Voiding dysfunction after vaginal prolapse surgery: etiology, prevention and treatment

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Chapter 7

A prospective study to identify risk factors for the occurrence of abnormal post void residual bladder volume (PVR) following vaginal prolapse surgery

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Abstract

Objective: To identify independent risk factors for the occurrence of abnormal post void residual bladder volume (PVR) following vaginal prolapse surgery.

Design: Prospective observational cohort study.

Setting: Five teaching hospitals and one non teaching hospital in the Netherlands.

Population: Women undergoing vaginal surgical correction for symptomatic pelvic organ prolapse.

Methods: Several patient characteristics, surgery related parameters including postoperative pain, situationally induced anxiety level and background level of anxiety were collected. Abnormal PVR was defined as a residual volume after voiding higher than 150 ml measured by a bladderscanning device. To identify independent risk factors for the development of abnormal post void residual volumes (PVR) potential variables were tested for statistical significance by performing univariable and multivariable logistic regression analysis with stepwise backward selection.

Main outcome measure: Abnormal PVR defined as a residual volume after voiding higher than 150 ml.

Results: A number of 342 patients were included of which 87 women developed abnormal PVR. Factors that were univariably associated with the development of abnormal PVR at a significance level of p=0.15 were included in a multivariable logistic regression analysis with stepwise backward selection to construct the final model with predictors for abnormal PVR. In the multivariable analysis with stepwise backward selection the strongest predictors were parity (OR 1.34, 95% CI 0.9-1.9), UDI pain domainscore (OR 1.11 95% CI 1.0 -1.3), situationally induced anxiety level (OR 1.39, 1.0 - 1.9) and point Ba (OR 1.25 95% CI 1.0-1.5). Of these factors situationally induced anxiety level and point Ba remained as the only two statistically significant predictors.

Conclusion: Abnormal PVR following vaginal prolapse surgery occurs more frequently in women with a higher preoperative stage anterior wall prolapse and higher level of anxiety after surgery.
Identifying patients at risk for incomplete voiding

Introduction
Vaginal prolapse surgery is intended to restore normal pelvic floor function by correcting anatomical abnormalities. One of the most common complications directly related to prolapse surgery is the occurrence of abnormal post void residual bladder volumes (PVR). 1-3 In most cases, treatment comprises bladder drainage for an additional period of several days. 4-6 Although this treatment may seem straightforward it inevitably increases risk of urinary tract infections, bothers patients and prolongs hospital stay in many. 7, 8 Efforts to identify risk factors for the occurrence of abnormal PVR could ultimately reduce the risk of this adverse event and improve counselling about the patient’s individual risk of developing abnormal PVR. Possible mechanisms which increase the risk of developing abnormal PVR include obstructive effects through the elevation of the bladderneck and urethra occurring during anterior compartment surgery, haematoma and oedema formation and damage to innervation of the bladder. 9 The finding however that patients undergoing posterior repair and levator myorrhaphy also run the risk of abnormal PVR has raised the hypothesis that also postoperative pain can adversely affect pelvic floor relaxation with bladder outlet obstruction as a result. 10, 11 However, pain has never been prospectively studied as a risk factor for incomplete voiding. Another hypothetical mechanism is that not only pain but also anxiety can inhibit pelvic floor relaxation and bladder function. This hypothesis is based on the documented pathway that higher anxiety levels induce sympathetic nerve activation resulting in inhibition of detrusor contractility and obstruction of bladder outflow. 12 The influence that psychological factors can have on voiding was illustrated by the observation that a request for voiding in a clinical environment resulted in an inability to void in a large proportion of patients. 13 However, anxiety as a possible risk factor for abnormal PVR has never been prospectively studied. Studying the role of post-operative pain and anxiety is especially relevant as these factors can potentially be influenced. We performed a prospective multi-centre study to identify risk factors for abnormal PVR after vaginal prolapse surgery and to evaluate whether post-operative pain and anxiety were among these risk factors.

