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Three-dimensional bladder ultrasonography with the BladderScan[®] overestimates post void residual one week after delivery



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ABSTRACT

Objective: Postpartum urinary retention is a frequent complication after childbirth. It is usually a temporary condition. However, unrecognised urinary retention can lead to considerable morbidity due to bladder over distention, detrusor atony and long term voiding dysfunction. In our clinic we noticed an overestimation of post void residual measured with the BladderScan[®] in comparison with catheterization in women one week after delivery.

Study design: We included 25 women in this prospective pilot study. These women had a urinary retention over 1000 ml within 4–5 h postpartum. Conform our local protocol, an indwelling catheter was inserted for one week. After removal of the indwelling catheter, a micturition trial was conducted. The post void residual was first measured with BladderScan[®] (BVI 3000), directly followed by clean intermittent catheterization which is the golden standard at this moment.

Results: There was a significant mean difference in post void residual measurements with the BladderScan[®] and catheterization of 312 ml (95% CI 220–404 ml) ($p < 0.001$). According to our post void residual definition of 200 ml, the sensitivity and specificity of the BladderScan[®] was respectively 100% and 17.6%. The positive predictive value was 36%.

Conclusion: The BladderScan[®] (BVI 3000) is a non-reliable instrument to measure post void residual one week postpartum. For now clean intermittent catheterization remains the golden standard.

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Introduction

Postpartum urinary retention is a frequent complication after childbirth [1].

Although the exact pathophysiology remains unclear, post void residual (PVR) is assumed to be a multifactorial process based on physiological, neurological and mechanical conditions. [2]. Risk factors for PVR after delivery are instrumental delivery, perineal trauma, epidural anesthesia, higher birth weight and nulliparity [3,4].

High PVR is usually a temporary condition. However, unrecognised retention can lead to with considerable morbidity due to bladder over distention, detrusor atony and long term voiding dysfunction [2,5]. Therefore it is important to adequately diagnose significant PVR.

Common used methods for PVR measurements are catheterization and (three-dimensional bladder) ultrasonography. Although catheterization is mentioned as the golden standard, it is an invasive procedure which can lead to an increased risk of urinary tract

infections and trauma [6]. Therefore, preferably a non-invasive ultrasonography is used.

Previous research has shown that three-dimensional bladder ultrasonography (BladderScan[®]) is a reliable instrument to determine PVR in men and non-pregnant women [7,8]. The three-dimensional bladder ultrasonography (BladderScan[®] (US, using the BVI 3000[®], Verathon, WA, USA) is most commonly used method in the Netherlands for determination of PVR in postoperative patients. However, the reliability of the BladderScan[®] in the postpartum period are conflicting [1,9–14].

In our clinic we noticed an overestimation of PVR's measured with the BladderScan[®] in comparison with catheterization in women one week after delivery. With this study, we intend to ascertain whether the BladderScan[®] is a reliable instrument for measurement of PVR in patients with postpartum urinary retention who conducted a micturition trial one week after delivery.

Materials and methods

We included 25 women in this prospective pilot study. These women had a urinary retention over 1000 ml within 4–5 h postpartum. Conform our local protocol, an indwelling catheter

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was inserted for one week. After removal of the indwelling catheter, a micturition trial was conducted. In our protocol, a catheterization is a normal procedure for evaluating PVR, but the BladderScan[®] is used as well. In this study, PVR was measured with the BladderScan[®] (US, using the BVI 3000[®], Verathon, WA, USA). This evaluation was directly followed by clean intermittent catheterization (CIC) to collect and determine the real volume of urinary retention, as catheterization is the golden standard to assess PVR. We defined PVR above 200 ml as significant.

The measurement of PVR was conducted by a continence nurse specialist who was trained in adequate measurement by firm Verathon; developers of the BladderScan[®]. All measurements were conducted according to the instructions of the BladderScan[®].

Statistical analysis was performed using IBM SPSS Statistics version 20.0. A two-sided p-value <0.05 was considered to indicate statistical significance. The Wilcoxon test was used to determine difference between PVR data of the BladderScan[®] and CIC. Spearman rank test was used for correlation between PVR data of the BladderScan[®] and CIC. For categorical characteristics frequencies were analysed in contingency tables with χ^2 statistics. Continuous variables were depicted as median with interquartile range. We calculated the sensitivity, specificity and positive predictive value of our PVR measurements with BladderScan[®] in comparison to CIC.

