Fig. 3) and hydrocele (Fig. 4) were seen in 9(9%) study subjects. No cases of epididymal cysts were bilateral. Unilateral right sided epididymal cysts were seen in 4(4%) study subjects and unilateral left sided epididymal cysts were seen in 5(5%) study subjects. Unilateral right sided hydrocele was detected in 2(2%) study subjects, while unilateral left sided hydrocele was seen in 3(3%) study subjects. Bilateral hydrocele was detected in 4(4%) of the study subjects. Microlithiasis (Fig. 5) was observed in 8(8%) study subjects, it was bilateral in 7(7%) study subjects and unilateral (right sided) in 1(1%) subject. Epididymal enlargement (Fig. 6) was found in 7(7%) of the study subjects and was bilateral in 6(6%) subjects. The only unilateral case was detected on the left side. Small testis was seen in 31(31%) of study subjects and in 29(29%) of them it was bilateral (Fig. 7). The left testis was not detectable in one patient because it had been surgically removed (Fig. 8). No cases of cryptorchidism or testicular tumour were seen.

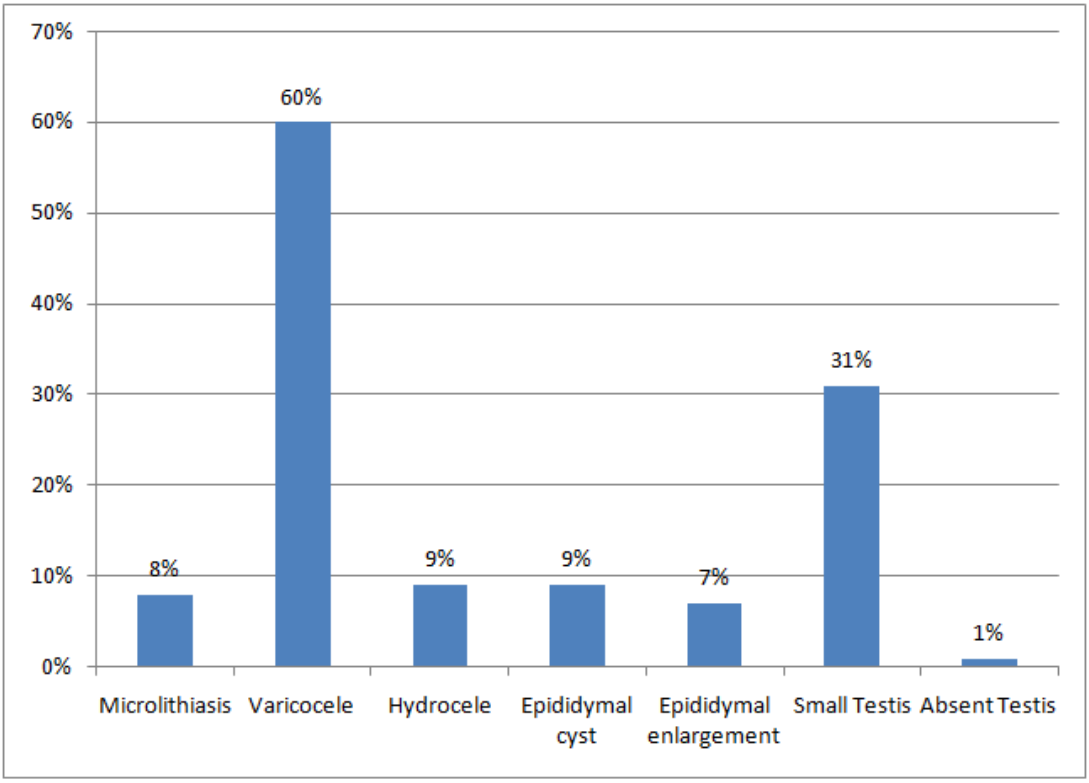

Fig. 1. Bar chart showing different scrotal ultrasound findings

Table 2. Duration of infertility of study subjects

Duration of infertility(Years)	Type of infertility		Percent(%)
	Primary (%)	Secondary (%)	
1-3	48(48)	17(17)	65(65)
4-6	14(14)	12(12)	26(26)
7-9	4(4)	2(2)	6(6)
≥10	0(0)	3(3)	3(3)
TOTAL	66(66)	34(34)	100(100)

