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Ultrasound Measurement of Testicular Volume in Healthy Nigerian Adults

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Abstract

Testicular volume is one of the important indices that depict the reproductive capability of a man. The diagnosis of androgenic and testicular diseases depends on the ability to elicit minimal changes in the testicular volume. There is however a paucity of data for testicular volume measurements by ultrasound in Nigeria, thus necessitating the need for accurate data on the volume of the testes in Nigerian men. We sought to establish the normal testicular volume in healthy Nigerian adults, comparing the volume of the right and left testis and to correlate the testicular volume and age, body weight, height and body mass index (BMI) respectively. The length, width and height of the testes were measured in 200 participants aged 18 to 64 years using an Aloka SSD 2500 machine with a 7.5Hz linear transducer. The mediastinum testes and rete testis were used as the land marks to identify the sagittal and transverse planes respectively and the Lamberts formula (L x W x H x 0.71) was used to calculate the testicular volume. The mean age and BMI were 31.6 ± 9.9 years and 23.7 ± 4.0 kg/m^2 respectively while the mean testicular volume in the study population was 15.6 ± 5.3cm^3. The mean testicular volume was 16.3 ± 5.4cm^3 on the right and 15.0 ± 5.9cm^3 on the left and that of the right testis was significantly greater than the left, $p<0.05$. There was a positive but weak correlation between subjects' height and volume of the right testis. Similarly, their weight and BMI also showed a positive but weak correlation with the volume of the right testis and the mean testicular volume. The mean testicular volume for healthy adult males in our environment is 15.6 ± 5.3cm^3 with the mean volume of the right and left testis being 16.3 ± 5.4cm^3 and 15.0 ± 5.9cm^3 respectively. It is hoped that these values would serve as a reference for future clinical works.

Key Words: Testicular Volume, Ultrasound, Nigerian

Introduction

The testes form a major part of the male reproductive system and are primarily responsible for the production of spermatozoa and the male sex hormone, testosterone [1, 2, 3]. Ninety eight percent of the entire testicular volume (TV) is composed of seminiferous tubules which are responsible for spermatogenesis [4, 5]. The volume of the testes in adults is therefore believed to be an index of spermatogenegesis. Larger testicles therefore contain more seminiferous tubules and thus produce more spermatozoa [6].

The volume of the testes is also known to correlate well with semen profile [7, 8]. Measurement of testicular volume therefore is regarded as one of the most important indices in the assessment of male fertility. In adolescence, the estimation of testicular volume is important for evaluating and diagnosing pre pubertal androgenic disturbances and assessing the effect of illness or therapy on gonadal function [9, 10, 11]. Testicular volume is also used to measure the clinical significance of varicocele especially in infertile men [12, 13, 14]. Therefore, in order to objectively assess testicular disease conditions in our environment, it is essential to have reference values of testicular volume for Nigeria men.

Testicular volume is known to vary in different races [15]. These differences have been attributed to both genetic and environmental factors. Also, studies have observed that the presently existing data on human testicular volume in the world is scanty [16]. Several factors are known to influence the volume of the testis from one individual to another. Literature also shows various degrees of correlation between the testicular volume and the weight, height, body mass index (BMI) and age [17]. It was also shown that variation exists between the volume of the right and the left testicles [6, 8].

The volume of the testes can be measured using radiological or non-radiological methods. The non-radiological methods include clinical measurement with calipers, visual comparison with graphical models and the use of orchidometers. These methods are however known to grossly overestimate the volume of the testes [18, 19, 20, 21, 22, 23]. The actual volume of the testes can be measured using the water displacement method which is however only employed in patients whose testes have been surgically removed [18].

Radiologically, ultrasonography and magnetic resonance imaging (MRI) can be employed in the measurement of testicular volume. MRI is used in the stereological measurement of testicular volume, using the Cavaliery principle that involves the use of testicular views in the axial and sagittal planes. This method however can only be employed as a complimentary method to the traditional techniques[24]. Moreover, it is time consuming and very expensive and only very few centers in Nigeria have a functional MRI unit.

Ultrasound is considered to be the standard method of measuring testicular volume and reports have shown a positive correlation between the results obtained by orchidometry and ultrasound [19, 25, 26]. Some other literatures state that ultrasound has been shown to be more accurate in the measurement of testicular volume than the clinical (orchidometry) methods described. Its sensitivity to volume differentials is greater than that derived from the non-radiological methods [20, 22]. It does not involve the use of ionizing radiation, is cheap and readily available in Nigeria.

