

# Bladder function after spinal anesthesia for cesarean section: an urodynamic evaluation

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**Abstract. – BACKGROUND:** This study evaluates the effects of spinal anesthesia with hyperbaric bupivacaine plus sufentanil on bladder function in women undergoing cesarean section.

**SUBJECTS AND METHODS:** Thirty caucasian healthy pregnant scheduled for elective Cesarean section under spinal anesthesia performed with hyperbaric bupivacaine plus sufentanil were enrolled. Filling cystometry, proprioceptive bladder sensation during cystometry, rate of spontaneous voiding, post void residual volume, anocutaneous and bulbocavernosus reflex were analyzed at 4, 6 and 8 hours after spinal anesthesia.

**RESULTS:** The proportion of women experiencing first sensation, first desire and strong desire at 4 hours was significantly different from that reported at 6 and 8 hours ( $p < 0.05$  for first sensation and  $p < 0.01$  for first and strong desire). Significant differences were also observed between volumes at which first sensation arose at first measurement (4 hours) and at second and third measurements ( $p < 0.01$ ). There was a significant difference in rate of spontaneous micturition, with 80% of patients at 8 hours able to spontaneously void versus 40% at 6 hours, ( $p < 0.01$ ). Moreover, a lower percentage of women had absent and/or light reflexes at 4 hour than at 6 and 8 hours ( $p < 0.01$ ).

**CONCLUSIONS:** Spinal anesthesia with bupivacaine plus sufentanil causes a clinically significant disturbance on bladder function in women undergoing cesarean section. Even though recovery of proprioceptive bladder sensation is fast, a full recovery of spontaneous voiding requires a much longer time. A close monitoring of urinary function and of bladder distension is, therefore, advisable.

*Key Words:*

Spinal anesthesia, Cesarean section, Bladder function.

## Introduction

The rate of Cesarean Section (CS) has constantly increased in all developed countries dur-

ing the last decade<sup>1,2</sup>. In current practice, CS is performed using regional anesthesia rather than general anesthesia because of reduced maternal mortality<sup>3</sup>.

In patients undergoing CS, regional anesthesia is often associated with the onset of postoperative urinary retention (PUR), with an estimated prevalence ranging from 3.5% and 24.1%<sup>4-6</sup>. To prevent urinary retention and bladder overdistention, empirical urinary catheterization during CS is commonly performed and recommended<sup>7</sup>. Unfortunately, bladder catheterization could result in urinary tract contamination<sup>8,9</sup>, which accounts for more than 80% of nosocomial urinary tract infection<sup>10</sup> and results in postoperative pain<sup>11</sup>.

The effect of spinal anesthesia on the lower urinary tract has been already described in healthy male volunteers<sup>12,13</sup>, in patients undergoing general surgery<sup>14</sup> and in male patients undergoing elective lower limb orthopaedic surgery<sup>15</sup>. However, evidence on the time to recovery and on the effects of intrathecal anesthesia on urinary function in obstetrical setting is still scant.

Therefore, this study was performed to evaluate the effect of spinal anesthesia with hyperbaric bupivacaine plus sufentanil on bladder function in women undergoing cesarean section.

## Subjects and Methods

After obtaining approval from the Ethical Committee of Catholic University of the Sacred Heart, Rome, Italy, and a written informed consent, 30 caucasian American Society of Anesthesiologists (ASA) Physical Status I patients with singleton term pregnancy scheduled for elective CS under spinal anesthesia were enrolled. Exclusion criteria were emergency CS, history of renal, lower urinary tract, spinal or neurological disorders, coagulation disorders, autoimmune

diseases, diabetes mellitus, obstetric pathologies and twin pregnancies. An ultrasound assessment of post-voiding residual volume was performed in all women at thirty-four weeks during the visit for the planning of the CS and repeated before the anesthetic procedure. Only those with a negative result were enrolled. The following clinical protocol was used:

1. Evaluation of sensory segmental anesthesia and lower extremity motor blockade every 30 minutes, following spinal injection;
2. Assessment of filling cystometry and evocation of perineal reflexes at 4, 6, and 8 hours after spinal anesthesia;
3. Evaluation of capability and efficiency of spontaneous voiding of urine at the end of each cystometric measurement. After spontaneous voiding an ultrasound evaluation of RV was performed.

