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Incidence of Postoperative Urinary Retention Following Spinal Anaesthesia with Colloid Co-Loading

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Abstract:

Objectives: *This prospective, randomised and double blinded study compared incidences of postoperative urinary retention (POUR) at three volumes of colloid co-loading during spinal anaesthesia (SA).*

Materials and Methods: *Ninety nine ASA I or II patients between 18-50 years old were randomised into either Group A (2.5 mL/kg), Group B (5.0 mL/kg) or Group C (7.5 mL/kg) volume co-loading with Gelofusine®. All patients voided spontaneously prior to SA. Ultrasonic bladder volumes were assessed at 2 and 4 hours post SA. Mean arterial pressure (MAP) and heart rate (HR) were recorded perioperatively.*

Results: *Incidence of POUR occurred only in Group C at 27.3%. Cumulative bladder volumes at 4 hours were significantly higher in Group C (460.8 ± 49.5 mL), followed by Group B (351.2 ± 65.0 mL) and Group A (235.2 ± 35.7 mL). The rate of bladder urine volume accumulation among groups was highest in Group C (110.5 ± 17.6 mL/hour) followed by Group B (84.3 ± 21.1 mL/hour) and Group A (61.3 ± 16.3 mL/hour). Mean colloid volume administered was 522.2 ± 69.1 mL ($p<0.001$) in patients with POUR. The time to spontaneous micturition was significantly earlier in Group C at 344.5 ± 58.1 minutes. The MAP was significantly lower in Group A during the initial 20 minutes post SA and 15.2% required a single rescue dose of ephedrine to maintain haemodynamic stability.*

Conclusion: *The incidence of POUR was significantly higher when co-loaded with 7.5 mL/kg of colloid. Mean arterial pressures were more stable when co-loaded with colloid volumes exceeding 5.0 mL/kg.*

Keywords: ***Postoperative urinary retention, spinal anaesthesia, colloid co-loading.***

1. Introduction

The incidence of postoperative urinary retention (POUR) is reportedly up to 70%. [1]-[6] The wide range of incidence reflects the dilemma when diagnosing POUR. The criteria are vast and inconsistent. Frequently used criteria include bladder distension, necessity of bladder catheterization and inability to micturate within 30 minutes postoperatively. [4]-[5] The former is based on supra-pubic pain particularly upon palpation and is least sensitive in detecting urinary retention. Bladder catheterization can be both diagnostic and therapeutic but is invasive. [2] Despite these challenges, successful micturition remained an important discharge criterion in most medical centres.

Previous studies have concluded that there are independent predictive risk factors for POUR. [4]-[10]. Advanced age, intraoperative fluids exceeding 750 mL, post anaesthetic recovery initial bladder volume ≥ 270 mL, spinal anaesthesia (SA) and long duration of surgeries are some associated factors at higher risk for developing urinary retention.

Co-loading with crystalloid fluid up to 20 mL/kg prior to SA is a common practice to prevent spinal induced hypotension (SIH). [11] If left untreated, it can lead to a reduction in mean arterial blood pressure (MAP) beyond 30%. [12] Co-loading with colloid is a potential alternative to reduce the incidence of POUR. Colloid's longer half-life allows it to remain in the intravascular compartment for an extended period. [13]-[15] Thus, effectively, reducing total volume of fluids given intra-operatively.

Bedside ultrasound assessment of bladder volume is gaining recognition. It is reliable, accurate and non-invasive. It can limit the use of in-dwelling urinary catheters and thus reduce

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its complications. [16]-[17] Catheterisation is recommended when the ultrasonic bladder volume reaches 500 mL in association with the inability to micturate. [4],[5],[16]

Hence, it is important to determine the volume of colloid co-loading which can prevent SIH and avoid POUR after SA.

2. Methods

This was a prospective, randomised and double blinded clinical study approved by the Medical Research, Ethics & Innovation Committee, Hospital Canselor Tuanku Muhriz (HCTM), Universiti Kebangsaan Malaysia Medical Centre (UKMMC) (Project Code:FF-2014-422).

Ninety nine patients aged between 18 to 50 years old with physical status of American Society of Anesthesiologists (ASA) I or II scheduled for lower limb orthopaedic surgeries under SA were recruited. Patients with a history of urogenital pathologies, body mass index ≥ 35 kg/m2, pre-existing abdominal mass, estimated duration of operation ≥ 2 hours or intraoperative blood loss ≥ 500 mL as well as preoperative post voiding bladder volume ≥ 200 mL were excluded.