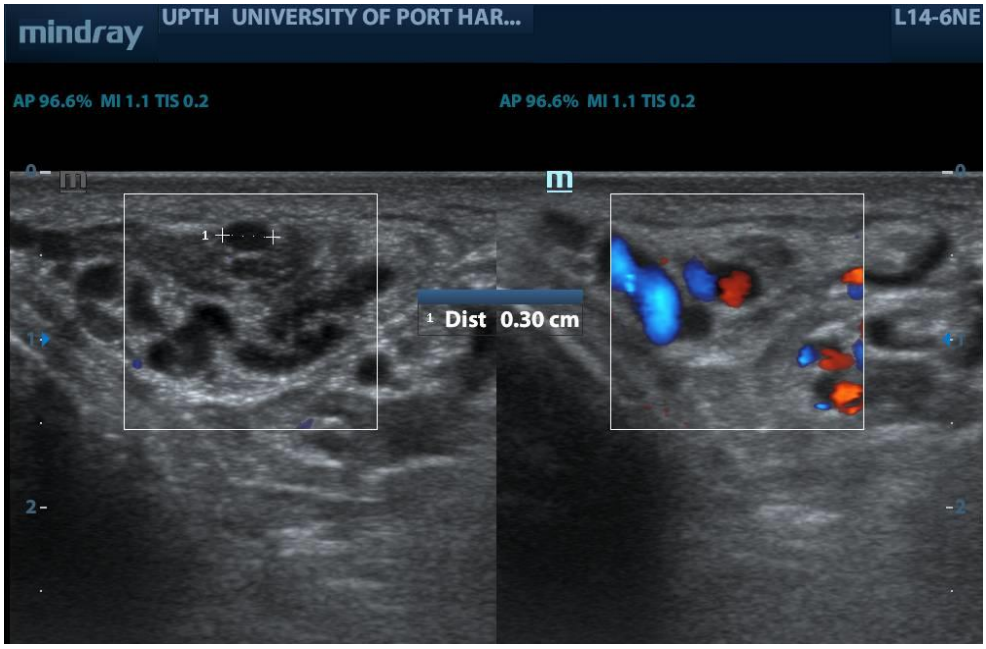

Fig. 2. Varicocele. Colour Doppler sonogram showing dilated veins of the pampiniform plexus measuring 3 mm in diameter

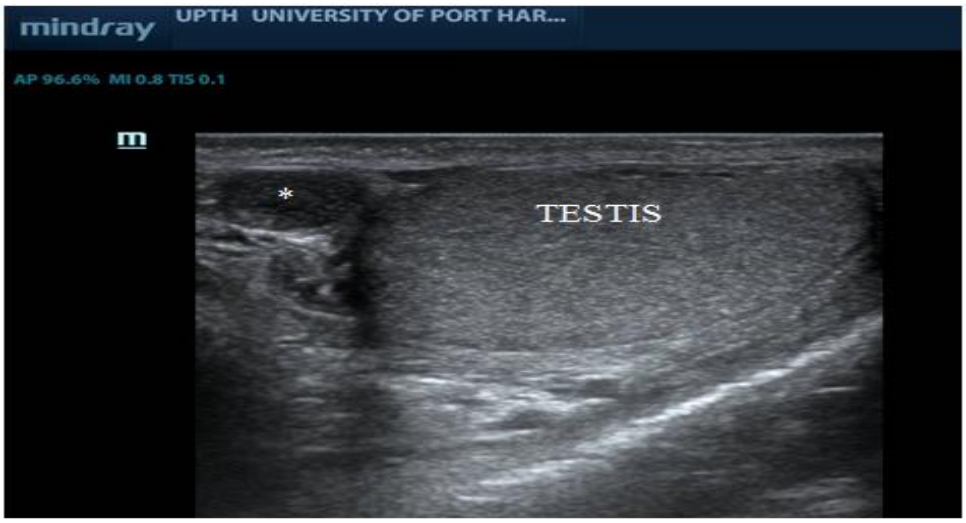

Fig. 3. Epididymal cyst. Sonogram shows a well defined thin walled cyst (*) with fine internal echoes in the head of the epididymis

