

Colloids vs crystalloids as prehydration regimen before spinal anaesthesia in elderly normotensive and hypertensive patients

Papagiannopoulou Pinelopi MD, PhD, Meitanidou Maria MD, Georgiadou Theodora MD, Kostoglou Christos MD, Georgiou Mary MD, PhD, Kanakoudis F MD, PhD

ABSTRACT

Colloids vs crystalloids as prehydration regimen before spinal anaesthesia in elderly normotensive and hypertensive patients

Papagiannopoulou PK, Meitanidou MN, Georgiadou ThI, Kostoglou ChS, Georgiou M, Kanakoudis F

This study was undertaken to investigate the efficacy of prehydration with crystalloids or colloids for preventing spinal anaesthesia-induced hypotension in elderly normotensive and hypertensive patients. Eighty physical status ASA I-III elderly patients were enrolled in this study, receiving spinal anaesthesia. Forty consecutive normotensive patients randomly assigned to receive fluid preloading 5ml kg⁻¹ i.v either crystalloid (Group N/RL, n=20) or colloid solution (Group N/Coll, n=20), and forty consecutive hypertensive patients were treated in similar manner (Group H/RL, n=20, Group H/Coll, n=20). Systolic (SAP) and diastolic (DAP) arterial pressure were recorded before fluid preloading (T1-baseline), before spinal anaesthesia (T2), 10min (T3), 30 min (T4) and 60 min (T5) after local anaesthetic's spinal administration. SAP and DAP decreased significantly ($p<0.05$ - $p<0.01$) at T4, T5 interval compared to baseline in all groups. In hypertensive patients reduction of SAP and DAP was greater with crystalloids. In normotensive patients significant reduction of SAP and DAP was noted at T4, T5 interval, but it was similar for both regimens. Conclusions: Fluid pretreatment with 5ml/kg crystalloids or colloids did not prevent the incidence of hypotension after spinal anaesthesia. Colloid prehydration seems to moderate this kind of hypotension compared to crystalloid solution in hypertensive patients.

Spinal anaesthesia often causes hypotension due to sympathetic blockade. More than 30% of the patients undergoing spinal anaesthesia develop intraoperatively hypotension[1]. This complication is more hazardous in elderly patients, as they may have decreased physiological reserve and compromised blood supply to vital organs.

Anaesthesiology Department
General Hospital of Thessaloniki "G. Gennimatas"

Additionally, spinal induced hypotension is a particularly important issue in patients with cardiovascular disease such as hypertension, because their risk of ischemia secondary to hypotension is thus increased[2]. Several approaches to treatment have been advocated[3]. Preloading with crystalloids for the prevention of spinal anaesthesia induced hypotension has gained widespread acceptance since the late 1960s[4,5]. In general, the use of crystalloids

requires a larger volume than colloid and this might cause pulmonary oedema in at high-risk patient, although one study found not to be the case[3]. Volume prehydration may reduce the incidence of spinal induced hypotension compared to no prehydration[6] but does not reliably prevent it[7] and the efficacy of iv fluids preloading to support arterial pressure during regional anesthesia has been queried especially in an ageing population[8]. Reports in elderly patients have shown, that crystalloid intravascular administration had no effect on spinal-induced hypotension while crystalloid, colloids or no prehydration did not reduced the incidence of hypotension[7].

The present study was undertaken to compare the influence of fluid preloading with a fixed volume of crystalloids or colloids in order to prevent hypotension after spinal anesthesia in normotensive and hypertensive elderly patients.

METHODS

The investigation was conducted in forty consecutive normotensive and forty consecutive hypertensive male patients, physical status ASA I-III, who received subarachnoid block for urological endoscopic procedures. The Hospital Ethical Committee approved this study and written informed consent was obtained from all participants. Patients with severe cardiac or respiratory disease, abnormal cardiac anatomy and cardiac rhythm other than sinus, all situations that could alter the normal response to antihypertensive treatment and those who were not willing to undergo spinal anesthesia were excluded from this study.

Patients were considered as hypertensive according to American Heart Association (AHA) criteria, if systolic arterial blood pressure (SAP) was >140mmHg, diastolic arterial blood pressure (DAP) >90mmHg, or both in two preoperative measurements (preanaesthetic visit and at 22.00 the night before operation). Patients, who had an established diagnosis of hypertension under treatment with antihypertensives, were categorized as hypertensive, even if they had not met the above AHA criteria of arterial pressure. All these patients

had been receiving their antihypertensive medications until the morning prior to anesthesia induction.