Since several disease conditions affect the testicular volume and the correlation between testicular volume and semen profile is very strong [8], the assessment of testicular volume can be used to evaluate the severity of testicular pathology. Unfortunately, there is paucity of data on ultrasound testicular volume in healthy Nigerian adults. The availability of such data will be of great value in assessing the health status of the testis in disease conditions. It is for this reason that we sought to measure the volume of the normal testis by ultrasound in healthy Nigerian men and correlate these with their age, height, weight and BMI. Having a reference value for testicular volume will help clinicians to properly and objectively evaluate male patients with sub fertility, help in the proper evaluation of androgenic and developmental problems in adolescent males, in proper assessment of the effect of varicocele on the testicular volume and thus helping clinicians to take prompt and accurate decisions concerning surgical intervention. Finally, with the availability of reference values, disease conditions which cause only minute changes in the testicular volume can properly be evaluated.

Materials and methods

Two hundred healthy randomly chosen men from 18-64 years who volunteered to participate in the study were scanned in the Radiology Department of a Nigerian University Teaching Hospital, after they were confirmed not to have any chronic illnesses such as diabetes mellitus, tuberculosis, human immunodeficiency virus/ acquired immunodeficiency syndrome, infertility, orchitis, varicocoele and testicular tumours through detailed history taking and laboratory tests.

It was a cross sectional study done from January to December 2011. Approval was obtained from the Research and Ethics committee of the hospital and written informed consent form was signed by each participant.

The Weights (W) and heights (H) of all subjects were recorded and the body mass index (BMI) calculated using the formula BMI = W/H^2 (Kg/m^2). All measurements were taken in standard SI units. An ultrasound machine, ALOKA SSD 2500, with 7.5Hz transducer was used.

Subjects were placed in the supine position with their trousers and pants pulled down to the mid-thigh level. The scrotum was supported by a small examination towel posteriorly to stabilize the testes and coupling gel was applied generously to maximize visualization of both testicular poles. The testes was then stabilized by placing a finger on the median raphe of the scrotal skin and gently scanned to avoid distortion of its shape and dimension.

In order to get the longitudinal plane of the testis, the probe was placed on the scrotal skin over the testis and rotated until the mediastinum testis was visualized in the same plane. The image was then frozen. The length of the testis (a-b) was measured by placing the electronic caliper in the most superior and inferior points of the testis while the height of the testis (c-d) was measured on the same frozen image by placing the calipers on the widest anterior-posterior point of the testis perpendicular to the longitudinal plane (**Figs 1a**).

The width (transverse plane) of the testis was then measured by rotating the probe until it is perpendicular to the longitudinal plane. At this point the rete testis will be visualized as hypoechoic septations on the lateral end of the image. The calipers are placed at the widest transverse diameter (e-f) (**Fig 1b**). To reduce error, the measurements were taken thrice and the average value calculated.

The testicular volume was calculated using the empiric formula of Lambert: L x W x H x 0.71 which is the most accurate formula for evaluating testicular volume [19, 25].

For proper analyses of results, the age, weight, and BMI of all the subjects were grouped into class intervals with age and weight grouped into class intervals of ten and BMI grouped into underweight, normal weight, overweight and obese.

Results

The mean age of the study population was 31.6 $\pm$9.9 years, and more than half of the study subjects 109 (54.5%) fell within the age bracket of 21-30 years while the least number, 12 (6%) were below 20 years, (**Table 1)**.

The weight ranged from 48 to 118kg with a mean of 71.4$\pm$12.38kg. Most of them were between 61-70 kg, 98 (49%) while the fewest were those below 51kg.

The most frequent height were between 1.7-1.79m, 89 (42.5%), with a mean height of 1.7$\pm$0.89m. Those who were $\geq$1.9m were only 2 (1%).

The mean BMI was 23.7$\pm$4.0kg/m^2, ranging from 15.1 - 39.5. BMI between 18 - 24.9kg/m^2 were considered normal and most of the study group, 123(61.5%) were in this group, while the obese group with BMI of >30kg/m^2 were the least frequent, 13(6.5%). The largest testicular volume was recorded in the 30 and above BMI group (**Table 2**).

