Accuracy of Prader orchidometer in measuring testicular volume

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Abstract

Background: Seminiferous tubules comprise 80-90% of testicular mass. Thus, the testicular volume is believed to be an index of spermatogenesis. Therefore, accurate testicular volume is one way to assess testicular function.

Objective: To determine the accuracy of Prader orchidometer for measuring the testicular volume by comparing the resultant measurement with the actual testicular volume in humans.

Materials and Methods: The testicular volumes of 121 testes from 62 patients with prostate cancer (mean age 72.74 ± 9.38 years) were measured using Prader orchidometer before therapeutic bilateral orchidectomy. The actual testicular volumes were then determined by water displacement of the testis.

Results: The mean testicular volume of the 121 testes was 10.60 ± 3.5 ml and13.26 ± 5.2 ml for water displacement and Prader orchidometer measurements, respectively. A strong correlation was found between the actual testicular volume and volumes obtained by Prader orchidometer (r = 0.926, P = 0.0001). The Prader orchidometer however, over-estimated the mean actual testicular volume by 2.66 ± 2.37 ml (25.10%).

Conclusion: The result of this study has shown that measuring the testicular volume by Prader orchidometer overestimates the actual testicular volume.

Key words: Accuracy, prader orchidometer, testicular volume

Date of Acceptance: 21-Oct-2012

Introduction

The testes are responsible for the production of spermatozoa and testosterone in man. Approximately, 80-90% of testicular volume is made up of seminiferous tubules and germ cells.[1,2] Thus, a reduction in the number of these cells is manifested by reduction in testicular volume.[3] Reliable and accurate determination of testicular volume is of great benefit in evaluating patients with a variety of disorders affecting testicular growth, development, and function.

Studies in infertile men have also shown that testicular volume correlates with seminal fluid assay parameters and sex hormone values, just like the simple measurement of testicular length, width, and depth.[4-6] Total testicular volume by orchidometer (i.e., summation of right and left) of 30 ml and above is indicative of normal testicular function.[4] These findings underscore the great importance of testicular volume measurement in the management of male infertility. In line with this, one of the components of minimum full evaluation for male infertility is palpation of the testes and measurement of their sizes.[7]

In the management of adolescent varicocele, testicular volume measurement aids in deciding when to operate, as getting seminal fluid analysis could be seen to be psychologically and ethically incorrect.[8-10] Other important uses of testicular volume measurement are the monitoring of patients following varicocele ablation in children and adults,

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Access this article online	
Quick Response Code:	Website: www.njcponline.com
	DOI: 10.4103/1119-3077.113460
	PMID: *******

and orchidopexy for undescended testes.[11,12] It is also a vital tool in staging puberty, as it is the first clinical evidence of puberty,[13] and in making a diagnosis of hypogonadal hypogonadism and Klinefelter's syndrome.[14-17]

Over the years, many instruments have been used in an attempt to accurately, reliably, and conveniently measure the testicular volume *in vivo*. These include rulers, tapes, vernier callipers, orchidometer, graphic models, and ultrasound scan.[8-22] Results with these instruments have been conflicting. So, we sought to critically assess the accuracy of Prader orchidometer which is cheap and can be made readily available in our clinics for routine testicular volume measurement.

Materials and Methods

This study was carried out over a period of 19 month, from June 2009 to December 2010. It is a hospital based cross-sectional prospective study of the testicular volume of patients with advanced prostate cancer who opt for bilateral orchidectomy, after counseling, as a form of hormone ablation therapy in our center.

Ethical approval was sought and obtained from the ethical committee of the hospital. All patients who had hydrocele, painful testis, and edematous scrotum were excluded. Also, those who did not give consent for the study were excluded. Patients who qualified for the study had their scrotum and contents examined, and the testicular volumes measured with a Prader orchidometer. The examinations were done in a warm room after application of a heating pad (we used hot water bottle) to the scrotum for about 5 min. The testes were then gently isolated and distinguished from the epididymis; and the scrotal skin stretched without compressing the testis. Using the orchidometer, a manual side-by-side comparison between the testis and the beads were made to identify the bead most similar in size to the testes; this indicated the testicular volumes.