This clinical study involved multiple operators, who were third and fourth year trainees in the Degree of Doctor of Anaesthesiology and Critical Care (Universiti Kebangsaan Malaysia) with more than 5 year experience in anaesthesia. Ultrasonic bladder volume assessment and the colloid co-loading process during SA were performed by a single investigator.

Once recruited, written informed consent was obtained following explanation of the study. All patients fasted for at least 6 hours. In the wards, intravenous (IV) access via an 18G branula was inserted for all patients and crystalloid maintenance at 100 mL/hour was started on the day of surgery. Clear fluids were allowed orally up to 2 hours before surgery.

All patients voided before being transferred to the operation room. First bladder ultrasound (SonoSiteTM M-Turbo SonoHD 2007, USA) was performed for the assessment of preoperative bladder volume. The estimated ultrasonic bladder volume (mL) = 0.46 x H x D x W, where H, D and W is the maximum ultrasonic bladder diameter in the oblique, vertical and transverse axis (cm). [18] Patients were then randomised via computer generated randomisation into Group A (2.5 mL/kg), Group B (5.0 mL/kg) or Group C (7.5 mL/kg) of colloid co-loading. The colloid used was Gelofusine® (B. Braun).

All patients received standard monitoring such as continuous electrocardiography, non-invasive blood pressure and pulse oximetry. The preoperative baseline blood pressure (BP) and heart rate (HR) were recorded. In the sitting position, the patient's lumbar region was cleaned under aseptic technique. Local infiltration at the puncture site was given with lignocaine 2%. The patient's subarachnoid space was entered at L3/4 or L4/5 until free backflow of cerebrospinal fluid was seen. Intrathecal injection with 15 mcg fentanyl and 2.5 mL of 0.5% hyperbaric bupivacaine was given. Gelofusine® co-loading according to the grouping was started concurrently during the cleansing of the patient's back until the end of intrathecal injection.

Immediately post SA, patients were placed in the supine position. Thereafter, BP and HR were recorded at time zero (defined as time taken immediately after SA and positioning) and at every 5 minutes until 30 minutes of surgery. Any adverse effects such as fluid overload or allergic reactions secondary to colloid infusion were observed, documented and managed according to institution protocol. Following colloid co-loading, fluid maintenance with Hartmann's solution at 1.0 mL/kg/hour was given throughout the surgery. All patients received IV midazolam 1.5 mg. IV ephedrine 6 mg boluses were given to keep mean arterial pressure (MAP) within 30% from baseline. Patients with unexpected duration of surgery exceeding 2 hours or had failed SA were dropped out of the study. Lower limb tourniquet was applied according to the respective surgeon's discretion.

Postoperatively, patients were observed for POUR at the recovery bay. They received fluid maintenance and were kept fasted for 4 hours. Trained recovery bay nurses monitored patients for supra-pubic pain and the urge to urinate. Ultrasonic bladder assessment was performed at 2 hours and 4 hours after SA. In this study, POUR was defined as the inability to urinate after 4 hours post SA with either ultrasonic bladder volume ≥ 500 mL or supra-pubic pain from distended bladder despite ultrasonic bladder volume ≤ 500 mL. In-out bladder catheterisation was performed when the criteria for POUR was present.

Prior to discharge from the recovery bay, fluid maintenance was stopped and patients were allowed to take orally. After 24 hours post SA, all patients were assessed on the timing of spontaneous micturition in the general wards.

Thirty patients per arm were required based on an alpha value (α) of 0.05 and power of 80% to detect 23.3% incidence of POUR in patients who received hyperbaric prilocaine 2% (60 mg) for ambulatory lower limb surgery. [1] A total of 99 patients were recruited after considering a drop-out of 10%. Data collection were analysed with the Statistic Package for the Social Science 22.0 TM Software (SPSS, IBM). The one-way Analysis of Variance (ANOVA) test was used to analyse normally distributed continuous variables. Continuous data not normally distributed were analysed by the Kruskal-Wallis test. Categorical data were