Methods
A prospective observational cohort study was performed in five teaching hospitals and one non teaching hospital in the Netherlands. Approval was obtained by the institutional review boards of all participating centres. In the period from August 2007 till May 2009 patients scheduled for vaginal prolapse surgery could participate in this study. Written informed consent was obtained from all participating patients. All patients aged 18 years and older undergoing vaginal prolapse surgery with or without
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the use of mesh were eligible. Exclusion criteria were: any diagnosed neurological or anxiety disorder under professional treatment or an indication for concomitant incontinence surgery.

Assessment of possible predictors for abnormal PVR

At their first visit at the outpatient clinic, patients were informed about the study. After written informed consent was obtained, participants completed a standardised urogynecologic interview and completed the Dutch validated version of the urogenital distress inventory (UDI). 14,15 Patients were asked to complete this questionnaire at home at least one day before surgery to determine the role of the severity of preoperative urogenital dysfunction in the occurrence of postoperative abnormal PVR. Routinely, prolapse was staged according by using the POPQ staging system. 16 Routine urodynamic investigation was not performed. Pre-operative urine analysis and culture were performed to rule out significant bacteriuria (defined as more than $10^5$ colony forming units) and cystitis (defined as bacteriuria with at least one of the following additional complaints; lower abdominal pain, dysuria or fever). All urinary tract infections were treated with antibiotics before surgery. To determine anxiety levels, patients were asked to complete the validated Dutch version of the Spielberger State-Trait Anxiety Inventory (STAI) before and after surgery. 17,18 The aim of the STAI is to quantify the level of anxiety experienced at any point in time by using the state questionnaire. The inherent anxiety normally felt by the subject is measured by using the trait questionnaire. The state and trait subscales, with 20 items each in a 4-point response format, range from 20-80 with higher scores indicating higher anxiety levels. Patients were asked to complete the trait form of the STAI questionnaire to measure the general baseline anxiety level at least 1 day before surgery. To determine the postoperative situational anxiety level, patients were asked to complete the state form 2 hours after removal of the catheter and before their first attempt for micturition. At the same time (2 hours after removal of the catheter and before the first attempt for micturition) post-operative pain was scored on a visual analogue scale. Patients were asked to put an “X” on a ten cm line ranging from 0-100 between the two extremes and the distance from the beginning of the line to the “X” was measured. Postoperative pain management between centers agreed in paracetamol given maximally 4 times daily in doses of 1 gram as the first step. After this step the second step included a maximum of 3 doses of non steroidal anti inflammatory drugs. The third step was the use of morfinomimetics. Regarding the last two steps variations in the protocol were accepted in the design of the study.
Identifying patients at risk for incomplete voiding

Peri-operative care
either general anesthesia or spinal analgesia was applied, based on the preference of the patient and anaesthesiologist. Single-shot intravenous antibiotics were standardly given to all patients before surgery. After completion of surgery a transurethral indwelling catheter was placed which was removed on the morning of the first postoperative day.

Surgical techniques
All procedures were performed or supervised by gynaecologists with a special interest in urogynaecology. Although small variations in surgical technique may have occurred, the surgeons had a common basis for their surgical principles. In primary prolapse surgery, prolapse of the anterior vaginal wall was corrected by anterior colporrhaphy, surgery of the posterior vaginal wall by posterior colporrhaphy and prolapse of the uterus by sacrospinous ligament fixation, manchester repair or by vaginal hysterectomy with McCall suspension. For recurrent prolapse a mesh was used in case of anterior or posterior vaginal wall prolapse.

