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Editorial Musings

A preliminary study of shear wave elastography for the evaluation of unilateral palpable undescended testes

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ABSTRACT

Objectives: We sought to compare unilateral palpable undescended testes and contralateral descended testes using shear wave elastography (SWE) to show potential quantitative differences in elasticity patterns, which might reflect the histologic features.
Methods: Approval for this prospective study was obtained from the local ethics committee. A total of 29 patients (mean age, 7.52 years; range, 1–18 years) with unilateral palpable undescended testes and contralateral descended testes were examined by greyscale ultrasonography and SWE between February 2015 and April 2016. The volume and the elasticity of each testicle were the main factors evaluated.
Results: There was no difference between undescended testes and contralateral descended testes in terms of volume. However, a significant difference was evident in SWE-derived quantitative data.
Conclusions: SWE seems to be a useful sonographic technique to predict histologic features of the undescended testicle, which might replace testicular biopsy in modern management of the undescended testis.

1. Introduction

The undescended testis is a very common anomaly in boys with a prevalence of 0.8%–1.5% at 1 year of age [1]. Approximately 80% of cases are unilateral [2]. Undescended testes are classified as palpable or non-palpable according to current guidelines. Palpable undescended testes account for nearly 70% of the cases [3,4].

Undescended testis is a well-known risk factor for testicular torsion, infertility, and testicular cancer [5]. The main reason for the increased risk of infertility and testicular cancer is maldevelopment of the testis due to improper environment [5]. The scrotum provides the ideal environment for the development and maturation of the germ cells. The higher temperature of the inguinal canal and abdomen, and the higher pressure in the inguinal canal that blocks testicular circulation, are the main factors that prevent germ cell development and maturation [1]. These changes are progressive, and if not treated, germ cell agenesis at puberty is inevitable [6,7]. To prevent histologic damage to undescended testes, orchidopexy is recommended as early as possible [3,4,8,9]. Testicular biopsy was the gold standard to assess for histologic features of damage to the undescended testis. However, owing to potential complications, testicular biopsy is no longer recommended in current guidelines [3,4].

Studies of undescended testes have focused on the potential risks posed, including infertility, torsion, and malignancy, as well as postoperative outcomes [3–5,9–15].

Shear wave elastography (SWE) is a novel elastographic method that tracks shear waves passing through tissues, quantifying the elasticity of structures and nodules [16]. Recent studies have suggested that SWE yields valuable quantitative information about the histological properties tissues by assessing stiffness [16]. The efficacy of SWE in the estimation of the degree of fibrosis as a result of damage has been shown in various organs including liver, kidney, and thyroid [17–19]. However, to our knowledge, no work

Abbreviations: SWE, shear wave elastography; ROI, region of interest; US, ultrasound.

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performed to date has assessed undescended testes with SWE to predict potential damage.

We measured testicular volume and elasticity in patients with unilateral palpable undescended testes and compared these results with the contralateral descended testis to assess potential quantitative differences in the elasticity patterns between the two organs, which might reflect the histological condition.

2. Materials and methods

Approval for this prospective study was obtained from the local ethics committee. Written informed consent was obtained from all patients. A total of 29 patients with unilateral palpable undescended testes, located in the proximal, middle or distal part of the inguinal canal, were included in our study. Patient's unilateral palpable undescended testes and contralateral descended testes were examined by greyscale ultrasonography and SWE between February 2015 and April 2016. The mean age of the patients was 7.52 years (range 1–18 years). Patients with abdominal undescended testes, bilateral undescended testes, non-palpable undescended testes, retractile testes, endocrine diseases, systemic diseases, and incomplete data were excluded from the study. The undescended testes were assigned to Group 1 while contralateral the descended testes were included in Group 2.

2.1. Ultrasonic evaluation

All testes were examined using an ultrasound scanner (Aixplorer, SuperSonic Imagine, Les Jardins de Duranne, Aix-en-Provence, France), which runs B-mode and SWE modalities. Linear transducers (4–15 MHz) were used for all examinations. All patients were examined by the same operator (I.A., who has 13 years of ultrasound experience and 5 years of SWE experience).

2.2. Volumetric evaluation

During greyscale examination, the transducer was placed on the inguinal region or on the scrotum. Testicular volume was measured with an automated formula (testicular volume = width × height × depth × 10^{-3} × 0.523).