### **Spinal Anesthesia**

Before regional anesthesia, Ringer lactate solution 15 ml/kg was administered. Spinal anesthesia was performed at L3-L4 interspace with a Whitacre 25 gauge needle using hyperbaric bupivacaine 0.5% (9 mg) plus sufentanil 5 mcg. The surgical intervention started when sensory block reached T4 level. Non-invasive blood pressure (NIBP), heart rate monitoring (ECG) and oxygen saturation (SpO<sub>2</sub>) were recorded every 3 minutes during the surgical procedure. Postoperative analgesia was managed with intravenous paracetamol 1 g (repeated up to 4 g at six-hourly intervals), intravenous ketorolac 30 mg, morphine 0,1 mg·kg<sup>-1</sup> at the end of surgery and i.v. morphine (patient controlled analgesia (1 mg bolus on demand, 8-min lock-out, maximal dose 30 mg/4h). Intra and postoperative occurrence of maternal side effects (nausea, vomiting and pruritus) were also recorded.

### **Filling Cystometry**

Cystometry measures the pressure-volume relationship of the bladder during filling and provides information about detrusor activity, urge sensation, bladder capacity and compliance. Water cystometry was performed using an open 10 Ch double-lumen transurethral catheter inserted in the bladder. The bladder was filled with saline solution at body temperature at a filling rate of 50 ml/min. We instructed the patient to report the following events: “first sensation of bladder filling” (first time in which the patient becomes

aware of bladder filling); “first desire to void” (first time in which the patient desires to pass urine at the next convenient moment); “strong desire to void” (persistent desire to void without the fear of leakage). The proportion of patient referring each event was calculated, as well as the corresponding filling volume. We evaluated also the maximum cystometric capacity (volume at which the patient felt not able to delay micturition anymore). If the maximum cystometric capacity was reached, we interrupted the infusion, removed the catheters and asked the patient to void. The Foley catheter was removed 8 hours after surgery in women able to urinate, it has been left longer in women who had not yet regained the ability to urinate.

After voiding, residual volume (RV) was measured with ultrasound and RV > 50 mL<sup>13</sup> was considered clinically significant.

### **Perineal Reflexes**

To evaluate the effect of spinal anesthesia on sacral parasympathetic reflex arch, which controls the activity of the detrusor muscle, we performed two neurophysiological tests after 4-6-8 h from spinal anesthesia: the anocutaneous reflex, in which we stimulated the contraction of the anal sphincter by touching the perineal skin, and the bulbocavernosus reflex, in which we stimulated the contraction of bulbocavernosus muscles and anal sphincter by squeezing the clitoris. All the evaluations were performed by the same operator, to eliminate the risk of inter-observer variations.

### **Statistical Analysis**

Results were analyzed by descriptive statistics and are presented as median (minimum; maximum). The analysis of differences between repeated measurements at 4, 6 and 8 hours was performed applying the General Linear Model for Repeated Measures. The Cochran test (an extension of McNemar test for repeated measures) was applied to evaluate the differences in dichotomous variables at different timepoints. A post-hoc analysis was carried out to evaluate pairwise differences with Bonferroni correction. Anocutaneous and bulbocavernosus reflexes were redefined in order to compare absent or light reflexes to middle and strong ones. The statistical significance level was set at  $p = 0.05$ . The analysis was performed using SPSS software for Windows version 12.0 (SPSS Inc., Chicago, IL, USA).

**Table I.** Proportion of patients (n=30) who experienced first sensation, first desire or strong desire to void at different time-points from the administration of spinal anesthesia.

| Event           | 4 hours, number (%) | 6 hours, number (%) | 8 hours, number (%) | p value* |
|-----------------|---------------------|---------------------|---------------------|----------|
| First sensation | 22 (73.3%)          | 30 (100%)           | 30 (100%)           | < 0.01   |
| First desire    | 16 (53.3%)          | 30 (100%)           | 30 (100%)           | < 0.01   |
| Strong desire   | 8 (26.7%)           | 26 (86.7%)          | 28 (93.3%)          | < 0.01   |

\*Among all time points.