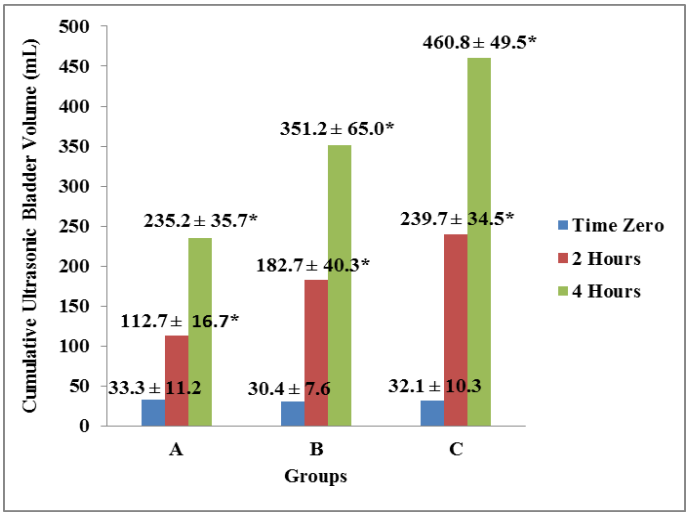
analysed using the Chi-Square test or Fisher Exact test as appropriate. Paired t-test was used to analyse bladder volumes at three different times within groups. A p value of less than 0.05 was considered as statistically significant.

3. Results

Ninety nine patients were analysed as there were no drop-outs. There were no significant differences in the demographic data, types and duration of surgery, and presence of limb tourniquet (Table I).

TABLE I: Demographic data, type and duration of surgery and presence of limb tourniquet. Values are expressed as means ± standard deviation (SD), numbers and median (Q1-Q3) where appropriate.

	Group A (n=33)	Group B (n=33)	Group C (n=33)
Age (years)	34.8 ± 11.0	34.5 ± 8.6	35.6 ± 10.7
BMI (kg/m^2)	23.1 ± 2.4	23.4 ± 2.2	23.4 ± 2.4
Gender (M/F)	23/10	21/12	23/10
ASA (I/II)	24/9	23/10	22/11
Type of Surgery (Elective/Emergency)	8/25	4/29	6/27
Surgical duration (minutes)	40.0 (30.0-60.0)	40.0 (27.5-62.5)	45.0 (32.5-67.5)
Tourniquet application	15	21	8



**Statistically significant at p < 0.05*

FIGURE 1: Cumulative ultrasonic bladder volume within groups. Values expressed as means ± SD.

Cumulative ultrasonic bladder volumes at 2 and 4 hours were significantly larger despite similar volumes at time zero in all groups. Group C had a significant incidence of POUR at 27.3 % (p < 0.001). None in Group A or B had POUR. Those with POUR had a mean cumulative ultrasonic bladder volume of 513.4 ± 26.6 mL with 6 patients exceeding 500 mL (Figure 1).

The mean colloid volume infused in patients with POUR was 522.2 ± 69.1 mL (p <0.001). Out of the 5 patients who had POUR with supra-pubic pain, only 2 had ultrasonic bladder volume exceeding 500 mL. No adverse effects with colloid infusion were noted throughout the study period (Table II).

TABLE II: Rate of bladder urine volume accumulation, colloid volume and supra-pubic pain. Values expressed as means ± SD and numbers with percentage in parenthesis where appropriate.

	Group A (n = 33)	Group B (n = 33)	Group C (n = 33)
Rate (mL/hour)			
1st 2 hours	39.7 ± 9.7*	76.1 ± 20.5*	103.8 ± 18.0*
2nd 2 hours	61.3 ± 16.3*	84.3 ± 21.1*	110.5 ± 17.6*
Colloid volume (mL)	159.1 ± 20.7*	329.6 ± 38.7*	482.2 ± 51.8*
Supra-pubic pain with POUR	0 (0)	0 (0)	5 (15.2)*

**Statistically significant at p < 0.05 between Group A and B, B and C and A and C*

Patients in Group B and C had a significantly shorter time to micturition post SA in the ward after excluding patients with POUR. The earliest time to spontaneous micturition occurred in Group C at 4 hours. The longest time to spontaneous micturition was 11.5 hours in Group A (Figure 2).