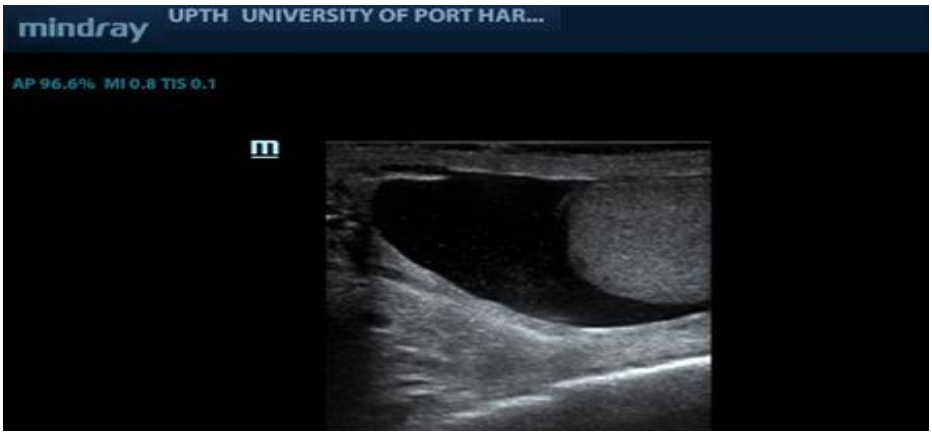

Fig. 4. Hydrocele. Sonogram shows a fluid collection within the tunica vaginalis containing fine echoes

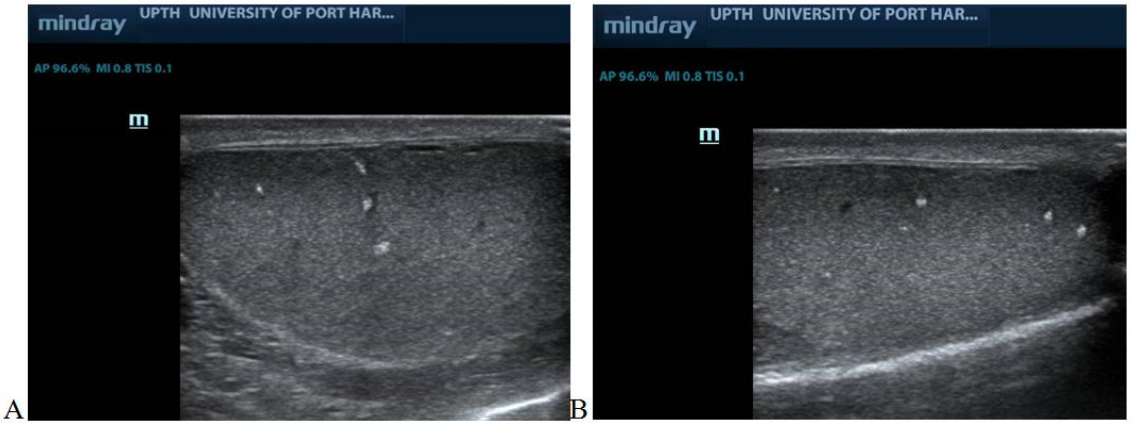

Fig. 5. Testicular Microlithiasis. Sonograms showing non-shadowing echogenic foci in the testicular parenchyma

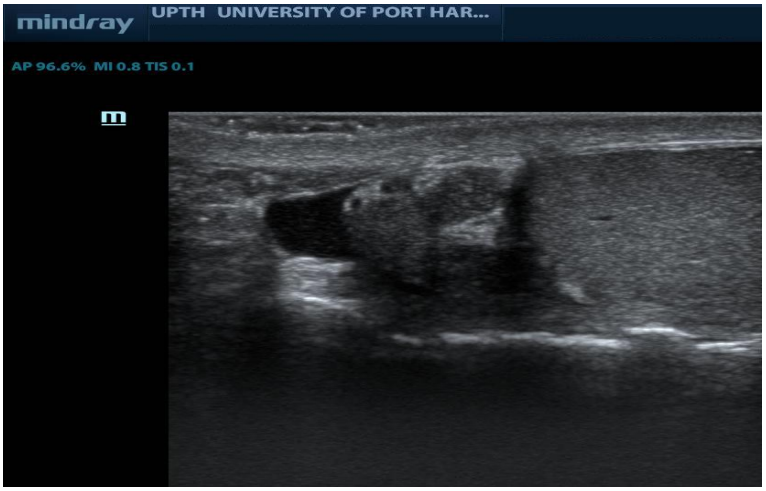

Fig. 6. Epididymal enlargement. Sonogram shows an enlarged epididymal head with reduced echogenecity

