



# Cystometrogram appearance in PUV is reliably quantified by the shape, wall, reflux and diverticuli (SWRD) score, and presages the need for intervention

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## Summary

### Objective

Radiological bladder abnormalities in boys with posterior urethral valves (PUV) are well recognised; however, the assessment is subjective. The shape, wall, reflux and diverticuli (SWRD) score objectively assesses shape, wall, reflux and diverticuli in a simple way. This study was undertaken to demonstrate that the SWRD score is reliable, reproducible and correlates with bladder outcome and videourodynamic (VUD) assessment in boys with PUV.

### Materials and methods

Three blinded assessors determined the SWRD scores of PUV bladders from cystometrograms taken during VUD from September 2012 to October 2013. The scores were correlated with clinical outcome and VUD pressure measurements. Data were given as median (interquartile range), non-parametric tests used as appropriate (Mann–Whitney U test, or Kruskal–Wallis) and  $P < 0.05$  was taken as significant.

### Results

A total of 55 boys with PUV underwent VUD assessment, for which 52 cystometrograms were available. The SWRD score for non-operative management was 1.0 (0.1–1.9) vs 2.0 (1.0–3.3) for operative intervention,  $P = 0.018$  (Summary Figure). The SWRD score for

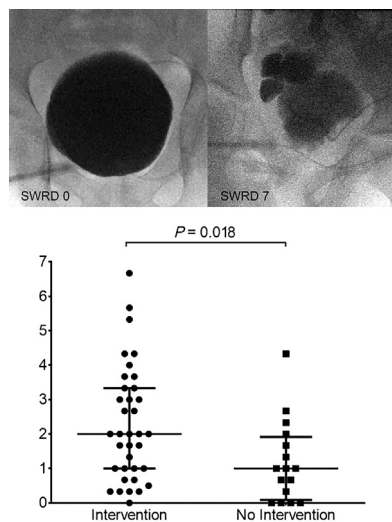
compliant bladders was 1.1 (0.6–2.0) vs hyper-compliant 1.7 (0.5–2.8) vs non-compliant 3.3 (2.8–5.0), Kruskal–Wallis  $P = 0.011$ . The hostile detrusor overactivity (DO) bladders (Pdet  $> 40$  cmH<sub>2</sub>O) had a SWRD score of 2.0 (1.3–3.7) vs 1.0 (0.5–2.5) for low-pressure DO bladders,  $P < 0.05$ .

### Discussion

In this series of patients, increasingly distorted bladder shape was seen to be associated with poor bladder dynamics on VUD. Patients with poorly compliant bladders had a significantly higher SWRD score than normal or megacystis patients. Severe DO was also significantly associated with a high SWRD score. Therefore, the radiological appearance of a hostile bladder represented a marker for high intravesical pressure. VUR and bladder diverticuli may lead to spurious pressure measurements during VUD; however, the SWRD score provided an independent mechanism with which to objectively assess these patients, even in the presence of gross VUR.

### Conclusions

The SWRD score is a simple and objective scoring system for the radiological abnormalities of PUV bladders. It correlates with clinical outcome and VUD assessment of compliance and DO, but is independent of pressure measurements and so not confounded by VUR acting as a 'pop-off' mechanism.



**Summary figure** Maximum and minimum possible shape, wall, reflux and diverticuli (SWRD) scores and the association of SWRD score with need for intervention.

## Introduction

PUV are the most common cause of congenital lower urinary tract obstruction in male infants, and can lead to abnormal kidney development and renal failure after birth [1]. Due to advances in prenatal screening and improved valve ablation techniques, the immediate outcome is usually good. However, late onset renal impairment develops in more than a third of boys with PUV [2]. Bladder dysfunction has been identified as an independent risk factor for end-stage renal disease (ESRD) [3]. Therefore, no matter how promising the initial result, vigilant follow-up is mandatory through adolescence and adulthood [4].

In 1982, Mitchell coined the term 'valve bladder' to describe dysfunctional bladders in patients with PUV [4,5]. Several different videourodynamic (VUD) patterns in valve bladder have been described [6,7]: they can be unstable, hypocompliant (valve bladder syndrome (VBS)) or acontractile (myogenic failure) [8]. Abnormal radiological appearances of bladders subjected to congenital bladder outlet obstruction (BOO), such as in PUV, have long been recognised by paediatric urologists and radiologists. However, these assessments have remained subjective. A recent systematic review of PUV identified the lack of a standardized quantification of obstruction and its severity, and it therefore recommended a mandatory objective classification of severity of obstruction [9]. To fulfil this need, the present study proposed a novel and objective scoring system for the bladder appearance on cystometrogram (CMG), based on the shape of the bladder, trabeculations of the bladder wall, presence of reflux and presence of bladder diverticuli (SWRD score). The SWRD score can be used as a tool with which to assess the requirement for a bladder drainage procedure.

