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Objective Measurement of Testicular Volume in Eastern Indian Population Using Ultrasonography and Comparison with Orchidometer Estimates

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Original Research Article

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Abstract: Testicular function has a direct correlation with testicular volume. Reduction in testicular size results in disturbed spermatogenesis. Therefore, accurate measurement of testicular volume is important .The aim of the study was to measure normal testicular volume of eastern Indian population by US and to compare with Orchidmeter estimates. Between 1st November 2016 to 30th June 2017 total 304 patients; those were not suffering from any testicular disease or trauma studied. Volume of both testes was measured using US and Prader Orchidmeter. Patients were divided into four age groups (16-25, 26-35,36-45, 46 and above). US volume of the left testis was 9.48 - 22.7 ml (mean 16.56 ml) and right 9.62 - 23.21 ml (mean 16.91 ml). Prader volume of left testis was 10 - 22.5 ml (mean 17.06 ml,) and right 10 - 22.5 ml (mean 17.15 ml). Here the difference of mean between RTUV (Rt testis US volume) and RTPV (Rt testis Prader volume) and between LTUV (Lt testis US volume) and LTPV (Lt testis Prader volume) are not statistically significant. The Pearson correlation in between RTUV with RTPV and LTUV with LTPV were positive and statistically significant ($p<0.001$) in all age groups. This study reveals strong correlation between US and Prader Orchidmeter measured testicular volume and difference of mean volume of each testis measured by either method are not statistically significant.so like USG, Prader Orchidmeter might provide a useful estimate of testicular size and testicular volume of eastern Indian population correlate with data of foreign literature.
Keywords: Testicular volume, Prader Orchidmeter, US Volume.

INTRODUCTION

Since its introduction in the late 1970s, Ultrasonography of the testis has been used successfully to diagnose and evaluate pathological testicular process. Ultrasonography imaging of scrotum has proved to be an accurate and safe diagnostic tool [1].

Testicular function has a direct correlation with testicular volume, since seminiferous tubules and germinal elements comprise approximately 98% of testicular mass [2, 3]. Reduction in testicular size is mainly caused by reduction of these histological elements due to primary dysplasia or secondary damage and can therefore result in disturbed spermatogenesis [4].Therefore, accurate measurement of testicular volume is important.

Reliable and accurate determination of the testicular volume is of great benefit in the evaluation of patients with disorders affecting testicular growth, development and function. Studies in infertile men have shown that the testicular volume has a direct correlation to seminal fluid and sex hormone assay, just like the simple measurement of testicular length, width and depth [5–7].

A total testicular volume (i.e. summation of right and left) of 20 ml and more, as determined by ultrasound, is indicative of normal testicular function [5]. These findings underscore the importance of testicular volume measurement in the management of male infertility. In line with this, one of the components of a minimum full evaluation of male infertility is palpation of the testes and measurement of their size [8].

In the management of adolescent varicocele, testicular volume measurement helps in deciding when to operate in cases where seminal fluid analysis could be seen to be psychologically or ethically incorrect [9–11]. Another important application of testicular volume measurement is the monitoring of patients following varicocele ablation in children and adults, and orchidopexy for undescended testes [12,13]

It is also a tool in staging puberty, as the testicular volume is the one of the most important clinical evidence of puberty [14], and in diagnosing idiopathic hypogonadotrophic hypogonadism and Klinefelter's syndrome [15–18].

Currently, a number of methods for testicular volume measurement are being used, including Prader orchidometry and ultrasonography (US). The Prader orchidometer is widely used in clinical settings. However, scrotal ultrasound offers the potential for greater accuracy in testicular measurement compared to the Prader orchidometer [1,19,20].

The study was designed to measure normal testicular volume by ultrasonography and to compare with Orchidometer estimates. It also aims to estimate how the testicular volume of eastern Indian population correlated with book literature mentioning foreign data.

SUBJECTS AND METHODS

This hospital-based randomised comparative study was carried out over a period of 8 months from 1st November 2016 to 30th June 2017. Ethical approval was sought and obtained from the ethical committee of our hospital (Memo no-IPGME&R/IEC/2017/315). Patients who did not give their consent to the study and patients with any testicular disease, testicular trauma or sterility, prostatic malignancy, undescended testis, prior testicular surgery, testicular infection or inflammation were excluded from this study.

