The assessment of bladder wall thickness using ultrasound has been postulated to contribute diagnostic information in patients with voiding dysfunction. In particular, several studies have focused on this tool’s role in patients with overactive bladder and detrusor overactivity. Given the evidence that increasing bladder outlet obstruction and detrusor overactivity cause detrusor hypertrophy, bladder wall thickness and its derivative, ultrasound-estimated bladder weight, may provide information regarding the severity of the underlying disease process. If proven as a diagnostic tool, this could provide clinicians with a test that is less invasive than urodynamics, the current gold standard. Unfortunately, enough discrepancy exists in the literature to prevent widespread application of this tool, and the role of bladder wall thickness assessment in the management of overactive bladder remains undetermined.

Introduction

Although urodynamics remain the gold standard investigation for evaluating patients with voiding dysfunction, there are disadvantages, specifically invasiveness, cost, morbidity [1], and interobserver variability [2]. The clinical management of patients with voiding dysfunction therefore relies not on one test but rather on a thoughtful evaluation of all available information, including the patient’s history, examination, imaging and laboratory results, and a variety of noninvasive and invasive tests of lower urinary tract function.

The measurement of bladder wall thickness (BWT) has long been promoted as an additional tool in the armamentarium of noninvasive tests for assessing voiding dysfunction. However, more researchers are finding that BWT has only a limited role in the management of voiding dysfunction and perhaps no role in patients with overactive bladder (OAB).

What Is OAB?

The OAB syndrome is defined by the symptom complex of urgency with or without urge incontinence, usually with frequency and nocturia [3]. The International Continence Society considers OAB to be suggestive of detrusor overactivity (DO), a urodynamic diagnosis that if present is evident during filling cystometry as phasic involuntary contractions, which may be spontaneous or provoked [4]. DO is evident in 36% to 77% of patients with OAB [5–8]. However, demonstration of DO on urodynamics may be irrelevant to subsequent treatment success [9,10].

The prevalence of OAB in American and European studies is about 16% in adult men and women, with a higher proportion of women suffering from OAB with urge incontinence [11,12]. OAB is associated with lower quality-of-life scores, higher depression scores, and poorer quality of sleep than those of matched controls [11].

OAB is a relatively new term, and although it is familiar and easy to use, it is criticized for being too general and nonspecific [13]. This is because a myriad of diseases are associated with this syndrome, and the disease is only considered OAB in the absence of the rather ill-defined term other pathology [4]. Conditions that may cause OAB include neurologic disease (eg, spinal cord injury, stroke, Parkinson’s disease, multiple sclerosis), irritation of the bladder wall (eg, inflammation, infection, or cancer), bladder outlet obstruction (BOO), diabetes, and stress urinary incontinence [14]. This wide range of diseases must be considered in any diagnostic or management algorithm for OAB.

What Is BWT?

Anatomically, the bladder wall includes the adventitia, detrusor muscle, and urothelium. On ultrasound imaging, the perivesical tissue/adventitia and urothelium appear hyperechoic, while sandwiched between is the hypoechoic
detrusor (Fig. 1) [15]. The urothelium and adventitia may be affected by factors such as inflammation or cancer rather than by hypertrophy and therefore may contribute to inaccuracies in clinical studies. Although most authors seem to measure the detrusor alone, several do not specify whether their ultrasonic measurements include the hyperechoic layers of the bladder wall [15,16]. Imprecise definitions have prompted some authors to use the separate term detrusor wall thickness.

BWT measurements vary greatly among studies of healthy individuals. The study by Oelke et al. [17] of 55 healthy males and females 15 to 40 years of age demonstrated a mean BWT of 1.4 mm in males and 1.2 mm in females. An earlier study by Hakenberg et al. [18] that used a lower frequency probe yielded results of 3.33 mm for men and 3.04 mm for women. BWT is greater in males of all ages, although not all studies demonstrate statistical significance [17–20]. A thicker detrusor wall in males may reflect the greater resistance of the male bladder outlet compared with that of the female.

There is a rise in BWT with age up to puberty [20,21]. However, among young adults and older patients, most authors agree that BWT stabilizes and that age does not correlate with BWT [17,22•,23•]. In healthy children, height and weight correlate with ultrasound-estimated bladder weight (UEBW), although the strongest linear correlation is found with age [21]. No correlation between BWT and height, weight, or body mass index has been found in adult studies [17,24].

What Is the Rationale for Measuring BWT in OAB Patients?
Whereas the link between BOO and hypertrophy of the detrusor has long been examined in animal models and observed in human studies [25–27], evidence for detrusor hypertrophy in OAB is more circumstantial. In patients with demonstrable DO on urodynamic testing, the sphincter typically activates in response to the unwanted detrusor contraction [14]. This isometric contraction against a closed sphincter is postulated to cause detrusor hypertrophy in OAB patients without BOO [28].

In the Elbadawi et al. [29] ultrastructural study of human detrusors, patients with DO were noted to have muscle cell profiles similar to those of normal bladders, although there was a mild increase in intercellular spaces. The characteristic profiles of enlarged hypertrophic muscle cells (commonly seen in BOO) were not observed. However, clinical studies have long observed a strong association between BOO and DO. Trabeculation is easily recognized cystoscopically or radiologically and ultrastructurally represents not detrusor myocyte hypertrophy but infiltration of the detrusor muscle bundles with increased connective tissue [30]. Early studies showed that trabeculation was in fact seen more commonly in association with DO than with BOO [31,32]. Trabeculation also correlates with severity of BOO, and this may reflect the high proportion of patients with secondary DO [33].

Variations in Ultrasound Technique for Measurement of BWT
Ultrasound accurately assesses BWT. In an autopsy study of 10 patients, BWT was measured with a 7.5-MHz probe and compared with histologic sections [15]. A nonsignificant mean difference of 0.17 mm (range, 0.04–0.33) was found. The authors proposed that the anterior wall thickness in the midline therefore could be representative of the bladder thickness in an individual patient. Comparison of results of BWT measurements between research centers is hindered by imprecise definitions and significant variations in ultrasound technique. This is in spite of the fact that low intraobserver or interobserver variability of ultrasound measurements of the bladder wall has been demonstrated by several authors [34–36]. The greatest variations among researchers are in the anatomic approach (transabdominal, transvaginal, or translabial), frequency of ultrasound transducer, bladder site measured, and bladder volume at which BWT measurement was obtained.

BWT decreases with increasing bladder volume [17,19,24,36,37]. Oelke et al. [17,24] demonstrated a distinct hyperbolic relationship between increasing volume and decreasing BWT whereby BWT stabilizes at 200 to 300 mL, or 40% to 60% capacity. Beyond this value, there is a small but insignificant difference up to full bladder capacity. This means that studies assessing bladders at empty to low volumes are less accurate than those that measure at higher volumes or at capacity. Kafer et al. [37] attempted to overcome this variability by developing the “bladder thickness index.” This is the ratio of average BWT to internal radius of the bladder and may be a useful index for children in whom avoid-

Figure 1. Ultrasound image of anterior bladder wall between markers, obtained using a 10- to 5-MHz transducer. The detrusor muscle can be seen as a hypoechoic layer sandwiched between the echogenic adventitia and mucosa.