Comparative Scrotal Ultrasound Findings in Fertile and Infertile Males in Jos, North Central Nigeria

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DOI: 10.29322/IJSRP.10.01.2020.p9773
http://dx.doi.org/10.29322/IJSRP.10.01.2020.p9773

***Abstract*- Introduction:** Infertility remains a threat to successful reproduction by couples desirous of pregnancy. Since the seminiferous tubules make up 70%–80% of the testicular mass, the testicular volume reflects spermatogenesis. The testicular volume demonstrates a relationship with the semen profiles in infertile men, and its measurement has been used to estimate spermatogenesis.

Materials and Methods: This was a cross-sectional comparative study where 85 infertile and 85 fertile male subjects were recruited and examined in Jos University Teaching Hospital. All the subjects had their seminal fluids analyzed and their testes examined using a high frequency(10 MHZ) linear transducer of an ultrasound scanner. The results were expressed as percentages and tests of significance were done using the chi-square and Student's *t*-test. A *P*-value of < 0.05 was considered statistically significant.

Results : The common abnormal scrotal ultrasound findings were hydroceles (32.7%), bilateral small volume testes (24.7%) and varicocele (22.9%).There were statistically significant difference between fertile and infertile men (p<0.05).The average testicular volume for fertile and infertile groups were 14.07 ± 3.08 ml and 9.37 ± 3.57 ml respectively (p<0.05).There was positive strong linear association between testicular volume and sperm count (coefficient of correlation 'r' =0.481, p<0.05).

Conclusion :This study found a strong positive correlation between ultrasound measured testicular volume and total sperm count. It was also observed that the critical mean testicular volume of less than 10.3ml is associated with sub-fertility.

***Index Terms*-** Male infertility, Seminal fluid analysis, mean testicular volume, scrotal ultrasound

I. Introduction

Parenthood is undeniably one of the most universally desired goals in adulthood, and most people have life plans that include children. However, not all couples who desire a pregnancy will achieve one spontaneously and a proportion of couples will need medical help to resolve underlying fertility problems.

Infertility is defined as inability of couples to achieve conception despite regular unprotected sexual intercourse for one year[1].Infertility in the male refers to the inability of a man to impregnate a woman after 12 months of regular and unprotected sexual intercourse that is if the woman has no gynecological problems[1].

About 8–12% of couples worldwide experienced some form of infertility during their reproductive lives, thus affecting 50–80 million couples with 20–35 million in Africa. It was therefore extrapolated that 3–4 million Nigerian couples are affected.[2]

The prevalence of infertility in Sub-Sahara Africa ranges from 20% to 40%. Fertility problems are shared by both male and females. Sub-fertile men are investigated to find a cause for their infertility.[3]

The aetiology of male infertility is multifactorial. The major causes of male factor infertility in Nigeria are infection and hormonal abnormalities.[4]

Male factor contributes significantly to the infertility burden in our environment and play a role in approximately 40-50% of all infertility cases.[1]

Seminal fluid evaluation is the primary investigative tool in the assessment of male fertility. However, this does not state the cause of the structural anatomical abnormality associated with the impaired or deranged spermiogram.

Ultrasound is non-invasive and adequately demonstrates all the essential parts of the scrotum that may be missed by clinical examination. It is a modality of choice for examination of the scrotum.

The role of ultrasonography in the evaluation of male infertility has expanded with advancements in technology with scrotal ultrasonography (scrotal US) serving multiple purposes in the sub-fertile man. Ultrasonography can measure the testicular volume which correlates with the level of spermatogenesis.There is positive strong linear association (r= 0.499 ,p=0.0001) between testicular volume and sperm count.[5]Small testicular volume is a crude indicator of severity of infertility with a statistically significant relationship between the testicular volume and the sperm density.

Therefore, unlike seminal fluid analysis, scrotal sonography can depicts scrotal abnormalities and also give an insight into aetiopathogenesis of the problem.

The objective of the study was to compare scrotal ultrasound findings in fertile and infertile males in Jos, Nigeria

II. MATERIALS AND METHODS

The study was conducted over a period of 9 months at the Jos University Teaching Hospital, a tertiary medical institution located in an urban and cosmopolitan area in Nigeria in which 85 patients diagnosed with male infertility were studied. The inclusion criteria for the subjects were history of infertility of at least 12 months duration, seminal fluid analysis(SFA) showing sperm density less than 20 million/ml of semen and age 18- 60 years. Eight five(85) subjects who had normal seminal fluid analysis results were recruited from among the patients in the clinic for comparison. The main inclusion criteria for the fertile subjects were normal SFA and age 18 -60 years.