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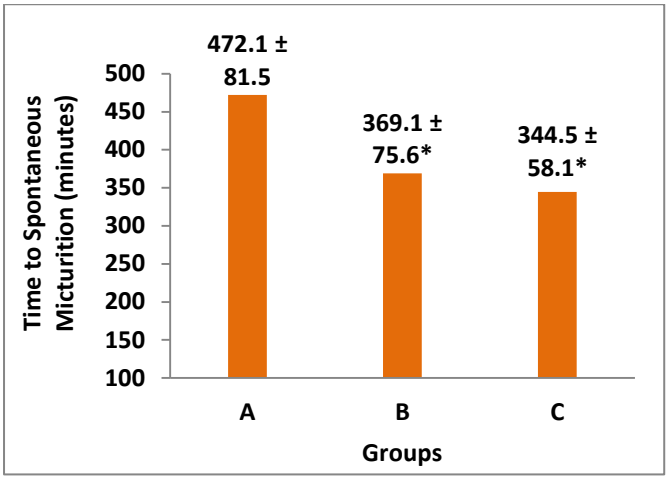
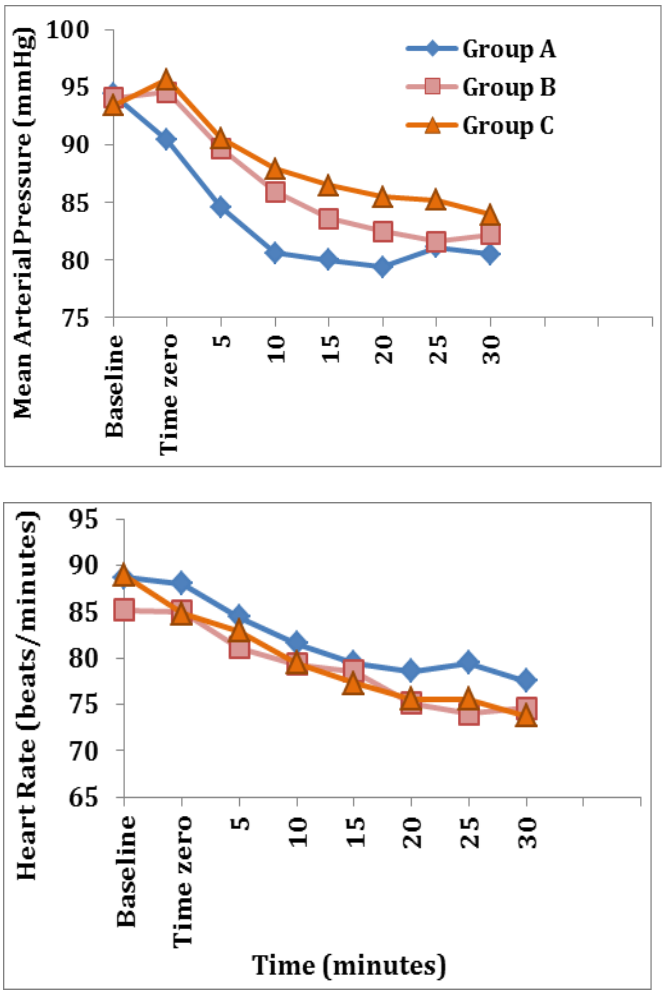


**Statistically significant at p < 0.05 between Group A with B and C*

FIGURE 2: Time to spontaneous micturition among groups.

The MAP was significantly lower in Group A between time zero up to 20 minutes intra-operatively. Only five (15.2 %) patients from Group A required a single rescue ephedrine bolus for SIH ($p = 0.005$) (Figure 3).



Statistically significant p < 0.05

FIGURE 3: Intraoperative mean arterial pressure (MAP) and heart rate (HR) between groups.

4. Discussion

The risk of developing POUR will be higher with increasing numbers of pre-disposing factors. [4]-[5],[19],[7]-[10] We detected an incidence of POUR at 27.3% in those who had spinal anaesthesia when co-loaded with a mean colloid volume of 482.2 ± 51.8 mL. The significantly higher intravascular co-loading volume in Group C led to the occurrence of urinary retention. [20] It was a lower incidence when compared to other studies as reflected by the presence of fewer pre-disposing factors in our study. [19]-[21] The usual risks were precluded as the study sample were in their mid-thirties, with equal male distribution across groups, had pre-operative ultrasonic bladder volume < 200 mL and completed their respective operations within 1 hour.