Orchidectomies were then performed for the patients, tagging the right testis for identification and removing the epididymis by sharp dissection. The actual testicular volumes were measured by water displacement method using a measuring cylinder. All the results were recorded in the study proforma.

Statistical analysis was done using Statistical Package for Social Sciences (SPSS) version 16.0. Simple frequencies were determined for age and descriptive statistics for the testicular volume measurements. Test of significance for testicular volumes was done using paired sample *t*-test, and correlation was done using Pearson correlation coefficient.

Results

A total of 62 patients were studied. Fifty-nine patients had bilateral testes, two had only the right testis, and one had only the left testis. So, only 121 testes were used in this study.

The age ranged from 55 years to 92 years, with a mean age of 72.74 ± 9.38 years. The peak age group was in the age range 71-75 years, which had 18 patients (29%).

The mean testicular volume measured by Prader orchidometer was 13.26 ± 5.21 ml (range 6-25) whereas the mean actual testicular volume as measured by water displacement was 10.60 ± 3.51 ml (range 4.40-20.00) [Table 1].

The Prader orchidometer overestimated the mean testicular volume by 2.66 ± 2.37 ml, that is by 25.10% [Table 2].

This mean difference in testicular volume between Prader orchidometer and the actual testicular volume measured by water displacement was statistically significant by the paired *t*-test (P = 0.0001). Though the mean difference in testicular volume was statistically significant, the mean testicular volume measured by Prader orchidometer

Table 1: Mean testicular volume measurement by Prader orchidometer and water displacement

	n	Minimum	Maximum	Mean	Std. deviation
Prader orchidometer	121	6.00	25.00	13.2562	5.20821
Water displacement	121	4.40	20.00	10.5950	3.51207
Valid *n* (listwise)	121				

*n=Number of testes

Table 2: Paired samples test between orchidometer and water displacement

Pair 1	Paired differences					*t*	df	Sig. (2-tailed)
	Mean	Std. deviation	Std. error mean	95% Confidence interval of the difference				
				Lower	Upper			
Prader orchidometer-water displacement	2.66116 (25.09%)	2.36592	0.21508	2.23531	3.08701	12.373	120	0.0001

*Sig=Significance

correlated strongly with the actual testicular volume with Pearson correlation coefficient r = 0.926 and P = 0.0001. The scatter diagram is as shown in Figure 1.

Discussion

The mean age of patients in this study was 72.74 ± 9.38 years. This is similar to the mean age of 74.5 ± 7.5 years reported by Sakamoto *et al.*[20] who studied testicular volumes of 40 testes in 20 patients. A study by Ogunbiyi *et al.*[23] in Ibadan Nigeria on the incidence of prostate cancer in Nigeria gave the mean age of 71.4 years (variance 14.3). Thus, considering that this study was done in patients with prostate cancer as our study population this age range of 72.74 ± 9.38 years is not unexpected.

The mean actual testicular volume measured by water displacement was 10.6 ± 3.5 ml (4.4-20.0) in this study. This mean actual testicular volume is the same as what Hsieh *et al.*[24] got in a similar work in China. He got a volume of 10.6 ml. It is however different from that of Sakamoto *et al.*[20] who got a mean actual testicular volume of 9.3 ± 4.5 ml. This difference may be because of his study of a smaller number of testes (40) compared to the 121 testes we studied. However, Hsieh *et al.*[24] who got a similar mean volume studied only 30 testes, which is even smaller than what Sakamoto *et al.* studied. Therefore, the sample size alone cannot explain the difference.