A non-probability convenience sampling method was used in recruiting **e**ligible participants consecutively from the infertility clinic until the sample size of 170 was reached.

Ethical approval was obtained from the Ethical and Research Review Committee of the Jos University Teaching Hospital and the informed consent was taken from all subjects.

Evaluation of the scrotum

Scrotal ultrasound examination was performed using GE LOGIQ V3 series ultrasound machine fitted with 10 MHz linear transducer in supine position and erect postures when needed with the help of Valsalva manoeuvre. Grayscale ultrasound was first conducted to determine the size and echogenicity of the testes. Colour Doppler interrogation was done to assess blood flow, spectral waveform pattern and velocity of flow and indices in the testes and epididymis.

The scrotal sac was further examined to detect other scrotal abnormalities such as Varicocele, hydrocele, epididymitis, epididymal cyst, Microlithiasis, and testicular tumors.

Data Analysis

A structured questionnaire was used to obtain relevant data and the results of the seminal analysis were documented from the case file.

The data was collated, entered into a computer and processed by the use of Statistical Package for Social Sciences (SPSS) version 23 to determine frequencies; means ± standard deviations; statistical associations of dependent and independent variables. Chi square test was used to test these associations. T-test was also used to determine the difference in the means of continuous variables between fertile and infertile males. All tests were 2-tailed, a 95% confidence interval was used and P-values of less than 0.05 ($P < 0.05$) was considered statistically significant.

III. RESULTS.

The mean age for infertile and fertile groups were 38.69 ±7.2 years and 37.94±6.1 years respectively. There was no statistically significant difference between the age distributions of the two groups($p > 0.05$).

Scrotal ultrasound findings in infertile and fertile respondents

Normal scrotal sonograms were seen in 56 respondents constituting 24.7% of the scrotal findings comprising10 (17.9%) in infertile patients and 46 (82.1%) in fertile group respectively. There was statistically significant difference in this findings in infertile and fertile group(Table1, $p<0.05$).

Scrotal ultrasonography detects numerous scrotal abnormalities constituting 70.8% and 29.2% for infertile and fertile groups respectively(Table 2).

Hydrocele was the most common abnormal scrotal ultrasound findings seen in 56 (32.7%) respondents, constituting 57.1% and 42.9% for infertile and fertile respondents respectively.

This was closely followed by bilateral small volume testes and varicocele seen in 42 (24.7%) and 39(22.9%) respondents respectively comprising 39(92.9%) infertile and 3(7.1%) fertile group for bilateral small volume testicles respectively while varicocele has 25(64.1%) and 14(35.9%) infertile and fertile group respectively. This was statistically significant in infertile males ($p<0.05$, Table 2).

Testicular microlithiasis and testicular tumour were seen in 6(3.5%) patients and 2(1.2 %) respondents respectively in the infertile group (Table 2).

Similarly, testicular atrophy and epididymal cysts were seen in 9 subjects each for infertile and control groups with the infertile category having higher incidences of 55.6% and 77.8% for epididymal cyst and testicular atrophy respectively (Table 2).

Relationship between testicular volumes in infertile and fertile males.

The average testicular volumes for fertile and infertile groups were 14.07 ± 3.08 and 9.37 ± 3.57 respectively. The mean right testicular volumes for fertile and infertile were 14.30 ± 3.13 and 9.55 ± 3.66 while the mean left testicular volumes were 13.85 ± 3.08 and 9.19 ± 3.84 for fertile and infertile groups respectively. These were statistically significant (Table 3).

Thirty nine (92.9%) infertile and 3(7.1%) fertile respondents had small testicular volume (<10.3ml) while 46(35.9%) infertile and 82(64.1%) fertile had normal testicular volume (>10.3ml).This was statistically significant (Table 4. $p<0.05$)

Association between testicular volume with sperm count, Age, Height, Weight and BMI

There is a positive strong linear association between testicular volume and sperm count with a coefficient of correlation ('r') of 0.481. This was statistically significant ($p<0.05$,Table 5). A positive weak linear association is noted between testicular volume with BMI and weight with coefficient of correlation ('r') of 0.029 and 0.011 respectively. These were statistically not significant ($p>0.05$).

