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Superb microvascular imaging for the detection of parenchymal perfusion in normal and undescended testes in young children

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ABSTRACT

Objectives: To compare the detectability of perfusion difference between normal and undescended testes (UDT) in young children using conventional Power Doppler Imaging (PDI) and Superb Microvascular Imaging (SMI).

Methods: We prospectively performed testicular ultrasonography including PDI and SMI for the evaluation of microvascular flow in young children. Microvascular flow was categorized into four grades (grade 0–4). Statistical analysis was performed to compare the differences between undescended and normal testes.

Results: We imaged 40 testes from 20 boys (age, 2–29 months). Testes sizes and volumes were similar between the 29 normal and 11 UDT. PDI demonstrated low grade flow in most normal (19/29) and UDT (11/11) without difference ($P = 0.130$). However, SMI detected differences in flow grades between normal and UDT ($P < 0.001$). In univariate analysis, age (odds ratio [OR], 0.829; $P = 0.012$) and low grade flow on SMI (OR of grade 0, 51.886 with $P < 0.001$ and OR of grade 1, 14.29 with $P = 0.017$) were associated with UDT. These parameters were also significant in multivariate analysis with larger area under the curve, compared with the results using PDI (0.892 vs. 0.726, $P = 0.002$).

Conclusions: SMI can detect perfusion difference between normal and UDT in young children better than PDI.

1. Introduction

Undescended testis (UDT) is the most common congenital anomaly affecting the genitalia of male infants, with a prevalence of 1% at 1 year of age [1]. The association between UDT and infertility or malignancy has been recognized for long [2]. In considering infertility, hyperthermia can be the cause of germ cell loss in UDT. For normal function, the scrotum need to be maintained at 1°–8 °C below normal body temperature [3]. The germinal cells can be sensitive to the hyperthermia resulting from normal body temperature in UDT. However, the role of imaging for the evaluation of UDT has been limited to testis localization, size measurement, and echogenicity assessment [4–7].

Here, we focused on blood flow in UDT because of the known decreased vascularity compared with normal testis [3,8]. Because conventional Doppler imaging could not detect blood flow in the testes of young children [9], we used Superb Microvascular Imaging (SMI), which is the latest imaging technique for detecting the subtle low-flow components. Both blood flow and tissue motion, called "clutter", produce ultrasonic Doppler signals. Conventional Doppler ultrasonography uses a wall filter to remove clutter and motion artifacts, resulting in a loss of low-flow components. However, this new technique can separate flow signals from underlying clutter using an adaptive algorithm. In this study, we investigated the use of SMI for the detection of low velocity blood flow components in the normal testes and UDT in young children and compared the perfusion difference in these two groups.

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Table 1
Comparison between the normal and undescended testis groups (mean ± SD).

		Normal group	Undescended testis group	[b]P value
Patients[a]	Number	N = 18	N = 9	
	Age, months	15.9 ± 7.9	7.8 ± 4.9	<0.001
Testes	Number	N = 29	N = 11	
	Size, mm	13.1 ± 2.1	12.9 ± 2.3	0.833
	Volume, cc	0.5 ± 0.2	0.4 ± 0.1	0.199
	Flow grades by PDI			0.130
	Grade 0	9 (31%)	7 (64%)	
	Grade 1	10 (35%)	4 (36%)	
	Grade 2	8 (28%)	0	
	Grade 3	2 (7%)	0	
	Flow grades by SMI			<0.001
	Grade 0	1 (4%)	5 (46%)	
	Grade 1	5 (17%)	4 (36%)	
	Grade 2	6 (21%)	2 (18%)	
	Grade 3	17 (59%)	0	

PDI: Power Doppler Imaging, SMI: Superb Microvascular Imaging.

[a] Total 20 patients were enrolled with seven unilateral and two bilateral undescended testes. The patients with unilateral undescended testes were included in both groups.

[b] Independent T-test, except flow grades analyzed using Fisher's exact test.

