Asian Journal of Medicine and Health
4(1): 1-6, 2017; Article no.AJMAH.29182

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Relationship between Testicular Volume and Sperm Count in Infertile Men in Southern Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJMAH/2017/29182
Editor(s):
(1) Giuseppe Murdaca, Clinical Immunology Unit, Department of Internal Medicine, University of Genoa, Italy.
Reviewers:
(1) Giorgio Cavallini, Gynepro Medical Team, andrological Section, via Tranquillo Cremona 8, Italy.
(2) Massimiliano Creta, Buon Consiglio Fatebenefratelli Hospital, Naples, Italy.
(3) Wagih Mommtaz Ghannam, Mansoura University, Egypt.
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(5) Eze Ejike Daniel, Federal University Lafia, Nigeria.
Complete Peer review History: http://www.sciencedomain.org/review-history/18599

Original Research Article

Received 27th August 2016
Accepted 26th March 2017
Published 12th April 2017

ABSTRACT

Background: The gold standard for assessment of testicular function in men being evaluated for infertility is semen analysis. There however is a correlation between the testicular volume and testicular function. Ultrasound of the testicles can be used to measure its volume and thus based on this relationship be a pointer to testicular function.
Aim: To examine the association between testicular volumes obtained by scrotal ultrasound and testicular function in infertile men in Southern Nigeria.
Patients and Methods: A prospective study of 100 infertile men referred to the Department of Radiology in the University of Port-Harcourt Teaching Hospital, over a nine month period for scrotal ultrasound examination. All scrotal ultrasound scans were carried out with a Mindray DC-8 diagnostic ultrasound system using a 7.5MHz transducer. Statistical analysis was carried out using Statistical Package for the Social Sciences (SPSS) 20.0. Pearson's Correlation was used for the correlation studies with a p values of less than 0.05 considered as statistically significant.
Results: The mean testicular volume (MTV) for the study population was 13.14 ± 5.16 cm^3.
A statistically significant positive correlation was noted between the total sperm count and testicular volume (r=0.397, p<0.0001). There was a peak in sperm concentration at a mean testicular volume

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(MTV) of 25.1-27 cm3. Severe oligospermia (sperm concentration <5 million cells/ml) was noted at a MTV of 7 cm^3 and less.
Conclusion: Testicular volumes obtained from scrotal ultrasound examination correlate positively with sperm concentration in a non-linear fashion. A mean testicular volume of greater than 7 cm^3 is necessary for sperm concentrations of > 5 million cells/ml.

Keywords: Testicular volume; scrotal ultrasound; sperm concentration.

1. INTRODUCTION

Infertility is defined clinically as “a disease of the reproductive system defined by the failure to achieve a clinical pregnancy after 12 months or more of regular unprotected sexual intercourse” [1]. It is also defined by the World Health Organization as “the inability of a sexually active, non-contracepting couple to achieve pregnancy in one year” [2].

In Nigeria, infertility is a cause of many psychological and social problems for the childless couple. This is because children are seen by society as a sign of the female partner's womanhood and the male partner's virility. They are a source of social status [3]. The management of male infertility usually begins with a clinical history and physical examination followed by Seminal fluid analysis [2,4,5]. Imaging also has a role to play with Scrotal ultrasound presently being used in many institutions as the first line imaging modality in the management of male infertility. This is because it is readily available and non-invasive [6]. Previous studies had reported a positive relationship between testicular volume and semen profile [7,8]. This is because about ninety percent of the testis is made up of seminiferous tubules where spermatogenesis occurs [7]. A larger testis has more seminiferous tubules and thus produces more sperm [7]. Ultrasound measurement of the testicular volume the with the Lambert formula of Length (L) X Width (W) X Height (H) X 0.71 has proved to be the most accurate of the available formulas [5,6]. It is reported in literature that the normal testicular volume measurement obtained by ultrasound is between 12 -15 ml [7] However, the minimum testicular volume for normal function has been investigated but not established [7,8].

This study aims to evaluate the relationship between testicular volume and total sperm count in men being investigated for infertility in Southern Nigeria. It also aims to determine the critical testicular volume necessary for adequate sperm production.