A very weak negative association is seen between testicular volume with age and height with coefficient of correlation of -0.050 and -0.070 respectively these were however, statistically not significant($p>0.05$).

Table 1: Relationship between scrotal ultrasound findings and fertility status

Scrotal finding	Infertile(%)	Fertile(%)	Total (%)
Normal	10(17.9)	46(82.1)	56(24.7)
Abnormal findings	121(70.8)	50(29.2)	171(75.3)
Total	131(57.7)	96(42.3)	227(100.0)**

X^2=48.376 df-1 P=0.001

**** Some respondents had multiple scrotal findings**

Table 2: Relationship between abnormal scrotal ultrasound findings and fertility status

Scrotal finding	Infertile(%)	Fertile(%)	Total (%)
Bilateral Epididymo-orchitis	3(3.5)	3(3.5)	6(3.5)
Unilateral Epididymo-orchitis	2(2.4)	0(0.0)	2(1.2)
Epididymal cyst	5(5.9)	4(4.7)	9(5.3)
Atrophy	7(8.2)	2(2.4)	9(5.3)
Small volume testes	39(45.9)	3(3.5)	42(24.6)
Testicular microlithiasis	6(7.1)	0(0.0)	6(3.5)
Testicular mass	2(2.4)	0(0.0)	2(1.2)
Hydrocele	32(37.6)	24(28.2)	56(32.7)
Varicocele	25(29.4)	14(16.5)	39(22.8)
Total	121(70.8)	50(29.2)	171(100.0)**

X^2=67.339 df-9 P=0.001

****Some respondents had multiple scrotal findings**

Table 3: Relationship between Average numerical parameters of respondents and fertility status

	Fertility status	N	Mean	Std deviation	Std Error mean
Rt. testicular vol.	Infertile	85	9.5482	3.66082	.39707
	Fertile	85	14.2953	3.12688	.33916
Lt. testicular vol.	Infertile	85	9.1941	3.84170	.41669
	Fertile	85	13.8494	3.07554	.33359
Ave. testicular vol.	Infertile	85	9.3712	3.56797	.38700
	Fertile	85	14.0724	3.08305	.33440

Table 4: Relationship between testicular volume and fertility status

		Infertile(%)	Fertile(%)	Total (%)
Testicular volume(group)				
	Low(<10.3)	39(92.9)	3(7.1)	42(24.7)
	Normal(10.3-20.9)	46(35.9)	82(64.1)	128(75.3)
Total		85(50.0)	85(50.0)	170(100.0)

X^2 = 40.982 , p=0.001

Table 5: Correlation between testicular volume and sperm count and BMI group

		Testicular volume(group)	Sperm count	BMI group
Testicular volume (group)	Correlation. coefficient	1.000	.481**	.029
	Sig.(2-tailed)		.001	.704
	N	170	170	170
Sperm count	Correlation coefficient	.481**	1.000	-.018
	Sig.(2-tailed)	.001		.814
	N	170	170	170
BMI Group	Correlation coefficient	.029	-.018	1.000
	Sig.(2-tailed)	.704	.814	
	N	170	170	170

****. Correlation is significant at the 0.01 level (2-tailed).**

IV. DISCUSSION

Undeniably, parenthood is a universally desired goal in adulthood. However, this does not occur spontaneously in some couples with a proportion needing medical help to resolve underlying fertility problems.

Male infertility refers to the inability of a male to achieve a pregnancy in a fertile female. This is commonly due to deficiencies in the semen quality. The male factor infertility play a role in approximately 50% of infertility cases and the testes are the central organs for male fertility.

Seminal fluid evaluation is the primary investigative tool in the assessment of male fertility.Over the last few decades, there have been reports to suggest decreased human semen quality (defined as sperm density) in the general population while scrotal ultrasound has also become the primary imaging modality in the evaluation of testicular function.[6,7]

The mean age for the infertile respondents was 38.69 ± 7.2 years with over half of the respondents being in the age range of 30– 39 years. This was similar to the finding of Tijani et al. in Lagos who documented a mean age of 36.5 ± 7.3 years.[7] This actually coincides with the active reproductive age group.