The mean length, height and width of the right testicle was (4.0$\pm$0.5cm, range 2.6-5.1), (2.3$\pm$0.3cm, range 1.2-3.0) and (2.5$\pm$0.3cm, range 1.4-3.6) respectively, while that of the left was (3.8$\pm$0.6cm, range 2.2-5.3), (2.2$\pm$0.4cm, range 1.4-3.5) and (2.4$\pm$0.4cm, range 1.4-3.5) respectively. The mean testicular volume for the study population was 15.6$\pm$5.3cm^3, range 2.8-35. The volume of the right and left testis measured (16.3+5.3cm^3,

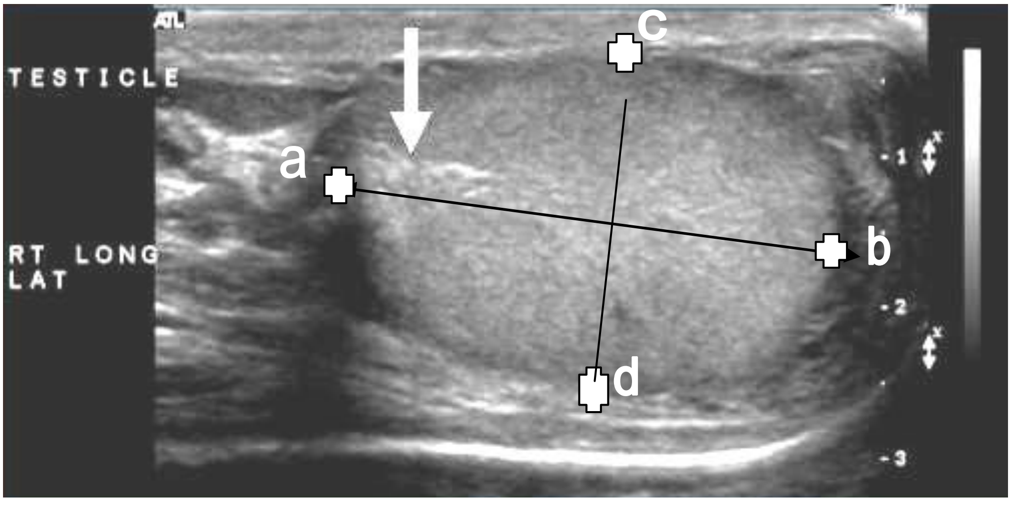

Figure-1a. Longitudinal scan of the testis showing the mediastinum testis (arrow) and the points of measurement.

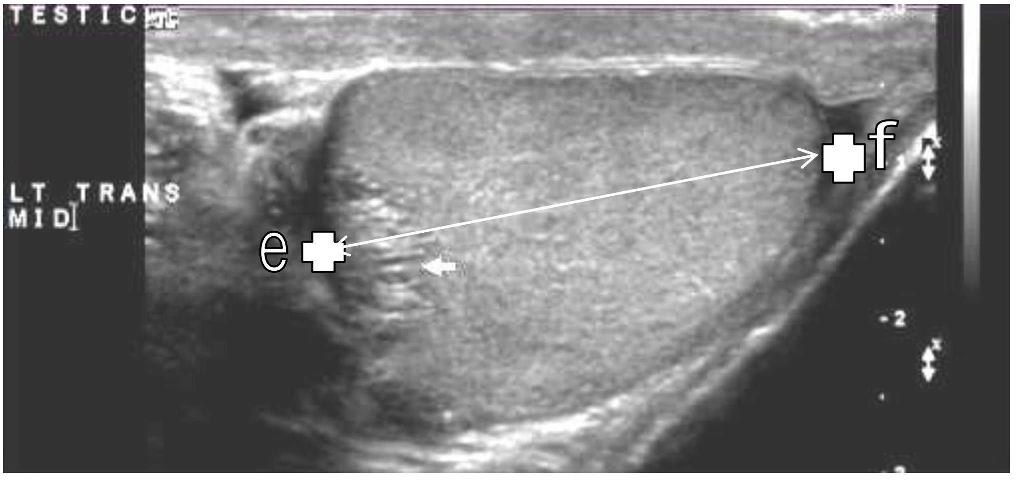

Figure-1b. Transverse scan of the testis showing the rete testis (arrow) and the points of measurement.