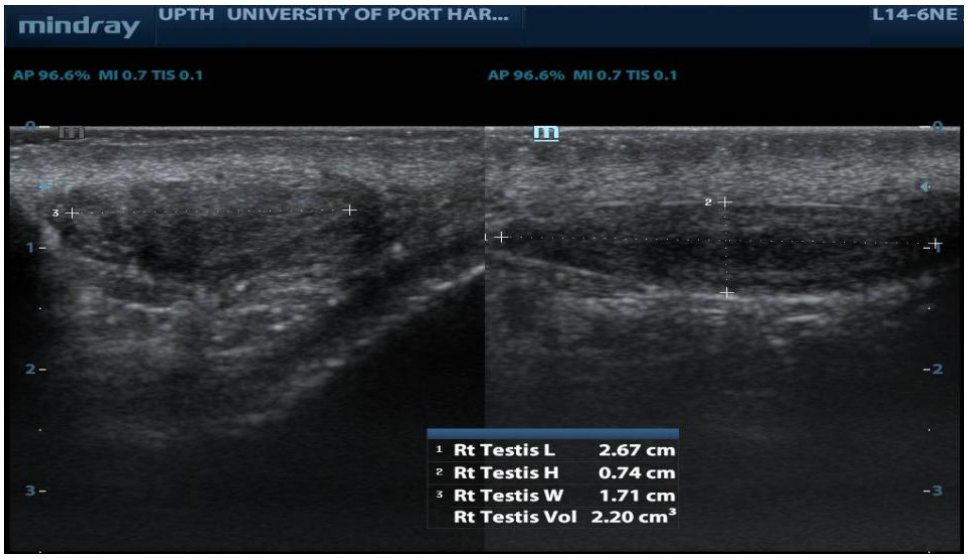

Fig. 7. Small testis. Sonogram showing a testis which on measurement had a volume of 2.20 cm^3

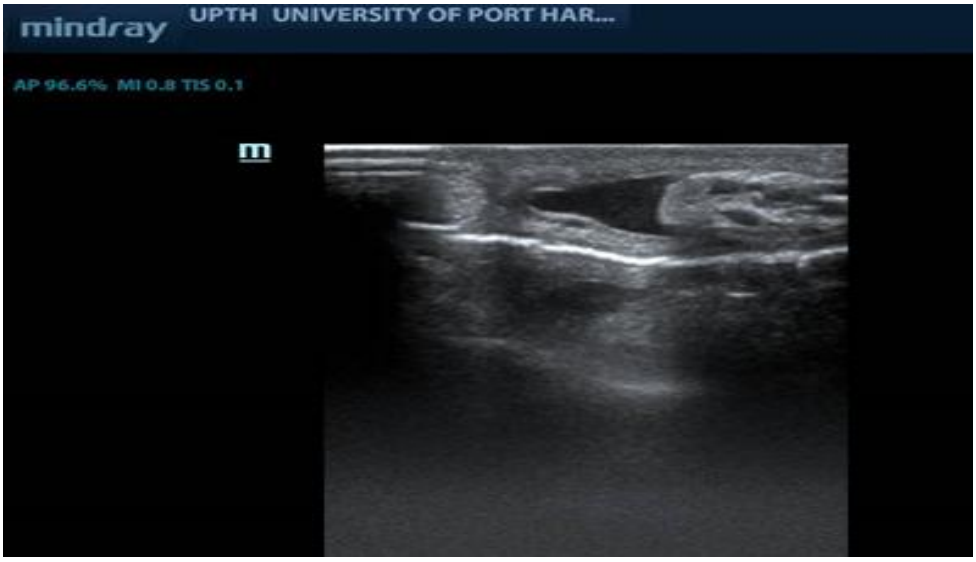

Fig. 8. Absent Testis: Sonogram showing an empty scrotal sac

Table 3. Relationship between scrotal pathologies and hours spent sitting during working hours