All the patients of 16 to 60 years of age, were subjected to scrotal ultrasound scans in order to check for any scrotal pathology and to measure the length (longitudinal diameter), width (transverse diameter) and height (anterior - posterior diameter) of each testes. These scans were carried out by using a 7.5 MHz probe.(Fig-1)

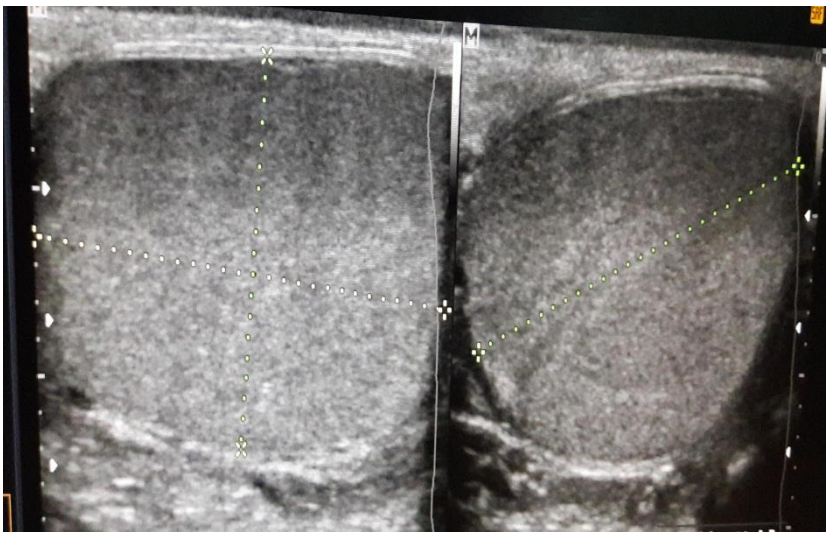

Fig-1: Dotted line showing Length and AP dimension (Height) in longitudinal plane and width in transverse plane.

Various formulas have been used to calculate the testicular volume measured by US. One recent study found 0.71 ! length ! width! height($L \times W \times H \times 0.71$) to be an accurate formula to estimate the volume of canine testes [19] . This formula, introduced by Lambert [21] in 1951, seems to be accurate for humans as well and has been used in several studies [7].

We have performed US measurements first, so we were blinded to the Prader Orchidmeter examinations. After assessing testis volume by US, testicular size was determined with the testis models of a Prader orchidometer, after the scrotal skin had been stretched over the testis in a warm room. The orchidometer consists of 12 ellipsoid models ranging in volume from 1 to 25 cm 3 (1 to 6, 8, 10, 12, 15, 20 and 25 cm 3). Estimated in-between values were recorded as well, like those values within 15 to 20 are taken as 17.5.and those within 20 to 25 are taken as 22.5.

We compared the testicular volume measured by this US and Prader methods in four age groups (Between 16 and 25yrs, 26 and 35yrs, 36 and 45yrs and 46 and 60 years).

Data Recording and Statistical Methods

The statistical package SPSS for Windows was used for all calculations and statistical analyses. The measured data were listed and Correlations between the volume measurements by US and Prader Orchidmeter were calculated with the Pearson correlation coefficient. Difference of mean testicular volume of each side by US and Prader Orchidometer method was also statistically analysed in each four age groups using pair t test.

RESULTS

Between from 1st November 2016 to 30th June 2017. Patients were enrolled in this study. Testicular volume of both testes could be measured in 304 of the cases (98.6), whereas 4 patients (1.31%) refused measurement by US due to embarrassment or fear. The ages of the 304 participating patients ranged from 16 to 60 years (mean 40.45 years, 42 median years).

General Characteristics

Of the 304 patient who were included had no significant Testicular pathology by history, clinical examination or US examination.