Normal scrotal ultrasound findings constituted 24.7% of the total findings in the study comprising 17.9% in infertile patients and 82.1% in the control group. This was at variance with the findings of scholars in Sri Lanka who found a much higher percentage of normal scrotal sonogram in 55.8%.[8] The higher normal sonogram in their study is most likely due to the fact that those with small testicular volumes were also categorized as normal while in this study they were grouped under abnormal finding. Ibrahim et al. in Zaria, North West Nigeria recorded a much lower value of 10.4% as normal scrotal sonogram.[6]

The prevalence of scrotal abnormalities in this study was 75.3% constituting 70.8% and 29.2% in infertile and control groups respectively. This was similar to the findings of a study in Jordan that recorded 85.3% in infertile males and 32.0% in control group.[9]

Similarly, Pierik et al.[10] and Sakamoto et al.[11] reported scrotal abnormalities in 38-65% of infertile men following their ultrasound evaluations.[10,11]

Scrotal hydrocele is frequently identified in infertile men by clinical examination and scrotal ultrasonography.

Hydrocele was the most common abnormal scrotal ultrasound finding in this study seen in 32.7% comprising 28.2% in fertile and 37.6% infertile men respectively. This was at variance with the findings of Qublan et al[12] who detected hydrocele in 16.7% of infertile men, compared to 8.7% of men in a control group of fertile men.[12] Tijani et al[7] and Dandapat et al. reported a similar trend.[7,13]. Pierik et al. noted much lower 3.2% incidence of hydrocele in infertile men.[10]

The effect of hydrocele on spermatogenesis, testicular size, testicular geometry ,scrotal temperature and testicular spectral wave pattern has been studied**.** Dandapat et al.[13] assessed the pressure effect of hydroceles in 120 men with unilateral idiopathic hydrocele and found no pressure effect in 70% of men, testicular flattening in 22% of the cohort and pressure-induced testicular atrophy in 8% of patients. Turgut et al.[14] noted time-related testicular size declines in patients with hydrocele and described a rounding rather than flattening effect of hydrocele on testicular shape.[14]

Some investigators have shown that hydrocele can affect spermatogenesis, which may be partially or totally absent.[13]The possible mechanisms that underlie impaired spermatogenesis include the pressure effect of the hydrocele on the testis,[14] the reaction of testicular cells to the highly proteinaceous fluid, and raised intrascrotal temperature.[15]The hydrostatic pressure of a hydrocele exceeds the pressure in blood vessels within the scrotum,[16] which interferes with arterial blood flow and might have an ischemic effect on the testicle.

In this study bilateral small volume testes and varicocele also showed similar trend of higher prevalence in infertile group compared to the control with prevalence of 92.9% versus 7.1% and 64.1% versus 35.9% for bilateral volume small testes and varicocele respectively.

Epididymal cysts were found in 5.3% of the participant evaluated sonographically. This is consistent with finding of Sakamoto et al in Japan who found epididymal cysts in 3.9% of the patients.[11]They may cause infertility by either partial or complete obstruction of the vas deferens.

Testicular microlithiasis was identified in 3.5% of the patients and it is thought to impair testicular function via immunological mechanism[6]. Various studies have reported incidence of between 0.6-9.0% in the healthy population, and an incidence of 0.8-20% in sub-fertile population[11].Testicular microlithiasis is associated with pathological conditions such as Klinefelter's syndrome, infertility, epididymal cysts, cryptorchidism, atrophy and torsion.[17]However, in this study there was no associated abnormality seen in patients with microlithiasis. In this study, the mean testicular volume (MTV) in the control group was 14.30 ± 3.13 ml and 13.85 ± 3.08ml for right and left respectively. This study agrees with previous study of scholars who reported mean volume of 15.38 ± 3.29 ml and 15.29 ± 3.89 ml for right and left respectively.[18]This was however at variance with the mean testicular volumes of 18.13± 3.85 ml and 18.37±3.62 ml for right and left respectively obtained by scholars in Seoul, Korea.[19]This was most likely due to the fact that the sample size was restricted to normal young men age range

19-27 years unlike this study where control group were between18years to 60 years. Testicular volume rapidly increases during puberty and peaks at age 30 years and thus an advancing age is a risk factor for decrease testicular volume.