2.3. SWE evaluation

During SWE examination, to avoid a compression effect of the transducer, the transducer was placed onto the skin surface over the testis with light contact using ample coupling gel and was kept stationary during acquisitions. Axial or longitudinal images were used for SWE examination where it is more feasible to obtain images. Tissue stiffness was displayed in a chromatic scale with progression from blue to red, which indicated stiffness values from low to high. Mean stiffness values of the testes were derived from three separate 3 mm diameter regions of interest (ROIs), which were placed in the testicular parenchyma. On the SWE image, ROIs were placed on the stiffest areas of the testicular parenchyma, determined from quantitative elasticity values displayed during the examination. Fig. 1 demonstrates SWE examinations of an undescended (a) and a contralateral descended (b) testis.

2.4. Statistical analysis

Statistical analysis was performed using commercial software (SPSS version 16.0, SPSS, Chicago IL, USA). The mean elasticity values were expressed as the mean of the three ROI measurements. The Kolmogorov–Smirnov test was used to analyse the normal distribution of data. The difference in shear elastic modulus data between undescended testes and contralateral descended testes was assessed using Student's *t*-test. All measurements are expressed as the mean ± two standard deviations. Statistical significance was accepted at $P < 0.05$.

3. Results

On greyscale ultrasound examination, the mean volume of the undescended testes (Group 1) was 0.962 mL. The SWE values ranged from 3 to 17 kPa (mean: 9.6 kPa ± 3.15 kPa). The mean testicular volume of the contralateral descended testes (Group 2) was 1.410 mL. None of our patient's testes have microlithiasis or have mass lesion (such as hematoma, tumor etc. . .), which both might affect SWE values.

The SWE values ranged from 3 to 9.5 kPa (mean: 4.76 kPa ± 1.5). Student's *t*-test revealed that there was no statistically significant between-group difference ($P = 0.232$) in volumes. The mean SWE value of Group 1 (9.6 kPa ± 3.15 kPa) was significantly higher than the mean value in Group 2 (4.76 kPa ± 1.5 kPa) ($P < 0.01$).

4. Discussion

We found that mean stiffness values of undescended testes were significantly higher than those of the contralateral descended testes. There was no significant difference in mean volume.

Undescended testicular abnormalities include progressive reduction in germ cell number and size of the seminiferous tubules that is followed by peritubular fibrosis and decreased number of Leydig cells [20]. These histologic changes have been reported to lead to a reduction in the volume of the undescended testis [21,22]. However, the volumes of the undescended testes were not significantly lower than those of the descended ones in our study, which is not compatible with most of the literature [20,21]. We believe that the small number of patients might explain our results.

On the other hand, the volumes of the testes in patients with unilateral undescended testis are not a reliable parameter to predict future outcomes. Lee et al. [23] demonstrated that there is no relationship between testicular size and future fertility. Noh et al. [24] showed that testicular volume does not accurately predict the germ cell count in patients with undescended testes, and therefore is not a reliable tool to select patients for post-orchidopexy hormonal therapy and cannot replace testicular biopsy in the modern management of cryptorchidism.

Hattapoglu et al. [25] evaluated shear wave velocity (SWV) values of the post-operative undescended testes and claimed SWV might be a new parameter in the surveillance of postoperative undescended testes besides testis volume. However to our knowledge, there is no SWE study for the evaluation of undescended testicles neither for the post or pre operative period in the literature. Notably, the elasticity values of the undescended testes were significantly higher than those of the contralateral undescended testes. As mentioned above, undescended testes have reduced numbers and delayed maturation of germ cells, which is consequently by interstitial fibrosis [22]. According to Hadziselimovic et al. [26], the histology of undescended testes was identical to that of normal testes up to 6 months of age, with histological changes of the undescended testis becoming prominent after 1 year. Since all of our undescended testis patients were older than 1.5 years, we suggest that all of the undescended testes in our study had sustained damage. We believe that peritubular interstitial fibrosis is the main factor that leads to the differences we detected in SWE-derived elasticities of the undescended testes.

SWE might play a critical role in the estimation of the extent of damage sustained by the undescended testis. This potential role were also demonstrated by study of Zhang et al. [27], in which potential value of SWE to detect testicular histological changes