Ethical approval

Ethical approval was not applicable, because this was an evaluation of standard care. The patients in this evaluation were informed and had no objection to the use of their information.

Results

The median interquartile range of PVR of the BladderScan[®] and CIC are respectively 403 ml (314–637 ml) and 95 ml (35–95 ml).

According to our PVR definition, only 3 patients measured a residu <200 ml by the BladderScan[®]. In 20 patients the BladderScan[®] measured PVR \geq 200 ml.

However, in 13 of these patients, CIC showed a PVR <200 ml (table S1). There was a significant mean difference in PVR measurements with the BladderScan[®] and CIC of 312 ml (95% CI 220–404 ml) ($p < 0.001$). There was a positive correlation between PVR data of the BladderScan[®] and CIC ($r = 0.60$; $p < 0.05$).

According to our PVR definition of 200 ml the sensitivity and specificity of the BladderScan[®] was respectively 100% and 17.6%. The positive predictive value was 36% (Table 1).

Comment

According to our study, the BladderScan[®] (BVI 3000) is a non-reliable instrument to measure adequate PVR one week postpartum.

To our knowledge we are the first to investigate the reliability of the BladderScan[®] one week postpartum. Our findings are in line with Pallis et al. [12] who measured the PVR one day postpartum.

Table 1

2x2 contingency table between three-dimensional bladder ultrasonography (Bladderscan[®] BVI 3000) versus clean intermittent catheterization.

	CIC (\geq 200 ml)	CIC (<200 ml)
Bladderscan [®] (\geq 200 ml)	8	14
Bladderscan [®] (<200 ml)	0	3

Results: Sensitivity 100% specificity 17.6% positive predictive value 36%; CIC = clean intermittent catheterization.

This is in contrast with all other previous studies [1,9–11] showed that the BladderScan[®] is a reliable instrument to measure PVR's (cut-off 300 ml and 400 ml) after vaginal delivery. However, they all measured PVR directly postpartum and use a higher cut of for significant PVR. Sensitivity and specificity vary with different cut-off values. Lukasse et al showed an decrease in specificity from 96% to 65%, but increase in sensitivity from 76% to 100% when the cut-off value changed from 400 ml until 300 ml [9]. This implicates, that small PVR leads to an overestimation and large PVR to a possible underestimation, which is in line with our findings.

In all studies a similar type of the BladderScan[®] (BVI 3000 or 6100) was used. The different outcome of the studies might be based on population size, the variety time of measurement (directly - <24 h) and heterogeneity of definitions of PVR (150–500 ml). However, the major difference might be related to the difficulty for the Bladderscan[®] to differentiate the bladder from the uterus postpartum. Directly postpartum, the uterus is about 18 week gestation, while after one week it is on the same level of the bladder. Thus, this may lead to an overestimation in measured bladder volume, as the Bladderscan[®] may be unable to differentiate in volume of the bladder and uterus. Therefore, the volume of the uterus might be counted in the measurement of the bladder volume.

Regarding the latest prospective study of Mulder et al, the reliability of measuring PVR with the BladderScan[®] (BVI 9400) is promising, according to a sensitivity of 85.4% and sensitivity of 85.6% with a cut-of range for PVR >500 ml directly postpartum [14]. Even though it is a methodically wise strong and large study, it also is the first which used the newer BladderScan[®] (BVI 9400). And therefore, their measurements may be more precise/accurate compared to the older models (BVI 3000, BVI 6100).

Strength of our study is that CIC and measurements with the BladderScan[®] was performed by one investigator who was trained adequately. Therefore, observational bias was minimalized.

A limitation of our study is the small study population. But the difference in this small population is already clinically significant.

In practise, we prefer to use the BladderScan[®], to maintain the benefits of non-invasive measurement. However, the Bladderscan[®] (BVI 9400) is only validated for PVR >500 ml. Also, this is the newest type of scan which is very expensive and therefore not (directly) available in all hospitals. Therefore, we advise further research in order to develop a formula for the BladderScan[®] BVI 3000 for the postpartum period. When postmictal urinary retention occurs, we advise the use of CIC above an indwelling catheter as described in Mulder et al. [16].

Conflict of interest

All authors report no conflict of interest.

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