2. Materials and methods

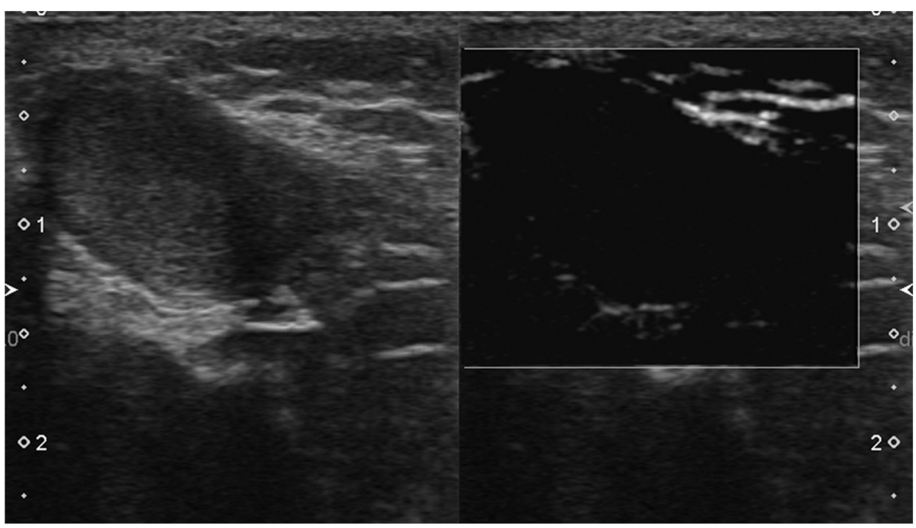
2.1. Patients

Institutional review board approval was obtained for this prospective study, and informed consent was obtained from each parent. Between June and October 2014, we performed testicular ultrasonography in all children who were referred to evaluate UDT and under the age of 36 months at our hospital. The diagnosis of UDT or normal testis was determined according to physical examination by two experienced pediatric urologists on the day of ultrasonography.

2.2. Ultrasonographic examinations including Doppler imaging

All testicular ultrasonography was performed in supine position by one experienced pediatric radiologist. Testicular ultrasonography including Doppler imaging was performed using a 7–18 MHz linear transducer (Aplio 500, Thoshiba Medical System Corporation, Tokyo, Japan). We only included the images with Power Doppler Imaging (PDI) and SMI for the analysis. We excluded children with an incidentally found testicular mass, inguinal hernia, epididymo-orchitis, previous hormone treatment history, or other inflammatory lesion that could affect vascularity in the testis. We

(A)



(B)

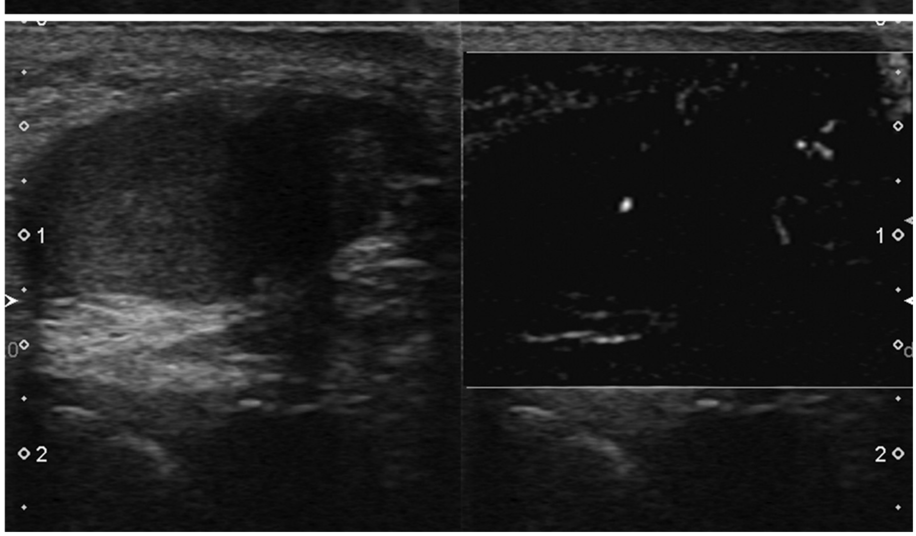


Fig. 1. The monochrome Superb Microvascular Imaging (mSMI) images according to each grade of flow. Flow was categorized into four grades: (A) grade 0, no detectable flow; (B) grade 1, one or two focal areas of flow; (C) grade 2, one linear or more than two focal areas of flow; (D) grade 3, more than one linear flow.