In the study by Sakamoto *et al.*,[20] the mean age of his patients was 74.5 ± 7.5 years and no range was given. As his study population was small, it means that the presence of a few extremely low age groups could have brought down the mean age of his perhaps older patient population. If this is true, it could explain why his mean actual testicular volume is lower as testicular volume (though relatively constant after puberty) has been found to start decreasing from the eight decade of life.[25]

Also, the fact that we studied different population groups; they studied people in Tokyo Japan, and we studied the population in Nnewi Nigeria could account for the difference. As environment and race have also been found to influence testis volume.[19,26,27]

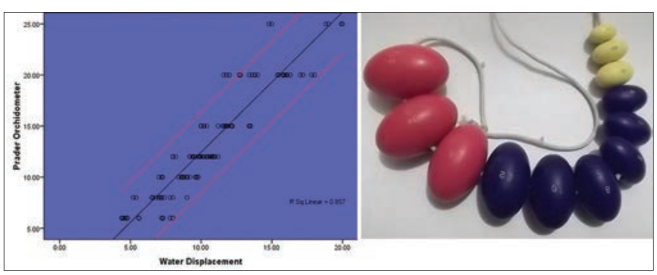

Figure 1: Scatterplot of prader orchidometer and water displacement (*R: Pearson correlation coefficient)

The Prader orchidometer overestimated testicular volume by 25.10% (2.66 mls) in this study. It has been shown to overestimate the actual testicular volume by a lot of other studies to varying degrees.[18,20,24] This is not unexpected as it adds the volume of the testicular covering. Other factors known to affect Prader orchidometer measurement are not properly separating the epididymis, size of the testis and expertise of the attending physician.[21] Paltiel *et al.*[19] in their study of 18 canine testes showed the orchidometer overestimated testicular volume by only 12% (1.6 ml). The actual cause of this difference is not certain, but it should be noted that he used dog testes and not human testes. Secondly, he did not measure the actual size of testes by water displacement like was done in this study. He got the testicular volume by weighing the testis and converting with the formula, volume = weight/density, while assuming that the density of dog testis is the same for human testis. Though the density of human testis has been found to be constant at 1.038 by Handerlsman *et al.*,[25] the assumption by Paltiel *et al.*[19] that the density of dog testes should be the same as that of humans is not entirely correct. In addition, the skin of dog scrotum may also have a different texture compared to that of human scrotum.

On the other hand, Sakamoto *et al.*[20] found that Prader orchidometer overestimated the mean testicular volume by 81.7% (6.68 ml). In his methodology, though they said the Prader orchidometer measurement was done by one experienced urologist, no mention was made of whether he attempted to exclude the epididymis which is one of the things that has been found to reduce the accuracy of Prader orchidometer.[8,22,28]

Rivkees *et al.*[18] showed that Prader orchidometer only over estimated by 30%. In his study however, he used animal models. They used the testes of 10 calves and nine dogs, and an artificial scrotum to simulate human scrotum. They also found that Prader orchidometer overestimates testicular volume to varying degrees depending on the size, but no mention was made of the average volume of the testes they measured. The smaller the testis the more the overestimation and vice versa, thus mention of the mean size of the testes measured would have been most appropriate.[4,18,22,29]

In this study, it was found that Prader orchidometer volume measurements correlated strongly with the actual testicular volumes measured by water displacement using Pearson correlation coefficient (r = 0.926, P = 0.0001). There is no consensus by previous studies on whether or not Prader orchidometer measurement correlates with actual testicular volume measurement.[19,20,24] Sakamoto *et al.*[20] found a strong correlation between the two (r = 0.818, P = 0.0001). Paltiel *et al.*[19] on the other hand did not find a statistically significant correlation between Prader orchidometer and actual testicular volumes (r^2 = 0.14, P = 0.12). Though they worked on animals and did not use the actual volume, but a derived one like was highlighted above. Even when Sakamoto *et al*. agree it correlate as in our own study, the accuracy recorded vary widely when compared to our result (81.7% overestimation as against 25.1% in our study). This may well be because of the inter-observer variability in the use of Prader orchidometer like was found by Tatsunami *et al*.[30] Therefore, there will be need for training and standardization for Prader orchidometer use so that its accuracy will be reproducible between attending physicians for clinical and research use.

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How to cite this article: Mbaeri TU, Orakwe JC, Nwofor AM, Oranusi KC, Mbonu OO. Accuracy of Prader orchidometer in measuring testicular volume. Niger J Clin Pract 2013;16:348-51.

Source of Support: Nil, **Conflict of Interest:** None declared.