It was hypothesized that the SWRD score can reliably quantify the radiological appearance of PUV bladders and, further, that this scoring scheme allows clinical information about management and prognosis to be obtained. An unfavourable radiological appearance may predict a hostile bladder and adverse clinical outcome with the need for intervention.

## Materials and methods

### Patient population

All patients who underwent VUD for PUV from September 2012 to October 2013 were identified from a prospective database of VUD for post hoc determination of their SWRD score. The mean age was 6 years (range 1–14).

Endoscopic valve resection was the preferred initial treatment method, and all boys were offered circumcision at the time of valve resection to reduce the risk of UTI [10]. Boys with PUV were then managed according to the local hospital algorithm, which was in use before the study started (Fig. 1).

These patients were clinically followed and had a VUD either for symptoms or as part of routine surveillance at 5 and 15 years of age. Symptoms warranting VUD included: worsening hydronephrosis (HUN),

worsening bladder function, recurrent UTI and incontinence (in toilet-trained boys).

Suprapubic placement of a VUD catheter under general anaesthetic was performed 3–5 days prior to VUD in those children who could not tolerate a urethral catheter. The delay between the suprapubic catheter placement and VUD was to ensure that anaesthetic recovery and postoperative pain had little impact on the study. At the present institution, VUDs were only performed on a fixed day of the week and operating theatre availability dictated when the SPC could be placed. Therefore, the gaps between catheterization and VUD were not consistent.

A team consisting of a consultant paediatric urologist, a specialist paediatric urology nurse and a senior radiographer performed the study. The patients were placed in the supine or semi-erect position with 10 ml/min filling of contrast (Iohexol 300 diluted 50:50 with saline). Abdominal (via rectal catheter), vesical and detrusor pressures were measured continuously. Routine urodynamic parameters were evaluated.

Compliance was calculated from two time points: (1) the pressure at the start of fill and (2) the volume at the end of fill. This allowed change in volume divided by change in detrusor pressure (Pdet) to be calculated, as described by the International Continence Society (ICS) [11]. For analysis of compliance, bladders were divided into the following: normally compliant (5–60 ml/cmH<sub>2</sub>O), hypercompliant (myogenic megacystis) >60 ml/cmH<sub>2</sub>O, and poorly or non-compliant (VBS) <5 ml/cmH<sub>2</sub>O.

Detrusor overactivity (DO) was measured as part of the VUD assessment. The International Children's Continence Society (ICCS) defines DO as detrusor contractions >15 cmH<sub>2</sub>O [12]. Dilatation can occur with Pdet >15 cmH<sub>2</sub>O, and urine production and glomerular filtration are reduced when Pdet >40 cmH<sub>2</sub>O [13,14]. The cut-off of detrusor overactivity >40 cmH<sub>2</sub>O is a marker of dangerous and severe DO; therefore, patients in the present study were divided into detrusor contractions <40 cmH<sub>2</sub>O and those with severe DO >40 cmH<sub>2</sub>O.

In the management algorithm, bladders with Pdet >40 cmH<sub>2</sub>O are considered 'unsafe' and Pdet <15 cmH<sub>2</sub>O is considered 'safe'.

### Shape, wall, reflux and diverticuli (SWRD) score

The CMGs were collected in a database and then randomised. Three blinded assessors independently scored the radiological appearances of these bladders. A senior consultant paediatric urologist, paediatric surgeon who recently completed training, and a paediatric surgical trainee on intermediate years of training were assessors.

The score was calculated from images obtained when the bladder was at two-thirds of its maximum measured capacity. However, in presence of reflux, the maximum bladder capacity was difficult to determine. Therefore, the CMG at the point where the reflux was clearly demonstrated was used for scoring, as no further bladder volume increase was generally observed beyond this point.

The scoring system is demonstrated in Fig. 2. The SWRD scoring scheme therefore adds these radiological abnormalities to give a minimum score of 0 for radiographically

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