All nine patients in Group C who had POUR received single therapeutic in-out bladder catheterisation. None of these patients required a repeat in-out or overnight indwelling bladder catheterization. Lau et al [17] recommended in-out in favour of 24 hours indwelling bladder catheterization to manage POUR as the latter demonstrated no further benefit. Prolonged unnecessary bladder catheterisation predisposes patients to complications such as catheter-related infections and urethral trauma. [2]

Spinal anaesthesia exacerbates the risk of developing dysfunctional micturition. [17] The odds for urinary retention were 1.8 times more likely in those receiving SA > 2 hours. [19] To achieve earlier recovery from SA, Karason et al [16] had successfully avoided postoperative bladder catheterisation by using lower doses of local anaesthetics at 1.5 mL of 0.5% hyperbaric bupivacaine and 7.5 mcg sufentanil. Their mean time for spontaneous micturition was 425 ± 147 minutes post SA. The mean time(s) to spontaneous micturition in our study groups were shorter comparatively. We attribute this difference to lower intra-operative fluid volumes and emphasis on colloid co-loading which are possible determining factors for POUR.

The initiation of micturition is under the control of an intact autonomic spinal cord reflex. Under normal circumstances, the first desire to micturate occurs when the bladder volume is 150 mL. Subsequent cumulative volume beyond 300 mL will cause escalating bladder wall tension. This augments the discomfort associated with the sensation to micturate and facilitates effective bladder emptying. [2]-[3]

Not surprisingly, we found the rate of bladder urine volume accumulation was significantly greater with more liberal volumes of colloid infusion. [16] This resulted in Group B and C's cumulative bladder volume exceeding 300 mL at 4

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hours in the recovery bay. Those in Group B and C who could spontaneously micturate did so earliest at 4 hours post SA as the complete recovery of bladder function still depended on sensori-motor block regression caudally. As the micturition reflex recovers, the sensation to void relied upon attaining threshold urine volume of 300 mL. Therefore, both Group B and C had earlier times to spontaneous micturition when compared to Group A whose cumulative bladder volume was lower at 4 hours (235.2 ± 35.7 mL).

Intraoperative fluids administration is crucial for maintaining adequate renal perfusion and urine production. [15],[22]. Unfortunately, the amount of intraoperative fluids is also a strong predictor of bladder volume at end of surgery with subsequent higher risk of early POUR. [23]-[24] As anticipated, Keita et al [5] detected 25.3% of patients with urinary retention when intraoperative fluid volume beyond 750 mL was given. They predicted a 2.3 fold increase in the risk for developing POUR.

We had a slightly higher incidence of POUR despite lower co-loading volume of 522.2 ± 69.1 mL (7.5 mL/kg). This was likely attributed by rapid IV colloid infusion giving rise to sudden right atrium distension. This causes abrupt release of atrial natriuretic peptide which reduces sodium and water load in the circulatory system by increasing the glomerular filtration rate. [15] Additionally, the longer intravascular half-life of colloid contributed to the preservation of satisfactory renal perfusion pressure. [15],[22] Interestingly, we did not observe urinary retention when co-loading with colloid of $\leq$ 5.0 mL/kg. The threshold for POUR probably is higher with restricted volumes of colloid in favour of other fluid types.

Co-loading with colloid is useful for treating SIH as the intravascular volume and pressure are restored efficiently. [25],[15] Despite that fact, our patients with the lowest colloid co-loading volume (2.5 mL/kg) had significant SIH for 20 minutes post SA. As the restoration of intravascular compartment depends on adequate fluid volume, the incidence of SIH tends to be higher in patients receiving lower volumes of colloid. [12] Nonetheless, the beneficial effect of intravascular colloid osmotic pressure at preventing SIH is at the expense of a 15 minutes delay in onset time. [22],[26] There was no compensatory increase in HR during this period. On the contrary, HR was significantly reduced from baseline due to sympathetic blockade from cephalic spread of intrathecal local anaesthetics. [12]

The sensitivity and specificity of bladder ultrasound assessment for diagnosing POUR are 97% and 91% respectively. [5] Four (12.1%) of our patients were diagnosed with POUR exclusively by ultrasound. The diagnosis of urinary retention would have otherwise been missed or delayed. The lack of either supra-pubic pain or palpable distended bladder remained inadequate to rule out POUR. [5]

There were a few limitations in this study. The volumes and types of preoperative fluid were not standardised. This may affect the study results as some patients fasted beyond 6 hours. The final level of established subarachnoid block was not documented. This may influence the duration of block regression and ultimately return of normal bladder function. In the future, we would like to suggest further comparison studies on using different types of colloid to minimise POUR while maintaining stable intraoperative haemodynamics.

5. Conclusion

The incidence of POUR was significantly higher when co-loading with 7.5 mL/kg of colloid. Mean arterial pressures were more stable when co-loading with colloid volumes exceeding 5.0 mL/kg.

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