Post-operative care
Postoperative care was standardised for all patients. None of the patients received post-operative epidural analgesia. A vaginal gauze was inserted directly after surgery. The catheter and gauze were removed on the morning of the first postoperative day. Directly after the first attempt to void, residual volume was measured in ml using a bladder scanning device (Diagnostic Ultrasound DxU BVI 3000 or BVI 6100®, Ijsselstein, the Netherlands). Also the voided volume was measured and required to be more than 100 mL to be considered representative enough to subsequently measure PVR. Patients with a PVR exceeding 150 ml were diagnosed as having an abnormal PVR. These patients were asked to participate in a trial comparing intermittent catheterisation and indwelling catheterisation.

Prognostic factors
The aim of the analysis was to identify independent risk factors for the occurrence of abnormal PVR following vaginal prolapse surgery. The following patient characteristics and variables were collected preoperatively to determine their influence on the risk of abnormal PVR: age, body mass index, parity, UDI domain scores for overactive bladder, pre-operative urinary stress incontinence, obstructive micturition and prolapse complaints measured before surgery as well as postoperative pain score and anxiety levels. Another postoperative variable included in the analysis was type of surgery.
Statistical analysis
First, the data were checked for linearity using histograms and normality plots. After this, the association between each variable and abnormal PVR was quantified using univariable logistic regression analysis. Subsequently, predictors that were univariably associated with the outcome (univariable p-value < 0.15) were included in a multivariable logistic regression model with stepwise backward selection using SPSS 18.0 (SPSS Statistics UK, SPSS Inc, Chicago, IL). To analyse if incomplete data could have affected the results of our study a missing value analysis was performed. Calibration of the model was performed using the Hosmer-Lemeshow test.

Results
From August 2007 till May 2009 a total of 1037 patients underwent vaginal prolapse surgery in the participating centers. Of these patients, 532 patients were invited to participate in this prospective study. Of the 419 patients who met the inclusion criteria and were willing to participate, 342 patients had a complete data set and could be included in the analysis, 87 of them experienced an abnormal PVR. Between centers no differences were found in occurrence of abnormal PVR and participation rates.

Figure 1: Patient flow through the study (STROBE)
Patient characteristics, pre-operative questionnaire results and performed procedures are shown in table 1.

Table 1: Patient characteristics of the included patients (n=342)

<table>
<thead>
<tr>
<th>Patient characteristics</th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age per year</td>
<td>61.7</td>
<td>(10.5)</td>
</tr>
<tr>
<td>BMI per kg/m²</td>
<td>25.7</td>
<td>(3.8)</td>
</tr>
<tr>
<td>Parity, n (median, range)</td>
<td>2</td>
<td>(0-5)</td>
</tr>
<tr>
<td>POP-Q (median, range)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ba</td>
<td>0</td>
<td>(-3-5)</td>
</tr>
<tr>
<td>Bp</td>
<td>-2</td>
<td>(-3-5)</td>
</tr>
<tr>
<td>C</td>
<td>-3</td>
<td>(-9-8)</td>
</tr>
<tr>
<td>Questionnaire results</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative baseline anxiety level</td>
<td>38.3</td>
<td>(8.8)</td>
</tr>
<tr>
<td>Postoperative situational anxiety level</td>
<td>34.3</td>
<td>(9.0)</td>
</tr>
<tr>
<td>Pain score</td>
<td>20.1</td>
<td>(19.9)</td>
</tr>
<tr>
<td>UDI overactive bladder domain score</td>
<td>29.6</td>
<td>(23.6)</td>
</tr>
<tr>
<td>UDI incontinence domain score</td>
<td>24.4</td>
<td>(23.6)</td>
</tr>
<tr>
<td>UDI obstructive domain score</td>
<td>21.2</td>
<td>(25.1)</td>
</tr>
<tr>
<td>UDI pain domain score</td>
<td>22.8</td>
<td>(23.7)</td>
</tr>
<tr>
<td>UDI prolapse domain score</td>
<td>42.5</td>
<td>(30.6)</td>
</tr>
</tbody>
</table>

| Performed procedures *       |       |       |
| Anterior colporrhaphy        | 272   | (79)   |
| Posterior colporrophy        | 133   | (39)   |
| Vaginal hysterectomy         | 86    | (25)   |
| Sacrospinous ligament fixation| 27    | (8)    |
| Manchester Fothergill         | 24    | (7)    |
| Polypropylene mesh            | 24    | (7)    |
| Kelly sutures                 | 14    | (4)    |