Enrolled in the Study, N = 314; mean age = 40.19 years (16-60yrs).
Refused to Participate, N = 4; mean age = 23 years (17-45yrs).
Participated in the Study N = 310; mean age = 40.32 years (16-60ys).
Excluded: N = 6; mean age = 33.6 years (19-47yrs).
Included in the Study, N = 304; mean age = 9.0 years (0.6–19.0yrs)

Testicular Volume Measured by US

In these 304 patients testicular volumes measured by US ranged from 9.48 to 23.21 ml (mean 16.73 ml, median 16.98 ml). The testicular volume of the left testis ranged from 9.48 to 22.7 ml (mean 16.56 ml, median 16.8ml) and the volume of the right testis ranged from 9.62 to 23.21 ml (mean 16.91 ml, median 17.03 ml). The largest difference between the testicular volumes in 16- 25 yrs age group was found (range 10.01–23.21 ml)

Testicular Volume Measured by Prader Orchidometer

The 304 mean testicular volumes measured by Prader Orchidometer ranged from 10 to 22.5 ml (mean 17.11 ml, median 17.5 ml). The volume of the left testis ranged from 10 to 22.5 ml (mean 17.06 ml, median 17.5 ml) and the volume of the right testis ranged from 10 to 22.5 ml (mean 17.15 ml, median 17.5 ml).

Measurement of Testicular Volume by US versus Prader Orchidometer

Here the difference of mean between RTUV and RTPV, in 16-25 years group (p=0.8270), in 26-35 years group (p=0.4407), in 36-45 years group, (p=0.4033) and in 46-60 years group,(p= 0.3187), none were statistically significant.

Similarly the difference of mean between LTUV and LTPV, in 16-25 years age group (p=0.5645), in 26-35 years age group (p=0.1385), in 36-45 years age group,(p=0.1445) and in 46-60 years age group ,(p= 0.0859),were not statistically significant.(Table-1)

Table−1: Distribution of Mean RTUV, RTPV, LTUV and LTPV according to different age group as measured by US and the Prader Orchidometer

Age (Years)		Number	Mean	SD	Minimum	Maximum	Median	p-value
16 -25	**RTUV**	55	17.8569	3.6682	10.2300	23.2100	19.0400	0.8270
	RTPV	55	18.0091	3.6177	10.0000	22.5000	20.0000	
	LTUV	55	17.5249	3.6546	10.0100	22.7000	18.9400	0.5645
	LTPV	55	17.9273	3.6469	10.0000	22.5000	20.0000	
26 -35	**RTUV**	56	19.4725	1.6558	15.9200	22.2500	19.4500	0.4407
	RTPV	56	19.7321	1.8877	15.0000	22.5000	20.0000	
	LTUV	56	19.1555	1.6407	15.2600	22.4600	19.3000	0.1385
	LTPV	56	19.6429	1.8109	15.0000	22.5000	20.0000	
36 -45	**RTUV**	69	16.9501	2.1586	9.6200	20.3800	17.1400	0.4033
	RTPV	69	17.2754	2.3926	10.0000	20.0000	17.5000	
	LTUV	69	16.5272	2.7436	2.4300	19.9400	16.9800	0.1445
	LTPV	69	17.1739	2.4221	10.0000	20.0000	17.5000	
46 -60	**RTUV**	124	15.2319	2.6366	2.6900	20.8400	15.4800	0.3187
	RTPV	124	15.5565	2.4769	12.0000	20.0000	15.0000	
	LTUV	124	14.9045	2.5877	2.8000	19.7000	15.0800	0.0859
	LTPV	124	15.4597	2.4821	10.0000	20.0000	15.0000	

RTUV-Right testicular USG volume. RTPV-Right testicular Prader (Orcidometer) volume.
LTUS-Left testicular USG volume. LTPV-Left testicular Prader (Orcidometer) volume.

Positive correlation was found in between RTUV with RTPV and LTUV with LTPV in above four mentioned age groups. All were statistically significant (p<0.001). The Pearson Correlation Coefficient were 0.973 and .975, 0.947 and .932, 0.947 and .807, 0.864 and .863 respectively. This correlation is positive also in total 304 population (.942 and .921) and is statistically significant (p<0.001). (Table-2 and Table-3)

Table-2: Correlation of testicular volume of each side between US and Prader Orchidmeter measured volume in different age groups

		Age (Years) 16 -25		Age (Years) 26 -35		Age (Years) 36 -45		Age (Years) 46 -60	
		RTPV	LTPV	RTPV	LTPV	RTPV	LTPV	RTPV	LTPV
RTUV	Pearson Correlation Coefficient	0.973**		.947**		.947**		.864**	
	p - value	<0.001		<0.001		<0.001		<0.001	
	Number	55		56		69		124	
LTUV	Pearson Correlation Coefficient		.975**		.932**		.807**		.863**
	p - value		<0.001		<0.001		<0.001		<0.001
	Number		55		56		69		124