Scrotal pathologies	Hours spent sitting during working hours		Total n (%)	P-value
	≥ 6 Hours n (%)	< 6 Hours n (%)		
Microlithiasis	4 (50)	4 (50)	8 (100)	1.000*
Varicocele	31 (51.7)	29 (48.3)	60 (100)	0.164
Hydrocele	5 (55.6)	4 (44.4)	9 (100)	0.729*
Epididymal cyst	7 (77.8)	2 (22.2)	9 (100)	0.076*
Epididymal enlargement	4 (57.1)	3 (42.9)	7 (100)	0.700*
Small testis	15 (48.4)	16 (51.6)	31 (100)	0.748

** Fisher's Exact test*

Occupation was grouped into two broad categories based on hours spent sitting during working hours. Patients who spent an average of less than 6 hours sitting in a day during working hours made up 54(54%) of the study population, while those who spent 6 hours or more comprised 46(46%) of the study population (Table 3).

6. DISCUSSION

Ultrasound is recognized as a valuable tool for diagnosis of intrascrotal abnormalities in infertile men including lesions not palpable on clinical examination [15].

This study examined 100 men who were being investigated for infertility and found pathologies in 83(83%) of them, while 17(17%) men had normal sonograms.

The mean age of patients was 38.16 ± 4.7 years, with a modal age group of 36-40 years. This is comparable to a study carried out by Tijani et al. [1] in south-west Nigeria where the mean age was 36.5±7.3 years as well as another study carried out in Japan by Sakamoto et al. [15] where the mean age was 35.8±5.4 years. This is most likely because the mid-30s is when the need to start a family commonly arises, so fertility problems are highlighted.

The average duration of infertility in this study was 3.3±2.2 years. This is lower than the mean number of 6 years of infertility found in a study in Calabar carried out by Ekwere et al. [16] and 5 years in another study by Nwajiaku et al. [17] in south-east Nigeria. This may be due to increasing awareness among the male partners that they may play a role in the issue of childlessness and so are seeking medical help earlier than in previous years. Primary infertility made up 66(66%) of the cases while 34(34%) were classed as secondary infertility cases. This finding was similar to the findings in a Calabar study carried out by Ekwere et al. [16] where 69.7% were primary infertility cases and 30.3% were secondary infertility cases. These findings contradicted with those of other studies [15,17,18] that reported secondary in infertility to have a higher frequency than primary infertility. This difference may be due to difference in sampling methods between the studies. A study carried out in Lagos, Nigeria by Akinola et al. [5] reported secondary infertility in 75.7% of its cases and primary infertility in 24.3%. This study grouped men that reported achieving pregnancy with any partner as secondary infertility, while the current study grouped only men who had previously achieved pregnancy with their present partner and the pregnancy had been carried to term as secondary infertility cases.

Previous studies carried out in Nigeria have shown that the major causes of male infertility include infection especially sexual transmitted diseases, varicocele, and testicular failure. A study of 504 infertile men carried out in Nigeria revealed that 28.8% of the patient's had varicoceles, 20.8% had a previous history of infection and 15% had bilateral testicular failure while 4% had cryptoorchidism [19]. In this study one or more abnormalities were evident on ultrasound in 83(83%) patients, while 17(17%) patients had normal scrotal sonograms. This percentage is similar to two studies carried out in Jordan by Qublan et al. [13] and Malkawi et al. [20]. It is however higher than that observed in studies carried out by Sakamoto et al. [15] in Japan and Tijani et al. [18] in Nigeria which reported abnormal sonograms in 65% of their patients.

Varicoceles are defined as an abnormal venous dilatations of the pampiniform plexus and this may present as scrotal pain, discomfort, testicular atrophy or infertility [21]. Varicocele is also thought to be the most cost effective treatable cause of male infertility [1,2]. Varicocele has been reported in several studies as the most commonly identified abnormality detected on scrotal ultrasound examination of infertile men [6,13,18]. The current study made similar findings of varicocele in 60(60%) study subjects.