Values are mean (SD) unless stated otherwise

* patients can have undergone more than one procedure

BMI = body mass index

UDI = urinary distress inventory

On all mentioned variables in table 1, univariable logistic regression analysis was performed, to define factors that were univariably associated with the development of abnormal PVR at a significance level of p=0.15. These factors are shown in table 2 and were included in a multivariable logistic regression analysis with stepwise backward selection to construct the final model with predictors for abnormal PVR. The results of the multivariable logistic regression analysis are also shown in table 2.
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Table 2: Outcomes of univariable analysis using logistic regression and multivariable analysis using logistic regression with stepwise backward selection for the association of patient characteristics and (peri) operative parameters with the development of post-operative abnormal PVR.

<table>
<thead>
<tr>
<th></th>
<th>Univariable analysis</th>
<th>Multivariable analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR 95% CI</td>
<td>P</td>
</tr>
<tr>
<td>Parity, n (median, range)</td>
<td>1.3  1.0-1.8</td>
<td>0.06</td>
</tr>
<tr>
<td>Ba</td>
<td>1.2  1.1-1.5</td>
<td>0.01</td>
</tr>
<tr>
<td>Pain score (per 10 points)</td>
<td>1.2  1.0-1.3</td>
<td>0.01</td>
</tr>
<tr>
<td>Postoperative situational anxiety</td>
<td>1.4  1.1-1.9</td>
<td>0.01</td>
</tr>
<tr>
<td>level (per 10 points)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative baseline anxiety level</td>
<td>1.3  0.9-1.7</td>
<td>0.11</td>
</tr>
<tr>
<td>(per 10 points)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UDI pain domain score (per 10</td>
<td>1.1  1.0-1.2</td>
<td>0.11</td>
</tr>
<tr>
<td>points)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UDI prolapse domain score (per</td>
<td>1.1  1.0-1.2</td>
<td>0.06</td>
</tr>
<tr>
<td>10 points)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterior colporrhaphy</td>
<td>2.3  1.1-4.7</td>
<td>0.02</td>
</tr>
<tr>
<td>Kelly sutures</td>
<td>4.2  1.4-12.4</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Factors included in the final model were: parity, UDI pain domain score, situationally induced anxiety level and point Ba. Of these factors situationally induced anxiety level and point Ba remained as the only two statistically significant predictors. The calibration of the model was good (Hosmer-Lemeshow test p=0.63). A missing value analysis showed that the missing data of the factors which were associated with abnormal PVR was missing completely at random.

Discussion

Our objective was to identify independent risk factors for the occurrence of abnormal post void residual bladder volume (PVR) following vaginal prolapse surgery. For this purpose demographic and peri-operative parameters of patients (n=342) undergoing vaginal prolapse surgery were prospectively collected and analysed.

The stage of anterior vaginal wall prolapse and postoperative situational anxiety level were identified as the two independent predictor for developing abnormal PVR. Before interpreting these results some issues need to be discussed.

First, the preoperative timing of the UDI questionnaire and baseline anxiety (trait) was done at least one day before surgery to reduce the possible influence of anxiety due to the coming operation. We can not exclude the possibility that this measurement still could have been influenced by anxiety due to the coming operation and therefore should have been timed earlier.
Second, voiding parameters like the pre-operative post-micturition residual bladder volume could not be included in this study as this was not a routine measurement in the participating centres. Knowing that, before surgery, prolapse and voiding dysfunction are related it is possible that a proportion of patients could have suffered from incomplete bladder emptying preoperatively. Although obtaining information about voiding efficiency and flow preoperatively would have been preferable we think that this has not limited the value of our study as the problem of high residual volumes pre-operatively is likely to resolve following vaginal prolapse surgery and pre-operative flow studies have not been found to have a significant predictive value for postoperative occurrence of incomplete voiding.

