Original Article

# Determination of the best position and site for color Doppler ultrasonographic evaluation of the testicular vein to define the clinical grades of varicocele ultrasonographically

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## Abstract

**Background:** There are no generally accepted criteria for the ultrasonographic diagnosis and grading of varicocele. We aimed to determine the best position and site for color Doppler ultrasonographic (CDUS) evaluation of the testicular vein to define the clinical grades of varicocele ultrasonographically.

**Materials and Methods:** This study consisted of 103 men (44 normal and 59 with clinical varicocele). First, WHO clinical grade of varicocele was determined by physical examination. Then, the diameter of largest testicular vein at four different sites was measured in both upright and supine positions with or without Valsalva maneuver. Finally, the cut-off points of venous diameter for different clinical grades were determined using the values of the position and sites that had the strongest correlation with the clinical grades.

**Results:** The strongest correlation between venous diameter and clinical grade of varicocele was observed when the venous diameter was measured at the level of epididymal head in the upright position with Valsalva maneuver ($r$: 0.87, $P$-value $< 0.0001$). In aforementioned conditions, venous diameter of 2.35 mm (sensitivity 87%, specificity 87%) can distinguish normal subjects from grade 1 varicocele, venous diameter of 3.15 mm (sensitivity 58%, specificity 70%) can discriminate grade 1 from grade 2, and venous diameter of 3.75 mm (sensitivity 83%, specificity 70%) can differentiate grade 2 from grade 3. Furthermore, venous diameter of 2.65 mm (sensitivity 91%, specificity 89%) can distinguish normal subjects from patients with clinical varicocele.

**Conclusion:** The best position for CDUS examination of patients suspected of having varicocele is the upright position with Valsalva maneuver, and the best site for venous diameter measurement is at the level of epididymal head.

**Key Words:** Color Doppler ultrasound, varicocele, venous diameter

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## INTRODUCTION

Varicocele is a common abnormality characterized by retrograde blood flow in the internal spermatic vein. This abnormal flow is caused by incompetence or absence of venous valves.[1] The association between male sub-fertility and clinical varicocele has been well documented.[2,3] Varicoceles have been found in approximately 15% of the general population;



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however, they have been diagnosed in 20-40% of infertile men.[4-6] There is no correlation between the varicocele size and the degree of testicular damage; therefore, it is vital to detect and treat this abnormality early even when it is sub-clinical.[7] The clinical diagnosis of varicocele is routinely made by physical examination in a warm environment. Based on physical findings, varicocele is categorized into four different grades.[8] However, because of relatively low specificity (about 70%) of this method, new imaging modalities have been introduced to detect varicocele more accurately.[4,9] Color Doppler ultrasound (CDUS) is a non-invasive method that has replaced venography — the former gold standard.[5]

Various ultrasonographic parameters, such as the spermatic cord diameter, venous diameter, and venous retrograde flow in either supine or upright positions with or without Valsalva maneuver, have been investigated to assess patients suspected of having varicocele.[10-18] However, there are no generally accepted criteria for the diagnosis of varicocele by this method,[5] and there is no exact ultrasonographic definition for different clinical grades of varicocele.

This study was aimed to define the different clinical grades of varicocele ultrasonographically, and to answer the following questions: (1) ultrasonographic study of which part of the spermatic cord has the best correlation with different clinical grades? (2) Which position is better for CDUS study of varicocele? (3) What are the cut-off values to define different clinical grades ultrasonographically?

## MATERIALS AND METHODS

### Study population and design

The cross-sectional study was performed on 103 men who were referred to our tertiary referral center for scrotal CDUS. Participants were either normal subjects selected from fertile men — with no history of urologic complaints — who attended orthopedic outpatient clinic for minor problems or patients with the clinical diagnosis of varicocele referred from urology outpatient clinic.

Any history of scrotal surgery was considered as the only exclusion criterion.

A single urologist examined and determined the clinical grade of varicocele in all participants, and a single radiologist blinded to the patients' clinical grades of varicocele performed all CDUS examinations.

All participants provided informed consent for the study, and the ethics committee of Isfahan University of Medical Sciences approved the study protocol.

### Physical examination

Prior to CDUS study, all participants were examined by an experienced urologist. The clinical diagnosis of varicocele was made by palpation and observation in the standing position before and during the Valsalva maneuver in a warm room.