The mean testicular volume in this study for the control group was significantly higher than the mean testicular volume of 9.55 ± 3.66 ml and 9.37 ± 3.56 ml for right and left respectively in the infertile group. This was consistent with the findings of other authors who documented the mean testicular volumes of 7.66 ml and 7.43 ml the right testis respectively[8] and low testicular volumes in men with infertility and oligospermia[7], as the seminiferous tubules responsible for spermatogenesis constitutes about 80% of testicular volume. This was, however at variance with the finding of a higher mean testicular volume of 18.3ml and 16.9ml for right and left respectively by Schiff et al. in New Yolk, USA using 159 sub fertile men.[20]This value for MTV in infertile men was also at variance with that reported by a study carried out by Kiridi et al. which was 13.3 ml.[17]

In this study, a testicular volume below 10.3ml had statistically significant effect on the fertility status of the individual ($p<0.05$).

Similarly, scholars in Tokyo, Japan documented a critical total testicular volume of 20ml (MTV of 10ml) using ultrasonography indicating normal or nearly normal testicular function.[11] However, a study in Tirana, Albania using 500 sub-fertile males, found that testicular volume has a direct correlation with semen parameters and the critical mean testicular volume indicating normal testicular function is 13.3 ml. The study also concluded that measurement of testicular volume can be helpful for assessing fertility at the initial physical examination.[5,20]

There was a positive strong linear association between testicular volume and sperm count($r= 0.481$, $p<0.05$) in this study. The study by Kristo et al. in Albania also showed positive correlation between testicular volume and sperm count ($r=0.499$, $p<0.0001$).[5]

Another study carried out in India by Sharath et al.[21] also showed a significant positive correlation between mean testicular volume and sperm count ($r=0.501$ $p<0.0001$) as well as a higher mean testicular volume for the fertile men compared to the infertile population.[21]

The mean testicular volume for the control population in the study by Sharath et al. in India was 11.45±2.65 ml while that for the infertile patients was 7.31±3.6 ml.[21]

Testicular volume is a measure of the level of spermatogenesis as there is relationship between the testicular volume and sperm count per ejaculate.[22] Small testicular volume is a crude indicator of severity of infertility with a statistically significant relationship between the testicular volume and the sperm density.

The minimum testicular volume necessary for adequate spermatogenesis is also yet to be determined. However, using the punched-out orchidometer, others have reported a critical mean testicular volume of 14 ml as the minimum for adequate spermatogenesis and a critical total testicular volume of 30 ml as the minimum for normal testicular function. However, orchidometers are known to overestimate testicular size especially the smaller testes.[7]

Condorelli et al. also found reduced semen parameters in patients with mean testicular volume of less than 12 ml.[22]

In this study, there is positive weak linear association ('r'=0.029, $p>0.05$) between testicular volume with BMI and weight of the participants. This was in agreement with the findings of Kiridi et al that demonstrated a positive correlation between testicular volume and BMI.[17]

A very weak negative association is seen between testicular volume with age and height.

This was at variance with the findings of Sobowale et al.[23] who reported a weak positive linear relationship between testicular volume and height.[23]

V. CONCLUSION

This study found a strong positive correlation between ultrasound measured testicular volume and total sperm count. It

was also observed that the critical mean testicular volumes of less than 10.3ml is associated with sub-fertility.
Ultrasound scan of the scrotum and its content is safe, reliable and indispensable modality in the evaluation of the scrotum and its contents especially in sub fertile subjects as this may aid early diagnosis and prompt management of treatable causes of infertility.

VI. RECOMMENDATION

Scrotal ultrasound should be done routinely in the evaluation of male infertility as it has been shown to give an insight to the possible outcome of the seminal fluid analysis and detect abnormalities that may not be clinically visible following clinical examination alone.

REFERENCES

[1] Uadia P, Emokpae A.Male infertility in Nigeria:A neglected reproductive health issue requiring attention.2015. Journal of Basic and Clinical Reproductive Science.4(2):45–53.

[2] Thomas K, Adeoye I, Olusanya O.Biochemical markers in seminal plasma of sub-fertile Nigerian men.1995. Tropical Journal of Obstetric Gynaecology. 1995;15:19–22.

[3] Cooper TG, Noonan E, Von-Eckardstein S, Auger J, Baker H, Behre H, et al. World health organization refernce values for human semen characteristics.Human Reproductive Update. 2010;16(3):231–45.