2. MATERIALS AND METHODS

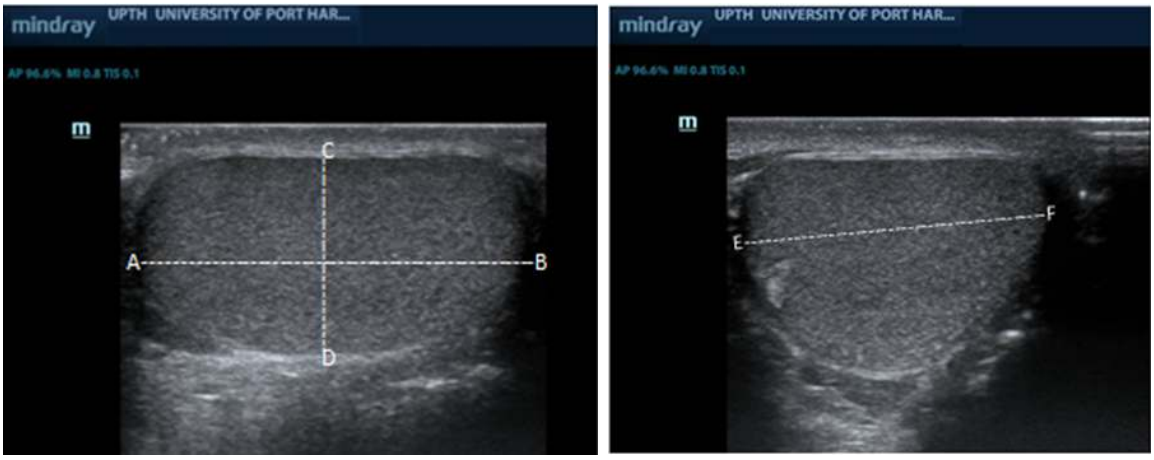
This study was a cross-sectional descriptive study carried out over a nine month period in the Department of Radiology of the University of Port-Harcourt Teaching Hospital (UPTH) in Port Harcourt, Rivers State, located in the South-South geopolitical zone of Nigeria. UPTH is a tertiary hospital that has a catchment area of the whole of Rivers State.

The minimum sample size for this study was calculated using the formula: $N=(Z\alpha+Z\beta)2PQ/D2$ [9]. Where N= minimum sample size, Zα= standard normal variate 1.96, Zβ=Power of the test set at 80%=0.84, P=11.2%=0.112 prevalence of infertility [10], Q=1-P=1-0.112=0.888, D=Level of precision=0.1.N= (1.96+0.84)2X0.112X0.888/0.12 =77.9735. Anticipated response rate set at 80% Selected sample size=N/ARR=77.97/ 0.8=97.4. After adding a 10% attrition rate, N was approximated to 100 males.

All subjects were referred to the Department of Radiology, for scrotal ultrasound from the urology clinic located in UPTH Port-Harcourt. Excluded from the study were men with a history of hypertension, diabetes mellitus or renal disease.

Ethical approval was obtained from the ethical committee of the hospital and informed consent was taken from all subjects.

All scrotal ultrasound scans were carried out using a Mindray DC-8 diagnostic ultrasound system with a 7.5MHz transducer in the presence of a male chaperone. The examination was explained to the subjects who were then placed in a supine position. Trousers and underwear were placed at the mid-thigh level. Support for the scrotum was via a folded towel positioned between the patient's legs. The penis



(A) **(B)**

Fig. 1. Grey scale ultrasound of a normal testis showing points of measurement: (A) longitudinal image; (B) transverse image

was then placed over the patient's suprapubic region and covered with another towel. Coupling gel was applied over both scrotal sacs and examination was done in both longitudinal and transverse planes.

The formula Length × Width × Height × 0.71 [5] was used to obtain the testicular volume. Three separate testicular length, width and height (Fig. 1) were measured using electronic calipers, excluding the epididymis. The largest measurement obtained for each testicular dimension was used for volume calculation. The sum of both testicular volumes made up the Total testicular volume (TTV). The TVV divided by 2 gave the Mean testicular volume (MTV).

Any study subject with a MTV of less than 10.3cm^3 was said to have a small testis [2].

The semen sample was collected after 3-4 days abstinence by masturbation and modified 'masturbation'. In modified masturbation, the wife of the subject did the 'masturbation' in a dedicated room within the hospital premises. This room has a dedicated bed and other facilities that aid the relaxation of the couple. The semen sample was then processed and analyzed in the laboratory. Subjects were educated on method of collection. The semen parameters [2] analyzed included semen volume, sperm concentration and total sperm count. Normal semen volume was considered as a volume of ≥ 2 ml. Normal sperm concentration was considered as a concentration of ≥ 15 x 10^6 cells/ml [2]. Abnormal sperm parameters [2] were considered as follows; aspermia - no ejaculate, azoospermia - no spermatozoa, oligospermia - < 15 x 10^6 cells/ml, severe oligospermia - < 5 x 10^6 cells/ml.

