Video cystometry in young infants with renal dilation or a history of urinary tract infection

Abstract Cystometry is increasingly being used in infants to diagnose bladder dysfunction. However, infantile urodynamic patterns have not been fully established. In this study we investigated the urodynamic patterns in young infants with renal dilation or a history of urinary tract infection, but with no apparent lower urinary tract symptoms. We use video cystometry with simultaneous perineal EMG recording. Thirty-five infants (27 male and 8 female) with congenital renal dilatation or a history of urinary tract infection at age 2 days to 24 months old were involved. We found that detrusor instability occurred in 8.6% of these subjects. Bladder capacity increased with age but less than would normally be expected. An intermittent voiding pattern was observed in 57% (20/35) of subjects and was characterized by a single or recurring increase in sphincter activity with a simultaneous rise in the voiding detrusor pressure curve. The maximum voiding detrusor pressure with pelvic floor overactivity was significantly higher than that with no pelvic floor overactivity (105 ± 44 cmH2O vs 69 ± 22 cmH2O, P < 0.001). The median post-voiding residual volume was 2 (range 0 to 65) ml. We conclude that in infants with no apparent lower urinary tract symptoms, bladder instability is uncommon, and the capacity is lower than the normally expected range; an intermittent voiding pattern is common and the residual urine volume showed great variation. This probably represents an immature detrusor-sphincter function.

Keywords Cystometry · Cystourethrography · Pediatrics · Voiding pattern

Introduction

Lower urinary tract abnormalities in infants, such as vesicoureteral reflux (VUR) and urinary tract infection (UTI) have been supposed to be associated with a dysfunction of the bladder [1, 10]. Consequently, cystometry is increasingly being used in infants as an important diagnostic tool for the evaluation of bladder dysfunction [14]. However, the significance of bladder dysfunction in infants with various urinary tract disorders is often uncertain due to the lack of normal data on urodynamic patterns in this age group [2, 16]. The voiding detrusor pressure is supposed to be higher in infants than in older children [2, 16] but the mechanism of the high voiding pressure is still unclear [16]. Recently, in a video urodynamic study, Bachelard et al. [2] noted that 70% of normal infants had disordered voiding while in their previous study of free voiding this occurred in only 15%–23% [7, 11]. Obviously more data are needed before making any conclusions.

In the present study we evaluated video urodynamics simultaneously with the recording of external sphincter activity in young infants with either renal dilation or one to two episodes of UTI at age 2–3 months, but without any detectable abnormality during the examination. Thus, the information obtained from these infants might increase our knowledge of the normal infantile voiding patterns. Consequently, our aim was to increase the understanding of infantile voiding patterns and investigate the relationship between high voiding pressure and the urethral external sphincter activity in infants.

Materials and methods

Subjects

A total of 35 asymptomatic infants were enrolled in this study, of which 27 were male and 8 female with a median age of 6.3 months (range 0.06–24 months) and 4.7 months (range 0.3–12 months), respectively. Thirteen of these infants suffered from congenital renal dilation; others had a history of one or two episodes of UTI at
2–3 months prior to the study. These subjects were examined by video cystometry screening for potential bladder dysfunction and VUR. No VUR or other lower urinary tract abnormalities were detected on examination.

Video cystometry
A slow filling (0.25 ml/kg body weight per minute) cystometry with a perineal electromyography (EMG) under fluoroscopy was performed using a Dan Tech Urodynamic Unit and a fluoroscopy monitor. Bladder and abdominal pressure as well as the cystourethral image were continually monitored and recorded during the examination for later analysis. When there was doubt, the cystometry was repeated.

A transurethral double lumen 6F catheter was used to fill the bladder and to record the intravesical pressure. Abdominal pressure was recorded through a balloon catheter placed in the rectum. Detrusor pressure was calculated by the subtraction the rectal pressure from the intravesical pressure. Contrast medium of 30% iothalamate meglumine (Comray 30, Mallinckrodt Medical) at 37°C was used to infuse the bladder. External sphincter activity was monitored through surface electrodes placed perineally. Before applying the electrode the skin was degreased and desquamatated with abrasive paper. The external sphincter activity was considered unchanged, increased or decreased compared to the basic EMG during the filling phase.