The next frequent abnormality observed in the present study was small testis which was seen in 31(31%) study subjects. The criteria for the definition of small testis was obtained from a previous study carried out in Port-Harcourt by Kiridi et al. [8] in which the lower limit of normal was reported as a mean testicular volume (MTV) of 10.3 cm. A study carried out in the Netherlands by Goede et al. [1] had a similar lower limit of normal at maturity which was a MTV of 10.22 ml. The normal MTV for maturity in the study by Geode et al. [22] in the Netherlands was 13.73±3.51 ml while the MTV in the study by Kiridi et al. [8] in Nigeria was 15.6±5.3 cm^3. The similarity in lower limits of normal with a disparity in the mean testicular volumes between the studies is likely due to the difference in the sampling methods which affected the range of ages of the study populations. Reports in

literature have shown that the average testicular volume in infertile men is significantly smaller than in fertile men [12,13,23]. These studies however did not report the number of patients that had small or atrophic testes.

Hydroceles have been reported in previous studies carried out on infertile men [16,17]. Hydroceles may be congenital or secondary to trauma, infection, testicular torsion or neoplasm. In this study hydroceles were detected in 9(9%) study subjects, which was a similar percentage to some other studies [16,17]. Hydroceles may cause infertility by its effect on sperm production as suggested by a study that revealed impaired spermatogenesis in 18% of patients with hydrocele. Mechanisms proposed for this include increased pressure on the testis due to the liquid in the tunica vaginalis, increase in scrotal temperature as well as reduced testicular circulation due to oedema [17].

Epididymal cysts were detected in 9(9%) study subjects in this study. This percentage was similar to that found in other studies [13,18,20,23]. They are believed to be the result of previous trauma or acute epididymitis [24]. Of the 9 study subjects with epididymal cysts in this study 2 had history of infection and 1 had a history of trauma. Epididymal cysts are thought to cause infertility by obstructing the proximal genital tract [20]. Some studies such as that carried out by Qublan et al. [13] in Jordan and Malkawi et al. [20] in Jordan have shown a significant increase in the presence of epididymal cysts in infertile men compared to fertile men. There are however, other studies like that carried out by Pierik et al. [6] in the Netherlands and Tijani et al. [18] in Nigeria, that do not show any significant difference between the two groups. Thus the role of epididymal cysts in infertility is not yet fully understood.

Testicular microlithiasis (TM) is a condition in which multiple calcifications are seen within the testicular parenchyma due to deposition of glycoprotein and calcium within the semineferous tubules. Various studies have reported the incidence of microlithiasis to be between 0.6-9.0% in the healthy population, 0.8-20% in the subfertile [15].

On ultrasound examination, testicular microlithiasis is visualized as multiple diffuse non-shadowing echogenic foci. Ultrasound diagnosis is based on following criteria: (1) Greater than five calcifications per image field (2) Calcifications less than 2 mm in diameter (3) Diffuse in nature (4) No acoustic shadowing and (5) No loss of testicular shape or volume.

It is associated with pathological conditions such as Klinefelter's syndrome, infertility, varicocele, epididymal cysts, cryptorchidism, testicular tumours, atrophy and torsion [6,23]. In this study microlithiasis was seen in 8(8%) of the study subjects. This percentage was similar to that obtained in studies by Qublan et al in Jordan [13], Sakamoto et al. in Japan [15] and Yee et al. [25] in Korea. In the study by Sakamoto et al. [15] in Japan, out of 30 patients with microlithiasis, 69.93% had co-existing pathologies which included varicocele(46.6%), epididymal cyst (6.67%), retractile testis (3.33%), history of mumps (10%) and previous orchidectomy (3.33%). Fifty percent of the patients with microlithiasis in this study had co-existing varicocele. Other co-existing conditions found in patients with microlithiasis in this study included epididymal enlargement (37.5%), hydrocele (12.5%), history of sexually transmitted infection (25%) and previous herniorrhaphy (12.5%). The study by Yee et al. [25] in Korea tried to establish the relationship between different scrotal pathologies and testicular microlithiasis. The study found a significant relationship between testicular microlithiasis and infertility ($p=0.002$). This finding is in line with many reports in literature of an increased risk of testicular tumours in patients with testicular microlithiasis [1,2]. However no cases of testicular tumour were recorded in this study. Some other similar studies by Qublan et al in Jordan and Malkawi et al also did not record testicular tumours [13,20] but most authors agree that patients with testicular microlithiasis should be followed up for the early detection of testicular tumours [6,23].

