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·*Original Article*·

Usefulness and limitation of punched-out orchidometer in testicular volume measurement

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Abstract

Aim: To determine the limitations of a punched-out orchidometer in practical use, we compared with a scrotal ultrasound (USG). **Methods:** A total of 281 testes from 142 males were examined using both a punched-out orchidometer and a USG. The volume differential between both methods was calculated and expressed as orchidometer/USG volume (O/U ratio). Distribution of the O/U ratio was determined and subdivided by clinical or pathological diagnosis. The correlations between the O/U ratio and patient age or orchidometer results were assessed. **Results:** There was a significant linear relationship between the results of orchidometer and USG ($r = 0.94$, $P < 0.0001$). The relationship between the O/U ratio and age or testicular volumes showed significant inverse correlations ($r = 0.22$, $P = 0.0002$, $r = 0.45$, $P < 0.0001$, respectively). Klinefelter's syndrome, ipsilateral detorted testes and hypogonadotropic hypogonadism comparatively showed a high O/U ratio. No incidental lesion was detected by USG necessitating treatment. **Conclusion:** The punched-out orchidometer gives estimates that correlated well with the USG measurements and provides enough information for routine andrological evaluation. We should be aware that the orchidometer often overestimates the testicular volume, especially for the patients with small testis or adolescents. *(Asian J Androl 2005 Mar; 7: 77–80)*

Keywords: orchidometer; testis; ultrasonography

1 Introduction

As well as semen and endocrinological analyses, the evaluation of testicular size is an initial and important method for estimating spermatogenesis and for monitoring the changes in pubertal status to optimize the treatment selection. Testicular volume has been traditionally and easily determined using orchidometers. There are several types of orchidometers, of which a Prader [1] or punched-out [2] orchidometer have often been used. The punched-out orchidometer, also called the Yamaguchi University or Rochester University or Takihara orchidometer, which was introduced in 1983, is comprised of a series of 16 punched-out ellipses of varying sizes that fit over the testis [2]. In the last decade, there have been an increasing number of reports about the usefulness and accuracy of scrotal ultrasound (USG) in testicular measurement [3–7]. There is a strong linear relationship between the results of the orchidometer and USG, whereas the orchidometer often overestimates the testicular vol-

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ume to a greater extent than USG [6–9]. The orchidometer has been widely used in andrology clinics because of its ease, reproducibility and low cost; however, there are no reports describing cases where orchidometric measurement may be incorrect. In this study, the relationship between orchidometer measurement and USG was determined. Then, we examined which disorders showed large discrepancies in the results between orchidometer and USG.

2 Materials and methods

2.1 Patients

Testicular volumes were determined by using a punched-out orchidometer. After an explanation regarding the safety, benefits and purpose of the study, we performed USG. As a result, 142 patients ranging in age from 5 to 53 years were included in this study. A total of 281 determinations were recorded. Three cases had been hemi-orchiectomied because of testicular tumor.

2.2 Measurement of testicular volume

The orchidometer consists of 16 punched-out elliptical rings with graded volumes, 1–30 mL (1 to 6, 8, 10, 12, 14, 16, 18, 20, 22, 24 and 26 mL). The proper ring was placed over the stretched scrotal skin up to the mid-portion of the testis away from the epididymis. If the ring was easily placed, a smaller size was placed and the testis was compressed to fit the ring. All measurements were performed by one urologist (K.S.). USG was performed using an Aloka SSD-2000 (Tokyo, Japan) with linear array transducers and imaging frequencies of 7.5 MHz. The largest measurements in axial, longitudinal and thickness were recorded and used to calculate testicular volume using the formula: length × width × thickness × 0.71 [10].

2.3 Analysis

The correlation between volume measurement obtained from orchidometer and those calculated by USG was assessed using Pearson's correlation coefficient (r) using a commercially available software package. The volume differential between the results of orchidometer and USG was calculated by orchidometer (mL)/USG (mL) and expressed as O/U ratio. The mean pulse minus standard deviation (SD) of O/U ratio was calculated and subdivided by clinical or pathological diagnosis. The correlation between the O/U ratio and age or orchidometer results was also assessed using Pearson's correlation coefficient (r).