Assessment of cystometry included bladder instability, compliance, maximum voiding detrusor pressure ($P_{\text{max, void, det}}$) and its relationship to sphincter activity, bladder capacity, voiding efficiency and post-voiding residual urine volume (PVR). Detrusor instability (DI) is defined as detrusor contractions during the filling phase not related to voiding. According to the definition of Bach-Elaine et al. (2) a detrusor contraction during the last minute before voiding is to be considered as a pre-voiding contraction and not instability. Bladder compliance is calculated by dividing the volume change by the changes in detrusor pressure during that change in bladder volume. The maximum detrusor pressure at voiding was categorized into a peak voiding detrusor pressure and a true voiding detrusor pressure. The peak voiding detrusor pressure indicated the $P_{\text{max, void, det}}$ voiding including both $P_{\text{max, void, det}}$ with pelvic floor overactivity and that with no pelvic floor overactivity. The true voiding detrusor pressure indicated the pressure that was recorded during the opening of the bladder outlet (urine stream). Detrusor after-contraction was described as a contraction of the detrusor occurring at the end of voiding. The value for maximum cystometry capacity was derived from volume voided plus PVR. The PVR was collected through the urethral catheter immediately after voiding. An intermittent voiding pattern means that the bladder outlet closed and reopened at least once during voiding, which was demonstrated by continuous video monitoring.

The activity of the infant during cystometry, such as crying, was recorded simultaneously. All examinations were performed with no sedatives or anaesthesia with the infants lying supine. The methods, definitions, and units conform to the standards proposed by the ICCS 9, except where specially noted. This study was approved by the ethics committee of The Chinese University of Hong Kong.

Study protocol
- Group 1: 13 infants (2 days to 2.5 months old) with renal dilatation
- Group 2: 22 infants (3 to 24 months old) with a history of 1 or 2 episodes of UTI
- Group 3: 10 subjects in whom the effects of the transurethral catheter on the voiding pattern were investigated by cystometry through both suprapubic and transurethral catheters. The peak and true maximum voiding detrusor pressure, voiding efficiency and the frequency of pelvic floor contraction during voiding was compared using both methods.

Statistical analyses
Values were expressed as mean ± SD. A linear regression was used for the analysis of the relationship between cystometry parameters and age. A paired t-test was used to compare the voiding detrusor pressure recorded through the suprapubic with that through the transurethral catheter, and the $P_{\text{max, void, det}}$ with increase in pelvic floor activity to that with no increase in pelvic floor activity in the same subject. Chi-square test was used to compare the frequency of intermittent voiding. The significance level was $P<0.05$.

Results
Detrusor instability was observed in 8.6% (3/35) of subjects. If the pre-voiding contraction was regarded as a DI, the incidence of the bladder instability would be 17% (6/35). The end filling detrusor pressure was 3 ± 1.4 (range 1 to 6) cmH2O. The median bladder compliance was 7 (range 2 to 35) ml/cm H2O and no significant correlation with age was noted ($P<0.05$).

Great variations were observed in $P_{\text{max, void, det}}$ and bladder capacity. The peak voiding detrusor pressure was significantly higher than that of the true maximum voiding detrusor pressure (Table 1), and both had a tendency to decrease with age although the correlation was not significant (Fig. 1A, B). The mean peak and true maximum voiding detrusor pressures were higher in males than in females but the difference was not significant. No significant correlation was found between pressure and bladder capacity. The estimated regression line of bladder capacity in milliliters as related to age in months in all infants is: bladder capacity = $25 + 3 \times$ age ($R^2 = 0.182$, $P<0.05$, $n = 35$) (Fig. 1C); in males, bladder capacity = $19 + 2.6 \times$ age ($R^2 = 0.27$, $P<0.01$); in females, bladder capacity = $23 + 1.2 \times$ age ($R^2 = 0.455$, $P = 0.067$).

<table>
<thead>
<tr>
<th>Sex</th>
<th>Number</th>
<th>Capacity (Range)</th>
<th>Voiding efficiency</th>
<th>$P_{\text{det}}$</th>
<th>t test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤ 2.5 months</td>
<td>&gt; 2.5 months</td>
<td>Maximum peak</td>
<td>Maximum void</td>
<td>$P$ value</td>
</tr>
<tr>
<td>M</td>
<td>27</td>
<td>28 ± 13 (8–44)</td>
<td>39 ± 34 (13–150)</td>
<td>0.86 ± 0.19 (0.21–1.0)</td>
<td>110 ± 44* (45–214)</td>
</tr>
<tr>
<td></td>
<td>F 8</td>
<td>46 ± 41 (18–108)</td>
<td>90 ± 73 (34–195)</td>
<td>0.89 ± 0.18 (0.54–1.0)</td>
<td>86 ± 37** (41–162)</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>34 ± 25 (8–108)</td>
<td>49 ± 46 (13–195)</td>
<td>0.87 ± 0.18 (0.21–1.0)</td>
<td>105 ± 44*** (41–214)</td>
</tr>
</tbody>
</table>

Table 1 Bladder capacity (ml), voiding efficiency, peak and true maximum voiding detrusor pressure (cmH2O) (mean ± SD)