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Accuracy of orchidometry in boys with varicocele

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Summary

Introduction
Orchidometric evaluation of the testis has been proposed as a cost-effective alternative to measurement of the testis with high-frequency linear ultrasound, which may be costly in terms of hospital resources and patient time. It is known from animal experiments, autopsy series, and small clinical studies that, under ideal conditions, orchidometry may approximate ultrasound measurement. However, little is known of the effectiveness of orchidometry in the clinical setting in a large sample of adolescents with varicocele.

Objective
We sought to analyze the performance characteristics of Rochester orchidometry and its agreement with ultrasound testis volumes in boys with varicocele.

Study design
Our institutional varicocele database was analyzed from March 2000 to May 2013, including all boys with Rochester orchidometric measurement and ultrasound-based volume measurement performed on the same day. The Lambert formula (L*W*H*0.71) was used to calculate ultrasound volumes. Seven-hundred and twenty measurements were included: 360 of the left testis, and 360 of the right testis. Each subject was included once; in the event of serial measurements the earliest measurement was analyzed. Bland–Altman plots with 95% limits of agreement were used to compare orchidometry and ultrasound measurements. Analysis was performed with JMP, v11 Pro.

Results
Age at exam ranged from 11.2 to 18.5 years (median 15.8). With respect to varicocele grade, 183 (50.8%) were grade III, 113 (31.4%) were grade II, 42 (11.7%) were grade I, 12 (0.3%) were bilateral, and 10 (0.3%) were ungraded. Mean ultrasound left testis volume was 13.6 cc (SD 6.6) and mean right testis volume was 15.1 cc (SD 6.9). Eleven surgeons performed the orchidometric measurements; one surgeon performed 71% of the exams. Mean overestimation on the right was 2.0 cc (SD 4.2) and on the left was 1.9 cc (SD 4.1); each was highly statistically significant ($p < 0.0001$, paired t test). Error was correlated with testis size, implying a greater degree of overestimation with increasing volume ($p < 0.01$, Pearson's correlation 0.09). Amount of volume overestimation and variability was not significantly different for right and left testis. Sensitivity and specificity of Rochester orchidometry to detect a testis volume differential (TVD) of 20% were 33% (95% CI 23–42%) and 96% (95% CI 92–97%), respectively. Testis size, varicocele grade, or examining surgeon had no effect on sensitivity or specificity.

Discussion
We have shown in a large series of boys with adolescent varicocele that in clinical practice there is a modest degree of overestimation of testis volume on average (1.9–2.0 cc), although there is a large range of volume estimation, such that the 95% confidence interval ranges are quite wide, from approximately 6 cc lower than the true volume to 10 cc greater than the true volume. Furthermore, the low sensitivity (33%) of orchidometry for 20% testis volume differential renders this a suboptimal screening tool for this clinical parameter, which has been shown to be associated with semen analysis outcomes. Knowledge of the performance characteristics of orchidometry is similarly important for research, as factors such as the prevalence of testis volume differential are then dependent on the modality of measurement. Lastly, that this was conducted over a long time course with several surgeons involved suggests that these data reflect real-world application of orchidometry.

Conclusions
Appropriate caution should be exercised when relying solely on orchidometric evaluation of the testis. Rochester orchidometry in general appears to overestimate testis size, and there is wide variability in the estimation. In clinical practice, the sensitivity of Rochester orchidometry is modest in detecting a 20% testis volume differential; this difference would be missed in approximately two out of three of boys screened with orchidometry alone.