3 Results

3.1 Correlation of orchidometer and USG

The mean testicular volumes in 281 testes measured by orchidometer and USG were 15.0 mL and 11.7 mL, respectively. The orchidometer overestimated testicular volume by 3.3 mL compared to USG. There is a strong linear relationship between orchidometer and USG ($r = 0.94$, $P < 0.0001$) (Figure 1). Patiel *et al.* reported that the formula ×0.71 provided a superior estimate of testicular volume [10]. Using the formula of length × width × thickness × 0.71, we can calculate the testicular volume more precisely compared to the result of other report [7, 11]. The mean O/U ratio in 281 testes was 1.37.

3.2 Differences of the results between orchidometer and USG, subdivided by age or testicular volume, and measured by orchidometer

The correlation between the O/U ratio and age was significant ($r = 0.22$, $P = 0.0002$). The correlation between the O/U ratio and testicular volumes measured by orchidometer was also significant ($r = 0.45$, $P < 0.0001$). The O/U ratio was high in the application of the orchidometer for adolescent boy or small testes. A 13-year-old boy was found to have a left varicocele (grade 1), whose bilateral testicular volumes were 12 mL by orchidometer. Serum luteinizing hormone (LH), follicle stimulationg hormone (FSH) and testosterone were within normal limits. We performed left varicocelectomy because of the difference in testicular volumes between right and left testes by USG (10.5 mL and 7.9 mL, respectively). Incidentally diagnosed testicular microlithiasis was detected in two men (4 testes, 1.5 %); one in the left varicocele patient and the other in a patient with Reifenstein's syndrome. Diagnostic biopsy was performed on both patients and the pathological diagnoses revealed no malignancy. An intratesticular cyst was detected in one testis (0.4 %) and the patient was followed up.

3.3 Differences of the results between orchidometer and USG subdivided by clinical diagnosis

Table 1 shows the O/U ratio (mean ± SE) subdivided by clinical or pathological diagnosis. The high O/U ra-

tios were determined in the testes of Klinefelter's syndrome (2.24 ± 0.82), ipsilateral detorted testes with mean 6.7 months follow-up periods (2.06 ± 0.34) and hypogonadtropic hypogonadism (1.74 ± 0.43). Common diseases in andrology clinics such as adult varicocele, idiopathic oligo-asthenozoospermia or obstructive azoospermia had relatively low O/U ratios (1.25, 1.27 and 1.27, respectively). Intraoperative findings of testicular sperm extraction from two Klinefelter's syndrome patients revealed severely thickened subcutaneous tissue and tunica vaginalis.

4 Discussion

Previous studies demonstrated the reliability and discrepancy of testicular measurements between the orchidometer and USG [6–9]. Using ultrasound as the estimated gold standard, these studies concluded that each orchidometer was equally reliable despite overestimating testis volume. There is also a significant positive correlation between the results of punched-out orchidometer and USG (Figure 1). In the case of small or preadolescent testes, we were apt to overestimate the testicular volume using the orchidometer.

When measuring testis size by the orchidometer, we must be aware that the skin and subcutaneous tissue are measured as well. Particularly in small testes, the percentage of thickness of the skin and subcutaneous tissue is relatively high. Furthermore, the shape of the testis is neither uniform nor necessarily ellipsoid, as has been proposed when applying the different formula in use. To overcome these disadvantages, it is noteworthy to emphasize how to use the punched-out orchidometer again [2]. Many examiners hesitate to push the testis into the smallest suitable ring in case this causes discomfort and are therefore apt to overestimate the testicular size. Also care should be taken not to include the epididymis and to stretch the scrotal skin adequately. The experience of the examiner undoubtedly affects the results [3]. Diamond *et al*. reported that measurements by nurses were higher than those by physicians, up to approximately 2 mL on average [7]. Overestimation of testicular size is greater in children. The punched-out orchidometer is useful for serial measurement when the absolute volume is not important, for example, in the follow of the development of individual testicular volume in children after orchidopexy [12]. Other factors which are difficult to evaluate, such as firmness or consistency of the testicle and the stress of the patient, may also affect results.