[4] Emokpae M.A, Uadia PO, Mohammed AZ, Omale-Itodo A.Hormonal abnormalities in azoospermic men in Kano, Northern Nigeria. Indian J Med Res.2006;124(3):299–304.

[5] Kristo A, Dani E. The Correlation between Ultrasound Testicular Volume and Conventional Semen Parameters in Albanian Subfertile Males. OA Maced J Med Sci. 2014; 2(3):464-466

[6] Ibrahim MZ ,Tabari AM, Igashi JB, Lawal S,Ahmed M. Scrotal Doppler Ultrasound Evaluation in Zaria, Nigeria. Niger J Basic Clin Sci.2016;13:89-93.

[7] Tijani KHH, Oyende BOO, Awosanya GOO, Ojewola RWW, Lawal AOO, Yusuf AOO Scrotal abnormalities and infertility in west African men: A comparison of fertile and sub-fertile men using scrotal ultrasonography.African J Urol.2014;20(4):180–183.

[8] Pethiyagoda AUB , Pethiyagoda K .Scrotal sonography in the assessment of subfertile males. International J Sci Res Pub. 2017; 7(5).873-876.

[9] Malkawi HY, Qublan HS, Kakish ME,Abu-khait SA.Frequency of Scrotal Abnormalities Detected By Ultrasound in Infertile Men At King Hussein.J Reproductive Med.2001;11(1):35–9.

[10] Pierik F, Dohle G, van Muiswinkel J, Vreeburg J, Weber R. Is routine scrotal ultrasound advantageous in infertile men? J Urol. 1999;162(5):1618–20.

[11] Sakamoto H, Yajima T, Nagata M, Okumura T, Suzuki K , OgawaY.Relationship between testicular size by ultrasonography and testicular function: Measurement of testicular length, width, and depth in patients with infertility. Int J Urol.2008; 15(6):529–33.

[12] 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):437–41.

[13] Dandapat MC, Padhi NC, Patra AP. Effect of hydrocele on testis and spermatogenesis. Br. J. Surg.1990; 77, 1293–1294 .

[14] Turgut A T et al. Unilateral idiopathic hydrocele has a substantial effect on the ipsilateral testicular geometry and resistivity indices. J. Ultrasound Med.2006; 25, 837–843

[15] Mihmanli, I. et al. Testicular size and vascular resistance before and after hydrocelectomy. AJR Am. J. Roentgenol.2004; 183, 1379–1385.

[16] Rados N, Trnski D, Keros P, Rados J. The biomechanical aspect of testis hydrocele. Acta Med. Croatica.1996; 50, 33–36.

[17] Kiridi E, Nwankwo N, Akinola R, Agi C, Ahmed A.Ultrasound measurement of testicular volume in healthy Nigerian adults. J Asian Sci Res.2011; 2(2):45–52.

[18] Innocent MC, Asomugha LA, Ukamaka MN, Aronu ME. Ultrasound measured testicular volume in Nigeria adults: Relationship of the three formulae with height, body weight, body -surface area, and body-mass index. Int J Adv Med Health Res.2016;3:86-90

[19] Bahk J, Jung J, Jin L,Min S .Cut-off value of testes volume in young adults and correlation among testes volume, body mass index, hormonal level, and seminal profiles. Urology. 2010;75:1318–23.

[20] Schiff J D, Li PS, Goldstein, M .Correlation of ultrasonographic and orchidometer measurements of testis volume in adults. Bri J Urol int. 2004;93(7):1015-7

[21] Sharath KC, Najafi M, Vineeth VS, Malini SS .Assessment of Testicular Volume in Correlation with Spermiogram of Infertile Males in South India. Advanced Studies in Biology.2013;5(7):327-335

[22] Condorelli R, Calogero AE, La Vignera S. Relationship between Testicular Volume andConventional or Nonconventional Sperm Parameters. International Journal of Endocrinology. 2013;2013:145792. doi:10.1155/2013/145792. Epub 2013 Sep 5. PMID: 24089610; PMCID: PMC3780703..

[23] Sobowale O, Akiwumi, O .Testicular volume and seminal fluid profile in fertile and infertile males in Ilorin, Nigeria. Int J Gynecol Obs.1989;28(2):155–61.

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