According to the WHO criteria for clinical grading of varicocele and findings on physical examination, patients were classified into four grades including grade 0 (no varicocele), grade 1 (palpable during Valsalva maneuver), grade 2 (palpable without Valsalva maneuver), and grade 3 (visible through the scrotal skin).

### Color doppler ultrasound examination

Using a 7.5 MHz transducer (G40™, Siemens Healthcare, Mountain View, CA, USA), all participants underwent a CDUS examination.

First, CDUS was performed while patients were in the upright position. Then, patients were re-examined in the supine position. All ultrasonographic studies were performed at rest and also during Valsalva maneuver.

Diameter of the testicular vein was measured at the level of four sites including the inguinal canal and at the head, body, and tail of the epididymis.

### Statistical analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) 20.0 (SPSS Inc., Chicago, IL, USA). One-way Analysis of Variance (ANOVA) was used to compare the mean age between patients with different clinical grades of varicocele. Spearman's ρ was used to determine correlation between varicocele clinical grades and venous and diameter. The cut-off points, sensitivity, and specificity were determined by receiver operator characteristic (ROC) analysis. *P*-values less than 0.05 were considered statistically significant.

## RESULTS

### Baseline and demographic data

There was no statistically significant difference between patients with different clinical grades of varicocele in mean age [Table 1].

### Correlation between clinical grade and venous diameter

Venous diameter in all positions and sites was significantly correlated with the clinical grade

of varicocele [Table 2]. However, the strongest correlation between venous diameter and clinical grade of varicocele was observed when the venous diameter was measured at the level of epididymal head in the upright position with Valsalva maneuver.

Considering the strong correlation between the clinical grades of varicocele and venous diameter measured at the level of epididymal head in the upright position with Valsalva maneuver, we determined the cut-off values of venous diameter that distinguish different clinical grades of varicocele in aforementioned conditions [Table 3 and Figure 1].

**Table 1: Comparison of age between different varicocele clinical grades**

| | | Age (years) | |
|---|---|---|---|
| | | Mean ± SD | Min-Max |
| Clinical grade | Grade 0 (*n*:44) | 24.29±6.11 | 15-40 |
| | Grade 1 (*n*:16) | 24.73±3.32 | 20-30 |
| | Grade 2 (*n*:19) | 24.47±7.41 | 17-39 |
| | Grade 3 (*n*:24) | 24.30±5.41 | 15-40 |
| Total (*n*:103) | | 24.39±5.83 | 15-40 |
| *P*-value | | 0.995 | |

*n*: Number of patients in each group, Min: Minimum, Max: Maximum

**Table 2: Correlation coefficient between clinical grade of varicocele and venous diameter in different positions**

| Venous diameters (*n*:103) | | | Correlation coefficients* |
|---|---|---|---|
| Inguinal canal | Supine position | Without Valsalva | 0.76 |
| | | With Valsalva | 0.76 |
| | Upright position | Without Valsalva | 0.78 |
| | | With Valsalva | 0.80 |
| Head | Supine position | Without Valsalva | 0.81 |
| | | With Valsalva | 0.84 |
| | Upright position | Without Valsalva | 0.84 |
| | | With Valsalva | 0.87 |
| Body | Supine position | Without Valsalva | 0.81 |
| | | With Valsalva | 0.75 |
| | Upright position | Without Valsalva | 0.80 |
| | | With Valsalva | 0.83 |
| Tail | Supine position | Without Valsalva | 0.77 |
| | | With Valsalva | 0.78 |
| | Upright position | Without Valsalva | 0.80 |
| | | With Valsalva | 0.81 |

*n*: Number of patients in each group, *$P < 0.001$

**Table 3: Cut-off value of venous diameter at the level of epididymal head in the upright position with Valsalva to distinguish different clinical grades of varicocele**

| Varicocele clinical grades | Cut-off value (mm) | Sensitivity (%) | Specificity (%) | AUC |
|---|---|---|---|---|
| 0-1 | 2.35 | 87 | 87 | 0.908 |
| 1-2 | 3.15 | 58 | 70 | 0.711 |
| 2-3 | 3.75 | 83 | 70 | 0.842 |

AUC: Area under curve

Then, in order to determine the sensitivity and specificity of CDUS in differentiating patients with varicocele from normal subjects, participants were divided into two groups of normal (grade 0) and varicocele (grades 1, 2, and 3).