In Klinefelter's syndrome patients, we often find

Table 1. Distribution of orchidometer/ultrasound ratio (O/U ratio) subdivided by clinical or pathological diagnosis.

Clinical or pathological diagnosis (No. testes)	O/U ratio (Mean ± SD)
Klinefelter's syndrome (8)	2.24 ± 0.82
Post-torsion (ipsilateral) (3)	2.06 ± 0.34
Hypogonadotropic hypogonadism (24)	1.74 ± 0.43
Maturation arrest (20)	1.49 ± 0.32
Retrograde ejaculation (10)	1.47 ± 0.50
Constitutional delay (6)	1.46 ± 0.09
Testicular cancer (contralateral) (3)	1.42 ± 0.14
Hypospermatogenesis (24)	1.37 ± 0.24
Sertoli cell only (12)	1.37 ± 0.07
Post-chemotherapy (10)	1.34 ± 0.18
Varicocele (pre-adolescent) (16)	1.33 ± 0.16
Post-mumpus orchitis (6)	1.28 ± 0.13
Obstructive azoospermia (20)	1.27 ± 0.16
Idiopathic oligo-asthenozoospermia (24)	1.27 ± 0.20
Varicocele (adult) (70)	1.25 ± 0.20
Post-torsion (contralateral) (3)	1.24 ± 0.17
Fertile eunuchoidism (4)	1.20 ± 0.05
Cystic dilatation of seminal vesicle (4)	1.18 ± 0.09
Reifenstein's syndrome (2)	1.17 ± 0.02
Young's syndrome (4)	1.16 ± 0.05
Congenital absence of vas deferens (8)	1.13 ± 0.14

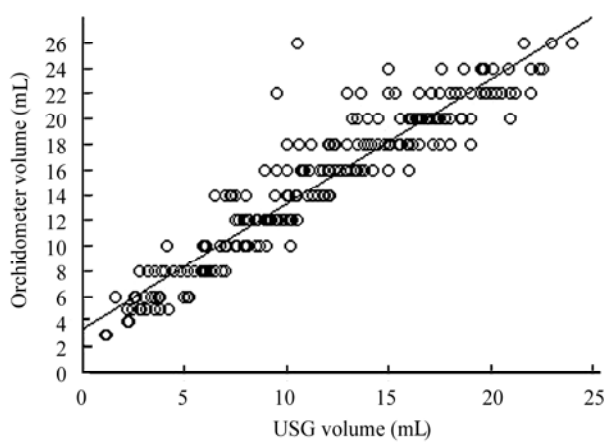

Figure 1. Approximate linear relationship between testicular volumes measured by punched-out orchidometer and ultrasound (r = 0.94, $P < 0.0001$).

unexpectedly small testes upon testicular sperm extraction if volume is evaluated only by orchidometer. More precise evaluation by USG gives us predictive information for successful sperm recovery [13]. For ipsilateral testis after torsion, we must be aware that orchidometer overestimates the testicular volume because of the thickened scrotal connective tissues and that USG is required during the follow-up period to detect the atrophy. Testes of patients with hypogonadism are often small and it is necessary to use USG to evaluate the initial testicular volume and to detect subtle changes during hormonal therapy.

Scrotal ultrasound is relatively expensive for routine use in andrology clinics. During USG measurement, the testis easily becomes compressed, resulting in distortion of shape and dimensions. In addition, if the axis of the testis is not perpendicular when using USG, the ellipsoid formula is not accurate. Although USG detects incidental intrascrotal pathology, these generally require treatment. In contrast, we are able to accurately evaluate testicular volume precisely using a punched-out orchidometer except when the testicular volume is low in conditions such as Klinefelter's syndrome, detorted testes and hypogonadism. Provided that the limitations of punched-out orchidometer are taken into account it is a useful and cheap method of measuring testicular volume.

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