Enlargement of the epididymis was noted in 7(7%) of the study subjects. Epididymal enlargement may appear as a heterogeneous mass with or without calcifications and is said to be secondary to infections [11,26]. There was a history of urinary tract infection in 20% of the patients in the current study. In the study by Qublan et al. [13] in Jordan, 20.5% of the patients examined had a history of recurrent urinary tract infection and sexually transmitted infections and 21% of the fin total study population had epididymal enlargement. These percentages are similar to those of this study as well as that carried out by Malkawi et al. [20] in Jordan. This study also noted that of the 7

patients who presented with epididymal enlargement, six of them presented as cases of primary infertility. Most of the reviewed literature did not try to establish relationship between the type of infertility and the scrotal abnormality found [6,13,15,18,20]. More research may need to be done in this area.

One patient in the study had an absent left testis. The left testis was surgically removed following trauma. There were however no patients with a history of cryptorchidism in this study.

The role of occupation in infertility has been explored by researchers in a bid to find the cause of male infertility [27]. Some studies have reported higher infertility rates in certain groups like those exposed to radiant heat, toxic chemicals, radiation, vibration and/or sitting for long hours due to the nature of their jobs [12]. A study by Wazir et al. [27] in Pakistan reported that 12.8% of the infertile men that participated in the study sat for long hours while working. Two studies carried out in Nigeria by Ugwuja et al. [28] and Owolabi et al. [26] revealed that civil servants had the highest percentages of abnormal sperm counts and thus more infertility. This classification may not be adequate since the civil service employs a range of individuals from professionals to unskilled workers. This means the actual nature of the work the individual carries out cannot be accurately ascertained i.e. his risk of exposure to chemicals, radiation or number of hours he spends sitting in an average working day. The current study grouped the workers according to the average number of hours spent sitting down in a day during working hours. The cut-off of six hours was chosen based on a previous study that revealed that sitting for more than six hours during work increased the DNA fragmentation index in spermatozoa which is linked to infertility [1]. Based on hours spent sitting down, 46% of the men spent more than six hours sitting during work hours while 54% spent less than 6 hours sitting. The group of men who sat for long hours (over six hours) had more scrotal abnormalities than those who sat for less than six hours (except for the case of small testis). This relationship was however found to not be significant. These findings suggest that sitting for long hours at work though proven to affect the sperm quality does not have a direct effect on the presence of scrotal pathologies.

7. CONCLUSION

Varicocele is the commonest abnormality in infertile men in this study. There is however no significant relationship between varicoceles or any scrotal ultrasound abnormality and the time spent sitting down during working hours.

8. RECOMMENDATION

1. Scrotal ultrasound is recommended for all males being investigated for infertility.
2. Studies with larger sample sizes are recommended to properly validate the findings of this study.

CONSENT AND ETHICAL APPROVAL

As per international standard or university standard guideline participant consent and ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. De Melo-Martin I. On cloning human beings: Bioethics. 2002;16(3):246-265.
2. Maruani P, Schwartz D. Sterility and fecundability estimation. J Theor Biol. 1983;105(2):211-9.
3. Parsons RB, Fisher AM, Bar Chama N, Mitty HA. MR Imaging in Male Infertility Radiographics 1997;17:627-637.
4. Spitz A, Kim ED, Lipshultz LI. Contemporary approach to male infertility evaluation Obstet Gynecol Clin North Am 2000;27:487-516.
5. Akinola OI, Fabamwo AO, Rabiu KA, Akinoso OA. Semen quality in male partners of infertile couples in Lagos Nigeria. International Journal of Tropical Medicine 2010;5(2):37-6.
6. Pierik FH, Dohle GR, van Muiswinkel JM, Vreeburg JT, Weber RF. Is routine scrotal ultrasound advantageous in infertile men? J Urol. 1999;162:1618-1620.
7. Joshi M. Role of ultrasound in assessment of male infertility. Biomed Imaging Interv J. 2007;3:12-47
8. Kiridi EK, Nwankwo NC, Akinola RA, Agi CA, Ahmed A. Ultrasound measurement of testicular volume in healthy Nigerian adults. Journal of Asian Scientific Research. 2011;2(2):45-52.
9. Dogra VS, Gottlieh RH, Oka M, Rubins DJ. Sonography of the scrotum. Radiology. 2003;227:18-36.