Table−3: showing Correlation of testicular volume of each side between US and Prader Orchidometer measured volume in total participants

		RTPV	LTPV
RTUV	Pearson Correlation Coefficient	.942**	
	p - value	<0.001	
	Number	304	
LTUV	Pearson Correlation Coefficient		.921**
	p - value		<0.001
	Number		304

DISCUSSION

This study provides normal volume of B/L Testis ultrasonographically. There are different means for measuring testicular volume, such as calipers, rulers, Orchidmeters, water displacement and US. The Prader orchidometer is widely used for the clinical assessment of testicular volume in the doctor's office especially in infertility clinics because it is practical and less time consuming than US. However, US is more precise [5,18].

The Orchidmeter measures the epididymis as well as the scrotal skin, and there is inter observer bias, as a result, it tends to overestimate testicular volume, especially in small testes, in which the epididymis is large in comparison to the total testicular volume. Because of its practical use, the Prader orchidometer is one of the main instruments in the analysis of testicular volume. A few studies comparing the orchidometer and US found that both methods correlated well [22,23] .

In healthy European adult humans, average testicular volume is 18 cm^3 per testis, with normal size ranging from 12 cm^3 to 30 cm^3. The average testicle size after puberty measures up to around 2 inches long, 0.8 inches in breadth, and 1.2 inches in height (5 x 2 x 3 cm) [24].

A study carried out to evaluate the relationship between testicular volume and function using scrotal ultrasound scan in black West African men. where examination of 236 subjects done over a period of one year. The mean testicular volume for the sub-fertile patients was 15.32 ml while it was 19.89 ml in the control group, was statistically significant. Mean testicular volume of 18–20 ml was associated with highest semen density. Severe oligospermia (<5 million/ml) was associated with mean testicular volume less than 12 ml [25].

Schiff *et al*. in 159 patients presenting for infertility found no difference in the volume of testes estimated by US and PDO. Mean right testis volume was 18 ± 9 cc by US *versus* 18 ± 6 cc by PDO (P = 0.5); mean left testis volume was 17 ± 6 by US and 17 ± 8 cc by PDO (P = 0.8) [26].

In another study testicular volume of infertile patients predicts the quality of semen. Using punched out orchidometer, Arai *et al*. showed that when the total testicular volume was 30 cc, 20 cc, and 10 cc, these infertile patients had normal, severe oligospermia, and azoospermia, respectively [27].

In the present study provides normal testicular volume range 9.48-23.21ml.(mean 16.73 ml, median 16.98 ml). The testicular volume of the left testis ranged

from 9.48 to 22.7 ml (mean 16.56 ml, median 16.8ml) and the volume of the right testis ranged from 9.62 to 23.21 ml (mean 16.91 ml, median 17.03 ml) measured by US in men aged 16-60 years, and by Prader Orchidometer volume ranged from 10 to 22.5 ml (mean 17.11 ml, median 17.5 ml). The volume of the left testis ranged from 10 to 22.5 ml (mean 17.06 ml, median 17.5 ml) and the volume of the right testis ranged from 10 to 22.5 ml (mean 17.15 ml, median 17.5 ml).

Here the comparison between the Orchidometer and ultrasound demonstrated a strong linear correlation. Population were divided into four age groups, we found the weakest correlation in the 46-60 yrs group (R=.864) for the right testis and 36-45 yrs group (R=.807) for the left testis. The strongest correlation was found in the age group of 16-25 years (R = 0.973 and .975 for right and left testis respectively)

CONCLUSION

This study provides normal testicular volume range 9.48-23.21ml, and these values can be used as a reference for normal volume, and to compare with different testicular abnormalities in Eastern Indian population and it correlates well with western book literature mentioning testicular volume (12-30 ml) Furthermore, we found an accurate correlation between the volumes measured by the Prader orchidometer and by US (R = 0.942 and .921 for right and left testis respectively). Therefore, volume measurement by the Prader orchidometer, as generally used in practice by doctors, can be used as a valid parameter for monitoring testicular volume as it is easy and quick OPD procedure.

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