Table-1 The age distribution with height, weight and BMI

Age(years)	No (%)	Mean ± SD Height(m)	Mean ± SD Weight(kg)	Mean ± SD BMI(kg/m^2)
<20	12(6%)	1.8 ± 0.1	52.5 ± 4.9	16.8 ± 0.9
21-30	109(54.5%)	1.7 ± 0.1	66.4 ± 6.3	21.6 ± 1.4
31-40	51(25.5%)	1.7 ± 0.1	75.3 ± 8.2	25.6 ± 1.1
41-50	13(6.5%)	1.6 ± 0.1	79.0 ± 4.5	28.2 ± 0.7
>50	15(7.5%)	1.7 ± 0.1	99.9 ± 10.0	23.7 ± 3.4

Key: No. number of subjects,

Table-2 Testicular volume in the various BMI groups

BMI(kg/m^2))	Mean±SD R. VOLUME(cm^3)	Mean±SD L. VOLUME (cm^3)	Mean± SD R+L(cm^3)
<18	16.6±4.0	16.4±3.7	16.5±3.8
18-24	16.0±5.3	14.4±6.0	15.2±5.5
25-29	16.3±4.3	15.3±5.0	15.8±4.5
30>	18.5±9.8	16.7±8.6	17.6±9.2

Table -3 The age distribution of length, height, width and volume of both testicles

	RIGHT TESTIS				**LEFT TESTIS**			
Age (years)	**M ±SD L(cm)**	**M ±SD H(cm)**	**M ± SD W(cm)**	**M± SD V(cm^3)**	**M ± SD L(cm)**	**M ± SD H(cm)**	**M ± SD W(cm)**	**M ± SD V(cm^3)**
<20	3.9±0.3	2.2±0.2	2.5±0.2	15.5±3.4	3.9±0.5	2.4±0.2	2.5±0.2	16.0±9.0
21-30	3.9±0.5	2.2±0.3	2.4±0.3	15.8±5.3	3.6±0.6	2.1±0.4	2.4±0.4	14.1±5.4
31-40	4.0±0.4	2.3±0.2	2.5±0.3	15.7±4.7	3.8±0.6	2.1±0.3	2.3±0.4	14.8±5.6
41-50	3.9±0.3	2.3±0.3	2.5±0.3	16.5±5.0	4.0±0.5	2.3±0.4	2.5±0.8	17.3±5.0
>50	4.0±0.6	2.3±0.4	2.6±0.3	18.4±9.0	4.0±0.8	2.2±0.4	2.5±0.4	16.6±8.0

Key: M= mean, SD= standard deviation
L = Length, H = height, W=width, V= volume

range 2.9-38) and (15.0+5.9cm^3, range 2.7-31.7) respectively, (**Table 3**). There was a significant statistical difference between the volume of the right and left testis, p=0.000.The age of the patients did not show any correlation with the volume of the right testis, the left testis, and the mean testicular volume p= 0.098, p=0.294 and p= 0.154 respectively.

The height of the study subjects showed significant statistical correlation with the volume of the right testis, p=0.027 but no correlation was found between height with the volume of the left testis and the mean testicular volume p= 0.783 and p=0.201 respectively.

The weight of the subjects also had a significant statistical correlation with the volume of the right testis (p= 0.000) and the mean testicular volume (p=0.04). However no significant correlation was found between weight and volume of the left testis p=0.53.

The BMI showed significant statistical correlation with the right testicular volume p=0.049 and the mean testicular volume p =0.04, but not with the volume of the left testis p=0.083.

The scatter plot graph of BMI versus mean right testicular volume and mean right and left testicular volume show a weak positive correlation with r = 0.019 and 0 015 respectively.

Discussion

Measurement of testicular volume in adults is an important tool in assessing the health status of the testis in disease states such as undescended testis, torsion, malignancies, orchitis and varicoceles. The non-invasiveness of ultrasound and the fact that it is devoid of radiation, allows for repeated monitoring of these disease entities. In addition to semen analysis and measurement of serum hormones, estimating testicular volume has been an integral part of evaluating male infertility, because testicular volume directly corresponds to semen profile[8].

The sample selection criteria used in this study is similar to that used by Jong et al[6], Aribarg et al[28] and Wikramanayake[29]. As in their studies, all the participants with past history or clinical features suggestive of testicular disease were excluded from the study.

Finding from this study however differs slightly from the values obtained by Jong et al [6] who reported the mean testicular volume of the right and left to be 18.26±3.21 and 18.09±3.79 respectively in Korean males. The mean testicular volume from our study is also at variance with that of Aribarg et al[27] who reported the mean testicular volume in Thai males to be 17.2±3.0. These slight differences in testicular volume could be due to environmental, nutritional and genetic factors as stated by Ku et al [17]. Furthermore, tropical countries like Nigeria have a high temperature which does not support spermatogenesis. Also, the malnutrition which exists in Nigeria may cause suboptimal testicular growth.