Last, there is no consensus about the true cut-off level for the diagnosis of incomplete voiding. Variations in this definition of PVR directly affect the observed prevalence and this could also have had its effect on our study. Although variation exists between definitions and some centers also use percentages of voided volume, in this study a cut off of 150 ml was used as this is the most popular cut off level. Therefore, we think the results of this study are applicable to daily clinical practice.

In the univariable analysis anterior colporrhaphy and point Ba were both found to increase the risk of abnormal PVR. In the multivariable analysis point Ba remained as an independent predictor. The finding of higher point Ba values as a risk factor might be explained by impairment of preoperative sensibility and contractility due to the higher prolapse stage, which persists postoperatively. However, unfortunately in this study no preoperative urodynamic assessment was done. Therefore we are not able to support or reject this proposed mechanism.

It can also be deduced that that performing anterior colporrhaphy only leads to impaired voiding when it is performed on patients with higher prolapse stage. An explanation can be a higher extent of dissection and consequently disruption of innervation when prolapse stage gets higher.

Pain and anxiety belong to another category of causes that are not directly associated nor anatomically related with the bladder. These factors can possibly obstruct bladder outflow through a disturbed relaxation of the pelvic floor, central inhibition of the bladder and/or alpha adrenergic stimulation of the bladder outlet respectively. Although the cause and effect relation of these factors and the occurrence of abnormal PVR might seem well established this is the first study to include these factors prospectively in a large cohort of patients undergoing vaginal prolapse surgery. Evidence to support the role of pain came from earlier studies in which it was observed that patients undergoing posterior repairs also were at increased risk of developing abnormal PVR. As the bladder and its innervation are obviously not directly damaged during posterior compartment surgery, the hypothesis was raised...
that a non-anatomical factor like pain could be of influence.\textsuperscript{10, 11, 26} Postoperative pain initially did show an effect in the univariable analysis. However, pain did not turn out to be a significant independent determinant in the multivariable analysis.

The second independent predictor in the multivariable analysis was postoperative situational anxiety level. We suspect that postoperative anxiety levels are likely to rise because patients are hospitalised, are faced with a request for efficient micturition with the threat of additional catheterisation as a consequence of incomplete voiding and possibly the feeling of loss of autonomy.\textsuperscript{27} The possible negative effect of posing such preconditions to patients was illustrated by the observation that a request for micturition in a hospitalised environment led to an absolute inability to void in 8 of 18 (44\%) otherwise healthy non-surgical subjects in another study.\textsuperscript{13} In the same study it was shown that voiding and the inability to void correlated well with the activation of different pontine regions.\textsuperscript{13}

More support for the relationship between anxiety and voiding impairment came from three earlier randomised studies which all showed a reduction of the postoperative incidence of abnormal PVR after urogynaecological surgery with the administration of alpha blocking agents.\textsuperscript{28, 29, 30} However, this is the first study that demonstrates a direct causal relation between anxiety and incomplete voiding. The finding of a higher anxiety level in patients developing abnormal PVR can have several possible reasons like the actual physical stress caused by the operation, being hospitalised and experiencing loss of autonomy. Therefore, future research will not only evaluate whether drug therapy intended to reduce anxiety results in improved bladder emptying but also whether stress reduction on the day of catheter removal results in a lower incidence of abnormal PVR.

**Conclusion**

The occurrence of abnormal PVR after vaginal prolapse surgery is both related to anxiety after surgery and the pre-operative stage of anterior vaginal wall prolapse. This finding provides a new insight in the etiology of abnormal PVR and is helpful in developing new strategies to prevent abnormal PVR.
References


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