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Demographics and Baseline Measures, n=360	
Age	
Median, years	15.8
Interquartile range, years	[14.2, 17.6]
Grade of Varicocele	
GI	42 (11.7%)
GII	113 (31.4%)
GIII	183 (50.8%)
Bilateral	12 (0.3%)
Ungraded	10 (0.3%)
Ultrasound Volume	
Left Testis, cc	13.6 cc (SD 6.6)
Right Testis, cc	15.1 cc (SD 6.9)

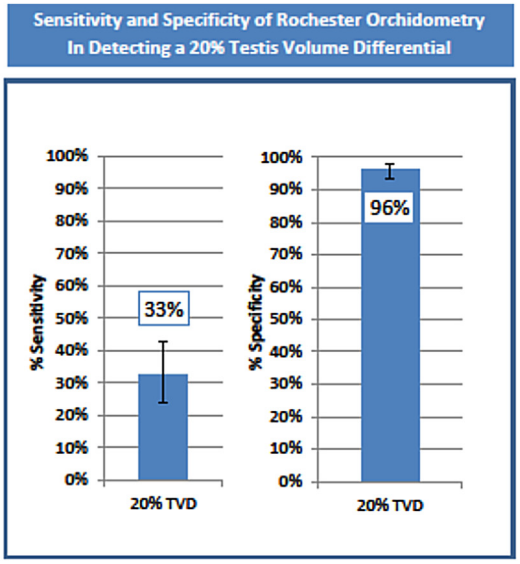

Figure The left portion of the figure displays the cohort characteristics including age, grade of varicocele, and testis size. The right portion of the figure shows the sensitivity and specificity of Rochester orchidometry in detecting a 20% testis volume differential with ultrasound as the reference standard.

Introduction

Metrics based on testis volume are the most studied parameters associated with semen analysis and surgical outcomes in the adolescent varicocele [1,2]. As such, the accurate measurement of testis volume is important both clinically in the care of boys with varicocele, and for research in evaluation of outcomes as a function of testis volume. Both Prader orchidometry [3] using calibrated beads and Rochester (or Takihara) orchidometry [4] using punched-out rings are popular methods of measuring testis volume. It has been demonstrated that ultrasound is more accurate than orchidometry in volume measurement in adults [5—10], children and adolescents [11—13], and experimental models [14]. This has not been evaluated in a large series of adolescents with varicocele. Importantly, the majority of studies are concerned with the overall accuracy of orchidometry in the measurement of absolute volume, but not in terms of the ability to detect testis volume differential (TVD).

As considerations of cost become more prominent, the cost of ultrasound is increasingly being recognized [15,16]. Alternatively, orchidometry is nearly "free" with the exception of the clinician's time and the one-time cost of the device. If orchidometry were to become more widespread, the relative performance characteristics of this device in the clinical setting should be defined. We sought to determine the degree to which Rochester orchidometry overestimates, underestimates, or accurately reports testis volume in boys with varicocele, as well as to define the 95% limits of agreement of orchidometry and ultrasound measured testis volume. We also sought to define the sensitivity and specificity of Rochester orchidometry in detecting TVD at a variety of thresholds (10%, 15%, and 20%) using ultrasound as the reference standard.

Methods

Our institutional varicocele database was analyzed from March 2000 to May 2013, including all boys with Rochester orchidometric measurement and ultrasound-based volume measurement performed on the same day. Sizes of the orchidometer rings were 1, 2, 3, 4, 5, 6, 8, 10, 14, 16, 19, 22, 26, 30, 34 cc; interpolation (estimating size of testes "between rings") was permitted at the clinician's discretion. All boys had a palpable varicocele. The Lambert formula (L*W*H*0.71) was used to calculate ultrasound volumes based on high-frequency linear ultrasound measurements [14]. Seven-hundred and twenty measurements were included: 360 of the left testis, and 360 of the right testis. Each subject was included once; in the event of serial measurements the earliest measurement was analyzed. This was selected to minimize potential bias resulting from knowledge of prior testis volumes that might be present in the medical record. All ultrasound exams were interpreted by pediatric radiologists; all orchidometric exams were performed by pediatric urologists.

Bland—Altman plots with 95% limits of agreement were used to compare orchidometry and ultrasound measurements [17]. The x-axis is the unweighted average of the two measures: orchidometry and ultrasound. The y-axis plots the difference in the two measures; values greater than zero show orchidometric overestimation and lower values show underestimation. The mean value of all points is calculated and a line shown across the figure (Fig. 1); a