This study showed a significant statistical difference between the volume of the right and the left testicle with the right testicle being larger than the left. The slight reduction of the testicular volume on the left could be due to the fact that the pampiniform plexus of vein are more prominent on the left [27] resulting in an increased temperature in the left testis with subsequent reduction in spermatogenesis and testicular volume on that side.

In our study, the age of the patients did not show any correlation with the volume of the right testis, the left testis, and the mean testicular volume. This finding is similar to that of Beres et al[30] on testicular size variant and Tajima et al[31] on testicular size. In their studies, they established that the testis achieved its maximal size by 18 years and remains so until 8o years when it starts decreasing in size.

There was significant correlation between the height of the subjects with the volume of the right testis but not with the left testicular volume and the mean testicular volume. This finding is in keeping with the study done by Sobowale and Akiwumi [8] in Nigeria which also showed a positive correlation between the height of the subjects and the testicular volume but not with the other parameters i.e. weight and BMI. However, the study by Sobowale and Akiwumi [8] did not specifically test the correlation of height with the each mean testicular volume.

The weight in our study showed significant correlation with the right testicular volume and the mean testicular volume but not with the left testicular volume, thus differing from the study done by Sobowale and Akiwumi [8]. However, our findings corroborated the findings by Wikramanayake [29], Jong et al[6] and Aribarg et al[28] whose studies showed a significant correlation between testicular volume with weight and BMI.

This study showed a persistent lack of correlation between the weight, BMI and Height with the left testicular volume. The reason for this observation is not known

As established by Aribarg et al[28] and Jong et al [6] the Pearson correlation and scatter plot graphs show poor linear correlation between the BMI and the volume of the right testis as well as that of the mean testicular volume.

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Conclusion

This study revealed that the mean testicular volume for healthy Nigerian adult population was 15.6±5.3cm^3. These values however differ slightly from that of the Caucasian and Asian population.

It is hoped that the normal values generated from this study would serve as a reference for future clinical evaluation.

References

1. **Inderbir S. (2002)** The male reproductive organ. In: Inderbir S (ed) Textbook of human histology. 2nd edition, Jaypee brothers. New Delhi. pp. 273-280.
2. **Ryan S, McNicholas M, Eustace S (2004)** The pelvis. In: Ryan S, McNicholas M, Eustace S (eds) Anatomy for diagnostic imaging. 2nd edition, Elsevier Saunders. Philadelphia. pp.232-235.
3. **Guyton AC, Hall JE (2004)** Reproductive and hormonal functions of the male. In: Guyton AC, Hall JE (eds) Medical physiology.10th edition, WB Saunders. Philadelphia. pp. 916-917.
4. **Setchell BP (1998)** Brooks DE. Anatomy, vasculature, innervations and fluids of the reproductive tracts. In: Knobil E, Neill JD (eds) The physiology of reproduction. 2nd edition, Raven Press. New York. pp. 753-836.
5. **Takihara H, Consentino MJ, Sakatoku J, Cockett ATK (1987)** "The significance of testicular size measurement in andrology: Correlation of testicular size with testicular function". Journal of Urology Vol.137, pp. 416-419.
6. **Jong Wang Lim, Jong yoon Barhk, and Seung ki min (2009)** "Testicular volume of Korean young adult men as measured by ultrasonography: Relationship with body mass index". Korean Journal of urology Vol.50, No.6, pp.591-595.
7. **Aria T, Takihara S, Horiuchi S (1993)** "Relationship of testicular volume to semen profile and serum hormone concentrations in infertile Japanese males". International Journal of Fertility Vol.43 pp. 40-47.
8. **Sobowale OB, Akiwumi O. (1989)** "Testicular volume and seminal fluid profile in fertile and infertile males in Ilorin, Nigeria". International Journal of Gynecology and Obstetrics Vol. 28, No.2, pp.155-161.
9. **Rundle AT and Sylvester PE (1962)** Measurement of testicular volume. It's application to assessment of maturation, and its use in diagnosis of hypogonadism. Archives of Disease in Childhood 37:514.
10. Schonfeld WA (1943) Primary and secondary sexual characteristics: A study of their development in males from birth to maturity, with biometric study of the penis and testes. American Journal of Disease in Childhood 65:353.
11. **Tanner JM (1962)** The reproductive system. In: Tanner JM (ed) Growth of adolescence.2nd edition, Blackwell. Oxford. PP. 222-226.
12. **Costabile RA, skoog S, Radowick M. (1992)** "Testicular volume assessment in adolescents with varicocele" Journal of Urology Vol.147, pp.1456-1457.
13. **Wu FCW, Brown DC, Butler GE (1993)** "Early morning plasma testosterone as an accurate predictor of imminent pubertal development in pre pubertal boys" Journal of Clinical Endocrinology and Metabolism Vol.76, pp. 26-31.