2.1 Data Analysis

Data analysis was done using the Statistical Package for the Social Sciences (SPSS) version 20.0. The evaluation of the testicular volume and testicular sperm count was correlated using Pearson's correlation and presented in a scatter plot. Statistically significant was set at p value of less than 0.05.

3. RESULTS

A total number of 100 subjects were evaluated with B-mode ultrasound 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

One subject had a history of left orchidectomy following trauma: The average testicular volume on the right was 13.04 ± 5.93 cm^3, while the average testicular volume on the left was 13.07 ± 5.16 cm^3. The average MTV for the study population was 13.14 ± 5.16 cm^3.

A statistically significant positive correlation between testicular volume and total sperm count was noted (r=0.397, p<0.0001) (Fig. 2). A mean testicular volume (MTV) of 25.1-27 cm^3 was associated with peak sperm concentration while severe oligospermia (sperm concentration <5 million cells/ml) was associated with MTV of 7 cm^3 or less (Fig. 3).

4. DISCUSSION

Semen analysis is considered the fundamental laboratory investigation for evaluation of male factor infertility. Many studies have shown that there is a significant correlation between testicular volume obtained by ultrasound and testicular function [7]. The results of

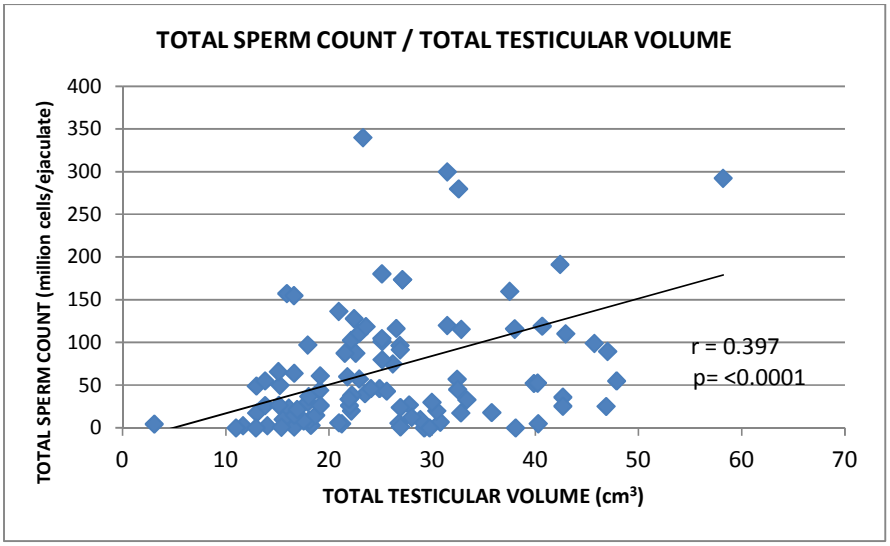


Fig. 2. Scatter plot showing the correlation between testicular volume and total sperm count