### Results

The median age of patients enrolled was 32 years (26; 45); their median weight at deliver was 74 kg (63; 105); the median gestational week was 39 (37; 42). Fetal size was not significantly different between patients. Evaluation of RV was negative in all subjects. Hemodynamic parameters (ECG, NIBP, SpO<sub>2</sub>) were always within normality range. Spinal anesthesia permitted a comfortable surgical procedure in all patients. No adverse effects were recorded.

Table I shows the proportions of patients who experienced first sensation, first desire and strong desire to void at 4, 6 and 8 hours after spinal anesthesia, whereas the corresponding filling volumes in women who experienced these events are reported in Table II. Overall, significant differences were observed in the proportion of women experiencing first sensation, first desire and strong desire between at different timepoints; in particular the proportion of women experiencing first sensation, first desire and strong desire at 4 hours was significantly different from that observed at 6 and 8 hours ( $p < 0.05$  for first sensation and  $p < 0.01$  for first and strong desire). Differences were also observed between volumes at which first sensation arose at first measurement (4h) and that reported at second and third measurements ( $p < 0.05$ ). Further differences

were reported in the maximum capacity between the first and the second/third measurements ( $p < 0.01$ ). At 8 hours, still 20% of patients were not able to urinate; this value was even higher at the previous timepoints (53.3% at 4 hours and 60% at 6 hours,  $p < 0.01$ ), with the difference between timepoints being statistically significant (Table III). Significant differences were observed also in the anocutaneous and bulbocavernosus reflexes, with a lower percentage of women with absent and/or light reflexes at 4 hour in comparison to 6 and 8 hours ( $p < 0.01$ ) (Table III). After voiding, evaluation of RV was negative in all subjects.

### Discussion

Our findings suggest that spinal anesthesia with bupivacaine plus sufentanil causes a clinically significant disturbance of bladder function in women undergoing cesarean section. Even though recovery of first sensation, first desire and strong desire to void are present yet at 4 at 6 hours, respectively only 46.7% and 40% of patients are able to void at this time. Conversely, recovery of sensations and ability to micturition are almost restored at 8 hours, when 80% of patients were able to void and the effects of spinal anesthesia on sacral reflexes are almost reverted, with the wide majority of patients showing a

**Table II.** Filling volumes in women who experienced first sensation, first desire or strong desire to void at different timepoints from the administration of spinal anesthesia.

| Parameter        | 4 hours            |                                      | 6 hours            |                                      | 8 hours            |                                      | p value* |
|------------------|--------------------|--------------------------------------|--------------------|--------------------------------------|--------------------|--------------------------------------|----------|
|                  | Number of patients | Median filling volume, ml (min; max) | Number of patients | Median filling volume, ml (min; max) | Number of patients | Median filling volume, ml (min; max) |          |
| First sensation  | 22                 | 311 (77; 500)                        | 30                 | 228 (60; 367)                        | 30                 | 207 (54; 328)                        | 0.01     |
| First desire     | 16                 | 317 (141; 500)                       | 30                 | 299.5 (109; 485)                     | 30                 | 282 (180; 361)                       | 0.17     |
| Strong desire    | 8                  | 370.5 (342; 390)                     | 26                 | 386.5 (225; 488)                     | 28                 | 383 (363; 396)                       | 0.12     |
| Maximum capacity | 30                 | 500 (400; 500)                       | 30                 | 400 (225; 500)                       | 30                 | 400 (400; 400)                       | < 0.01   |

\*Among all time points.