With the cut-off point of 2.65 mm, the best sensitivity and specificity were achieved (91% and 89%, respectively). The area under curve (AUC) was 0.962 [Figure 2].

## DISCUSSION

Varicocele is the most common curable cause of male-type infertility, and surgical treatment of this abnormality improves the quality of semen in approximately 60-80% of patients.[15,19,20] For this reason, accurate evaluation and early detection of this abnormality plays an important role in the basic work-up of male-type infertility. Although physical examination is usually considered as the first-step assessment of men suspected of having varicocele, it can identify only up to 40% of small varicoceles.[19] In addition, physical examination is limited by its inherent subjectivity, and its accuracy depends on several factors such as the experience of the examiner, the body habitus of the patient, and the contractile state of the scrotum.[21] Therefore, various diagnostic modalities and different criteria have been emerged to diagnose varicocele more accurately.

Radiological assessment can detect even small-sized varicoceles, and therefore, may have a profound effect on the success of management of varicocele.[22,23]

In contrast to venography — the former gold standard diagnostic method — which is invasive, expensive, and is associated with morbidity, CDUS is a safe, non-invasive, reliable, and practical diagnostic tool.[14,15,24,25] Scrotal CDUS examination can be performed in different positions. Moreover, different parts of the testicular vein can be investigated to determine the grade of varicocele. However, it is not clear that CDUS in which position and at which part of the testicular vein provides more accurate assessment of the clinical grade of varicocele. According to the examination condition, different cut-off values can be considered to describe various clinical grades of varicocele. Hence, it would be necessary to determine a standard condition for CDUS assessment of patients suspected of having varicocele more accurately, and to have an ultrasonographic definition for each clinical grade of varicocele.

Determination of cut-off points for each clinical grade helps both radiologists and urologists to make better

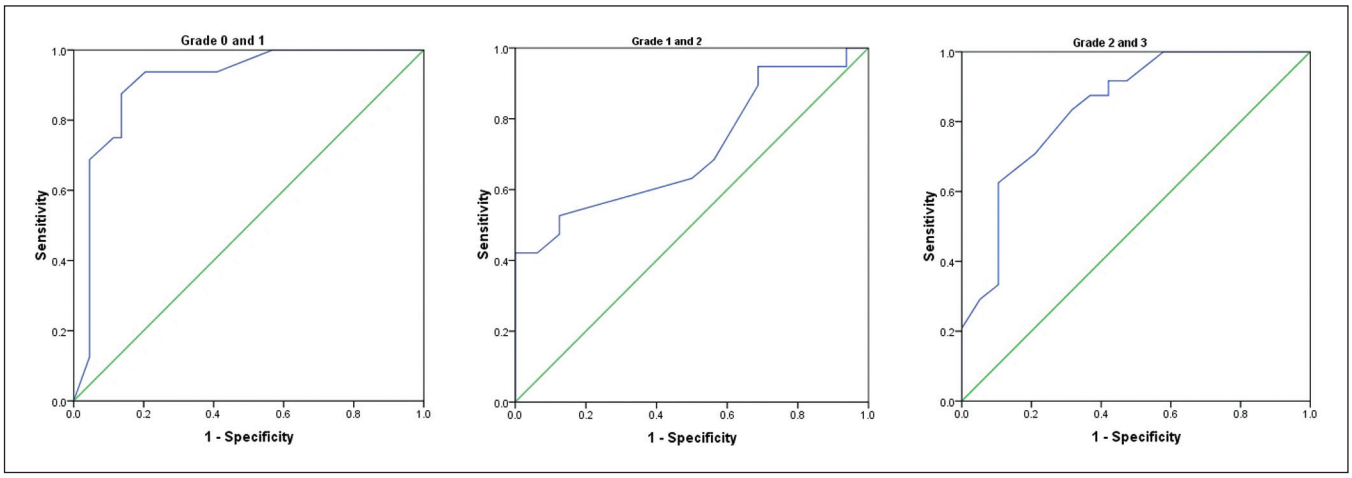


**Figure 1:** ROC curve analysis to determine cut-off values of venous diameter at the level of epididymal head in the upright position with Valsalva to distinguish different clinical grades of varicocele