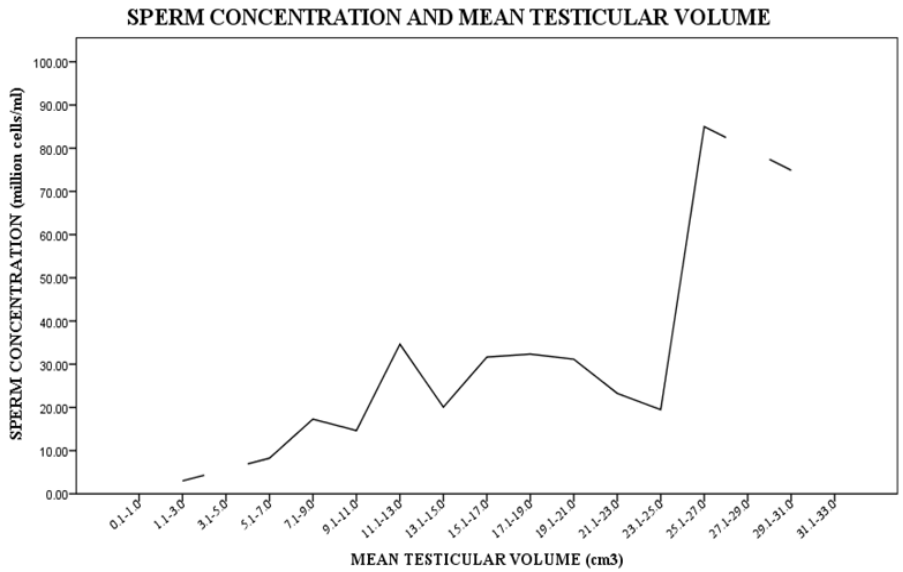


Fig. 3. Line graph of sperm concentration and mean testicular volume

this study agree with previous studies as there was a statistically significant positive correlation between testicular volume and total sperm count (p<0.0001). Tijani et al. [11] in Nigeria reported significant positive correlation between the mean testicular volume and total sperm concentration (p<0.05). The mean testicular volume (MTV) in this current study was 13.14±5.37 cm^3. This value for MTV in infertile men was similar to that reported by a study carried out in Kiridi et al. which was 13.3 ml [12]. The study by Kristo et al. [13] in Albania also showed positive correlation between testicular volume and sperm count (r=0.499, p<0.0001). The study by Tijani et al. [11] in Nigeria reported a MTV of 15.32±3.1ml from the 136 infertile men assessed and this reported value was significantly higher than for the control (19.9±3.8ml; p<0.05). Another study carried out in India by Sharath et al. [14] also showed a significant positive correlation between testicular volume and sperm count (r=0.501 p <0.0001) as well a higher MTV for the control population compared to the infertile population. The MTV for the control population in the study by Sharath et al. [14] in India was 11.45±2.65 ml while that for the infertile patients was 7.31±3.6 ml. This current study however did not have a fertile control population for this comparism to be analysed. The study carried out by Tijani et al. [11] Nigeria also reported that a peak in sperm density was noted at a MTV of 18-20 ml with sperm concentration falling at volumes higher or lower than 18-20 ml. This led them to conclude that that volume i.e. 18-20 ml may be the optimal testicular volume (OTV) for spermatogenesis though they called for larger studies. In the current study however there is a sharp peak in sperm concentration at a MTV of 25.1-27 cm^3. In a study by Sakamoto et al. [7] in Japan there were two peaks in sperm density at a MTV of 20-22.5ml and at greater than 25 ml. These differences may be because the study by Tijani et al. [11] only recruited patients who were azoospermic or oligospermic who had at least a 2 year history of infertility. This criteria was not used to select the patients in the current study as 50% of the study population had normal sperm concentration. The study by Sakamoto et al. [15] in Japan excluded patients that had pathologies that could affect testicular volume and this criteria was not used in the current study. These conflicting results may lead one to question if there is truly an OTV for the general population but more research has to be carried out. Further research will also have to better define and stream line criteria for study inclusion and may need a larger study and control population. The current study also observed that a MTV of 7 cm^3 and below was associated with severe oligospermia (sperm concentration <5 X 10^6 cells/ml). This is similar to the reports by Sakamoto et al. [15] in Japan and Sharath et al. [14] in India who noted that a Total testicular volume (TTV) of less than 15 ml and 16.1 ml (MTV of 7.5 ml and 8.05 ml) respectively were associated with severe oligospermia. These values however differ from that obtained by Tijani et al. [11] in Nigeria who reported severe oligospermia at a MTV of 12 ml or less. This difference is most likely due to difference in sampling methods between the studies.

5. LIMITATIONS

Other variables that may affect the sperm volume were not included in this study.

6. CONCLUSION

This study found a significant positive correlation between testicular volume and total sperm count. It was also observed that mean testicular volumes of less than 7 cm^3 were associated with severe oligospermia and sperm concentration tended to increase from above this value to peak at a mean testicular volume of 25.1-27 cm^3. When this is compared to other studies it implies that a mean testicular volume of at least above 7 cm^3 is necessary to produce sperm concentrations out of the severe oligospermic range. However, the value for an optimum testicular volume still needs further investigation.

DISCLAIMER

This manuscript was presented in the conference "2016 NMA Rivers scientific conference - ISSN 1597-4292" available link is: "http://webcache.googleusercontent.com/search?q=cache:3CujooFIqrIJ:www.tnhjph.com/index.php/tnhj/article/viewFile/270/pdf+&cd=7&hl=en&ct=clnk&gl=in" date July to September 2016, A Publication of Nigerian Medical Association, Rivers State, Nigeria.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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