10. Bennett HF, Overdeck DL, Middleton WD. Sonographic follow-up of patients with testicular microlithiasis. Radiology. 1995;197:365.
11. Rifkin MD, Kurtz AB, Goldberg BB. Epididymis examined by ultrasound: Correlation with pathology. Radiology. 1984;151:187–190.
12. Kim ED, Lipshultz LI. Role of ultrasound in the assessment of male infertility. J Clin Ultrasound. 1996;24:437-453.
13. Qublan HS, Al-Okoor K, Al-Ghoweri AS, Abu-Qamar A. Sonographic spectrum of scrotal abnormalities in infertile men. J Clin Ultrasound. 2007;35(8):437-441.
14. Ammar T, Sidhu PS, Wilkins CJ. Male infertility: The role of imaging in diagnosis and management. Br J Radiol. 2012;85:59-68.
15. Sakamoto H, Saito K, Shichizyo T, Ishikawa K, Igarashi A, Yoshida H. Color doppler ultrasonography as a routine clinical examination in male infertility. Int J Urol. 2006;13(8):1073-8.
16. Ekwere PD, Archibong EI, Bassey EE, Ekabua JE, Ekanem EI, Feyi-Waboso P. Infertility among Nigerian couples as seen in Calabar. Port Harcourt Medical Journal. 2007;2:35-40.
17. Nwajiaku LA, Mbachu II, Ikeako L. Prevalence, clinical pattern and major causes of male infertility in south-east Nigeria: A five year review. Afrimedic Journal. 2012;3(2):16-19.
18. Tijani KH, Oyende BO, Awosanya GO, Ojewola RW, Lawal AO, Yusuf AO. Scrotal abnormalities and infertility in West African men: A comparison of fertile and sub-fertile men using scrotal ultrasonography. Afr J Urol. 2014;20(4):180-183.
19. Osegbe DN, Amaku EO. The causes of male infertility in 504 consecutive Nigerian patients. Int Urol Nephrol. 1985;17(4):349-58.
20. Malkawi HY, Qublan HS, Kakish ME, Abu-Khait SA. Frequency of scrotal abnormalities detected by ultrasound in infertile men at King Hussein medical center. J Res Med Sci. 2004;11:35-39.
21. Joshi NV, Medina H, Osuna JA. Ultrastructural pathology of varicocele spermatozoa by using atomic force microscopy. Arch Androl. 2001;47(2):143-52.
22. Geode J, Hack WW, Sijstermans K, van der Voort-Doedens LM, Van der Ploeg T, Meijde Vries A et al. Normative values for testicular volume measured by ultrasonography in a normal population from infancy to adolescence. Horm Res Paediatr. 2011;76:56-64.
23. Gordon SJ, Otite U, Maheshkumar P, Cannon P, Nargund VH. The use of scrotal ultrasound in male infertility. BJU International. 2001;87:415-418.
24. Nashan D, Behre HM, Grunert JH, Nieschlag E. Diagnostic value of scrotal sonography in infertile men: report on 658 cases. Andrologia. 1990;22:387–95.
25. Yee WS, Kim YS, Kim SJ, Choi JB, Kim SI, Ahn HS. Testicular microlithiasis: Prevalence and clinical significance in a population referred for scrotal ultrasonography. Korean J Urol. 2011;52(3):172-177.
26. Owolabi AT, Fasubaa OB, Ogunniyi SO. Semen quality of male partners of infertile couples in Ile-Ife, Nigeria. Niger J Clin Pract. 2013;16:37-40.
27. Wazir BG, Orakzai AN, Ikramullah, Nawaz A, Rafiq M. Male factor infertility: Five years experience. Ann Pak Inst Med Sci. 2010;6(1):7-10.
28. Ugwuja EI, Ugwu NC, Ejikeme BN. Prevalence of low sperm count and abnormal semen parameters in male partners of women consulting an infertility clinic in Abakaliki, Nigeria. Afr J Reprod Health. 2008;12(1):67-73.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/67045