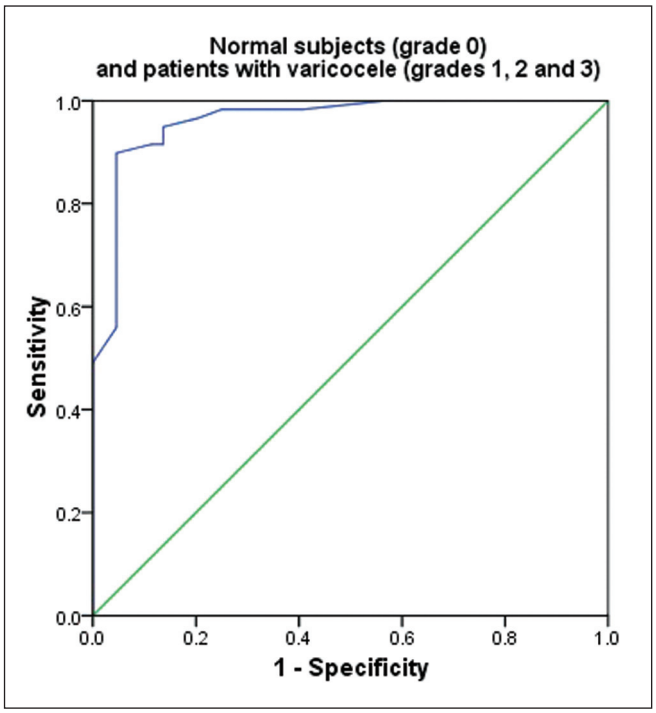


**Figure 2:** ROC curve analysis to determine cut-off point of venous diameter at the level of epididymal head in the upright position with Valsalva to distinguish patients with varicocele from normal subjects

estimation and assessment of patients' condition. It would reduce the subjectivity of investigations, would make a common standard statement about the severity of varicocele, and may reduce the risk of misinterpretations between various radiologists involved in CDUS and urologists.[10]

To the best of our knowledge, this is the first study that was designed to describe the best condition for CDUS in patients with the clinical diagnosis of varicocele and to determine the cut-off points of venous diameter on CDUS representative of each clinical grade.

Our findings revealed that venous diameter in all examined conditions and at all aforementioned sites was directly correlated with the clinical grade of varicocele in all investigated positions.

We also found that CDUS examination of the testicular vein at the level of epididymal head when the patient was in the upright position doing Valsalva maneuver had the strongest correlation with the clinical grades of varicocele. Using CDUS to distinguish varicocele clinical grade 1 from normal subjects led to high sensitivity and specificity, whereas a comparison of other consecutive grades (grade 1 with grade 2 and grade 2 with grade 3) showed lower sensitivity and specificity values for the optimal cut-off points.

Regardless of the clinical grade of varicocele, CDUS of the testicular vein at the level of epididymal head in the upright position doing Valsalva maneuver showed high sensitivity and specificity in differentiating normal subjects from patients with varicocele.

Unlike some previous studies that mixed up data of different clinical grades,[12,15,16] or did not specify the exact position and condition in which CDUS studies have been done;[11,14,17] this study was performed on patients whose clinical grades of varicocele were determined, and CDUS examination was performed in separate conditions and at different sites of the testicular vein to find out the best position and site for CDUS.

A previous study by Pilatz *et al*. also compared mean of venous diameter between different clinical grades, and concluded that clinical varicoceles can be predicted with high accuracy based only on the diameter of testicular veins using cut-point values of >2.45 mm in rest or >2.95 mm during Valsalva maneuver in the

supine position. However, they only performed CDUS in one position, and measured the diameter of the largest vein in the pampiniform plexus.[5]

They reported a cut-off point of 2.95 mm for discriminating between testicular units without and with clinical varicocele (sensitivity 84%, specificity 81%) while patients were in the supine position doing Valsalva maneuver.[5] Comparing with their findings, we observed higher sensitivity and specificity (91% and 89% respectively) when patients were examined in the upright position doing Valsalva maneuver, and the venous diameter of 2.65 mm at the level of the epididymal head was selected as cut-off point.

In summary, we conclude that the upright position doing Valsalva maneuver could be the most accurate condition for scrotal CDUS examination. Furthermore, the venous diameter at the level of epididymal head is the best ultrasonographic parameter that can distinguish normal subjects from patients with clinical varicocele, and also can define different clinical grades of varicocele ultrasonographically. However, in order to determine more accurate cut-off points, further investigations with larger sample size are suggested.

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