**Table III.** Proportion of patients (n=30) who experienced first sensation, first desire or strong desire to void at different time-points from the administration of spinal anesthesia.

| Parameter                     | 4 hours, number (%) | 6 hours, number (%) | 8 hours, number (%) | p value* |
|-------------------------------|---------------------|---------------------|---------------------|----------|
| Micturition                   | 14 (46.7%)          | 12 (40%)            | 24 (80%)            | < 0.01   |
| <b>Anocutaneous reflex</b>    |                     |                     |                     |          |
| Middle/Strong                 | 16 (53.3%)          | 30 (100%)           | 30 (100%)           | < 0.01   |
| Absent/Light                  | 14 (46.7%)          | 0 (0%)              | 0 (0%)              |          |
| <b>Bulbocavernosus reflex</b> |                     |                     |                     |          |
| Middle/Strong                 | 10 (30.3%)          | 25 (83.3%)          | 28 (93.3%)          | < 0.01   |

\*Among all time points.

middle/strong bulbocavernosus reflex. On this basis, urinary catheterization seems to be indicated at least for 8 hours, when urinary function is almost restored.

Disturbances of bladder function in pregnant submitted to cesarean section can be associated with obstetric, surgical and anesthesiological factors. Pregnancy is characterized by hormonal changes that reduce the smooth muscle tone of bladder that tends to be hypotonic after delivery, with an increased risk of urinary retention<sup>14</sup>. Surgical section also can increase urinary retention causing bruising and edema of the bladder at the uterovesical area<sup>15,16</sup>, postoperative immobility and wound pain<sup>17</sup>. Finally, the anesthesiological technique can affect lower urinary tract. Disturbances of micturition have a prevalence ranging between 3% and 42%, and are related to subarachnoid injection of local anesthetics and/or opioids<sup>18-22</sup>. Intrathecal local anesthetics cause an interruption of the micturition reflex by blocking both afferent nerves (producing bladder analgesia) and efferent fibers (causing a detrusor blockade)<sup>12</sup>. Intrathecal opioids may present an additive or synergistic effect with local anesthetic. Binding of opioids with m and d receptors in spinal cord causes the inhibition of sacral parasympathetic outflow decreasing detrusor tone, attenuating perception of bladder sensation and permitting passive filling<sup>23,24</sup>. Mechanism of action of opioids is mainly spinal-mediated: urinary retention is less common when an equivalent dose of opioid is administered intraventricularly, intravenously or intramuscularly, with respect to spinal administration<sup>24,25</sup>.

In our study, the analysis of cystometric parameters and neurophysiological tests indicated that women were able to void spontaneously and to feel perineal reflexes with high intensity only after 8-h from spinal anesthesia when 80% of subjects had a normal micturition. Equally, the maximum cystometric capacities were within normal ranges (< 400

ml) only at the same timepoint, with values that did not exceed 400 ml. In contrast, at 4 hours the bladder function was still impaired, as indicated by inability to spontaneously void, by the reduced proprioceptive sensation, by the suprphysiological maximum cystometric capacity and by the lack of strong response in the anocutaneous and bulbocavernosus reflex reported in majority of patients. Interestingly, 6 hours after anesthesia the proprioceptive sensation of the bladder was almost restored, but only 40% of women were able to void, with the risk of acute postoperative distension, as previously reported by Axelsson<sup>26</sup> and Kamphuis et al<sup>12</sup>.

There are some limitations of the methodology in this study. The woman's previous bladder sensitivity and voiding function were not known, they could not be assessed because women were recruited in the third trimester. None of the women had history of lower urinary tract disorders and we assumed that there were no underlying pre-existing factors that would have affected the bladder function after delivery. Additionally, we couldn't perform pressure-flow study. To perform pressure-flow study is needed orthostatic position but patients undergoing spinal anesthesia should keep the lithotomy position for 12 hours. However, being RV negative both before and after the anesthetic procedure, it could be excluded the presence of obstructive problems.

Even though we evaluated a small group of pregnant, our urodynamic evaluations may have an immediate clinical implication. According to Kamphuis et al<sup>10</sup>, after spinal anesthesia the bladder contractility returns much later than the recovery of sensory function: patients may, therefore, experience urge, but they may still not be able to void, with the risk of bladder distension. A close monitoring of bladder filling in women who underwent to spinal anesthesia for cesarean section seems required to reduce the risk of acute urinary retention.



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