14. **Sayfan J,Siplovich L, Fujii M (1997)** "Varicocele treatment in pre pubertal boys presenting with testicular growth arrest" Journal of Urology Vol.157, pp.1456-1457.
15. **Katharina MM, jourma T, Annie – Maarit S, Marko K, Marla C, Ida M et al (2006)** "Larger testes and higher inhibin B levels in Finish boys than in Danish boys" The Journal of Clinical Endocrinology and Metabolism Vol. 91, No.7, pp.2732-2737.
16. **Ursular M (1998)** Ethnic differences in testicular size: A possible link with the cytogenetics of true hermaphroditism. Human reproduction Vol.4, No.3, pp. 445-449.
17. **Ku JH, KIM ME, Jeon YS, Lee NK and Park YH (2002)** "Factors influencing testicular volume in young men: results of a community based study". BJU Vol. 90, pp.446-450.
18. **Al Salim A, Murchison PJT, Rana A, Elton RA, Hargreave TB (1995)** "Evaluation of testicular volume using three orchidometers compared with ultrasonographic measurements" British Journal of urology Vol.76, pp.632-635.
19. **Rivkees SA, Hall DA, Boepple BA (1987)** "Accuracy and reproducibility of clinical measurement of testicular volume" Journal of Paediatrics Vol. 110, pp.914-917.
20. **Lenz S, Giwercman A, Elsborg A, Cohr KH, Jelnes JE, Carlsen E et al (1993)** "Ultrasonic testicular texture and size in 444 men from the general population: Correlation to semen Quality" European journal of urology Vol.24, pp. 231-238.
21. **Diamond DA, Paltiel HJ, DiCanzio J. (2000)** "Comparative assessment of paediatric testicular volume: Orchidometer versus ultrasound" Journal of Urology Vol.164, pp.1111-1114.
22. **Taskinen S, Taavitsainen M, and Wikstrom S (1996)** "Measurement of testicular volume: Comparison of three different methods" Journal of Urology Vol.155, pp.930-933.
23. **Shiriashi K, Takihara H, Kamiryo Y, Naito K (2005)** "Usefulness and limitations of punched out orchidommeters in testicular volume measurement" Asian Journal of Andrology Vol.7, pp.77-80.
24. **Sahin K, Mahmet Y, HIlmi O, Faik Y, orhan O, Yakup G (2009)** "Magnetic resonance imaging in complementary method to sterologgical measurement of testicular volume" Journal of Urology Vol. 73, pp.1131-1135.
25. **Behre HM, NaHsan D, Nieschlag E.(1989)** "Objective measurement of testicular volume by ultrasound: Evaluaton of the technique and comparison with orchidometer estimates" International Journal of Andrology Vol. 12, pp.395-403.
26. **Schiff JD, LI PS, Goldstein M (2004)** "Correlation of ultrasonographic and orchidometer measurement of testicular volume in adults" British Journal of urology International Vol.93, pp.1015-1017.
27. **Sakamoto H, Ogawa Y, Yoshida H (2009)** "Relationship between testicular volume and varicocele in patients with infertility" Urology Vol.71, No.1, pp.104-109.
28. **Aribag A, Kenkeerati W, Vorapaiboonsak V, Leepipatpaiboon S, Farley TMM (2008)** "Testicular volume, semen profile and serum levels of fertile Thai males" International journal of Andrology Vol.9, No.3, pp.170-180.
29. **Wikramanayake E (2008)** "Testicular size in young adult Sinhalese" International Journal of Andrology Vol.18, No.1, pp.29-31.
30. **Beres GY, Czeisel E (2007)** "Testicular volume variation from 0 to 28 years of age" Journal of international Urology and Nephrology Vol.21, No.3, pp.159-167.
31. **Tajima M (1998)** "Testicular measurement by test size orchidometer" Acta urologica Japonica Vol. 34, No.11, pp.2013-2020.