All patients participating in this study – normotensive and hypertensive-were randomly allocated to be administered prehydration with 5ml/kg crystalloid (Ringer's Lactated) or colloid solutions (6% hydroxyethylstarch 130/0.4 - VOLUVEN®). So normotensive patients were further allocated to received i.v crystalloid solution-Ringer's Lactated (Group N/RL, n=20) or i.v colloid solutions (Group N/Coll, n=20). Hypertensive patients were also divided into two groups in the same manner. Patients in Group H/RL (n=20) received iv crystalloid solution while patients in Group H/Coll (n=20) received iv colloid solutions. All patients participating in this study did not receive intravenous fluids until arrival in the operative theater and received no premedication. On the arrival, an 18-gauge cannula was placed in a peripheral vein. Standard monitoring included ECG, pulse oximetry and noninvasive blood pressure measurement. Spinal anesthesia performed in the sitting position at the L3-4 interspace with a 22-gauge using 4 ml levobupivacaine 0.5% and the level of anesthesia was determined by pinprick at 5 and 15 min after local anaesthetic administration. Motor blockade was also assessed at 5 and 15 min after anesthesia using Bromage Scale [9]. In the supine position, a baseline arterial blood pressure -systolic (SAP), diastolic (DAP)- was recorded using an automated oscillotonometer (Dinamap™, Helsinki, Finland). Noninvasive arterial pressure (SAP, DAP) measurements were recorded before fluid preloading (T1-baseline), before spinal blockade (T2), 10min (T3), 30 min (T4) and 60 min (T5) after the administration of the local anesthetic. After prehydration an iv infusion of crystalloid solution (RL) was continued at a rate of 5ml/Kg/h. All groups received preloading over a 15 min period. Episodes of hypotension were defined as blood pressure value of SAP<90mmHg or 25% decreases from baseline SAP in accordance with several studies in this field[3]. In case of hypotension, patients were treated with rescue bolus doses of ephedrine 5 mg until SAP had increased over the above-mentioned levels.

Bradycardia (HR<50 bpm) was treated with iv atropine. No additional sedatives were given during operation.

number of hypertensive patients (including treated/untreated) (Table 1) and baseline haemodynamic variables (Table 2).

Table 1. Demographic data, duration of surgery and number of patients in study groups

	NORMOTENSIVE PATIENTS		HYPERTENSIVE PATIENTS	
	N/RL (n=20)	N/Coll (n=20)	H/RL (n=20)	H/Coll (n=20)
Age (yr)	61±11	62±11	70±8	68±8
Weight (Kg)	76±10	76±8	79±11	77±10
Height (m)	1.70±6.5	1.70±6.3	1.67±7.3	1.70±5.6
Duration of surgery (min)	57±26	57±26	55±25	55±20
ASA status (I/II/III)	3/12/5	3/12/5	2/15/3	1/15/4
Sensory level at 15 min	T8 (T6-T10)	T8 (T6-T9)	T8 (T6-T9)	T8 (T6-T10)
Hypertension (treated/untreated)	-	-	13/7	15/5

Values are expressed as mean±SD, Median (min-max) for sensory level, No of cases for treated/untreated hypertensives

All data are presented as mean±SD. Statistical analysis was performed between groups with 2-way ANOVA and within groups with 1-way ANOVA and post-hoc Dunnet test. A p<0.05 value was considered statistically significant.

Twenty-eight out of forty hypertensive patients were receiving long-term medications included calcium channel blockers, beta-blockers, thiazide diuretics, and angiotensin-converting enzyme inhibitors.

Table 2. Baseline haemodynamic data in the four study groups

	Groups			
	N/RL (n=20)	H/RL (n=20)	N/Coll (n=20)	H/Coll (n=20)
SAP (mmHg)	132±14	159±21	130±18	151±15
DAP (mmHg)	79±8	85±12	79±11	79±9
HR (bpm)	74±8	74±13	74±10	79±9

Values are expressed as mean ± SD

RESULTS

Twenty patients were studied in each group. Each of the groups enrolled was similar in terms of age, height, weight, ASA status, sensory level at 15 min, duration of surgery,

Systolic Arterial Pressure measurements

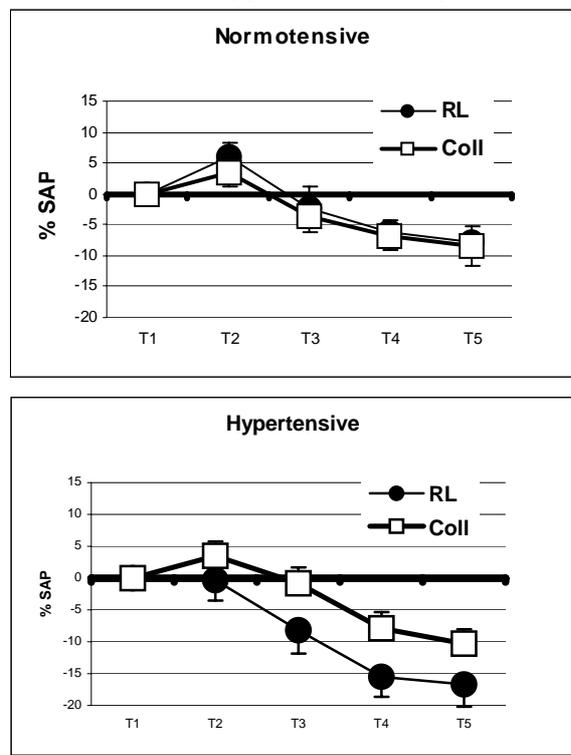
In normotensive patients, SAP fluctuation was similar between the two prehydration regimens studied (p=0.34). In both groups a significant reduction of SAP was noted at 30 min (p<0.01 for N/RL, p<0.05 for N/Coll) and 60 min

($p < 0.01$) after the administration of the local anesthetic (Figure 1A).

In hypertensive patients, the overall incidence of hypotension was greater in Group H/RL

line ($p < 0.01$). In Group RL the reduction was greater (T5: Group H/RL 16% \pm 15 vs Group H/Coll 8% \pm 13) (Figure 2B).

Figure 1. Percentage reduction of Systolic Arterial Pressure (SAP) in elderly Normotensive (A) and Hypertensive (B) patients



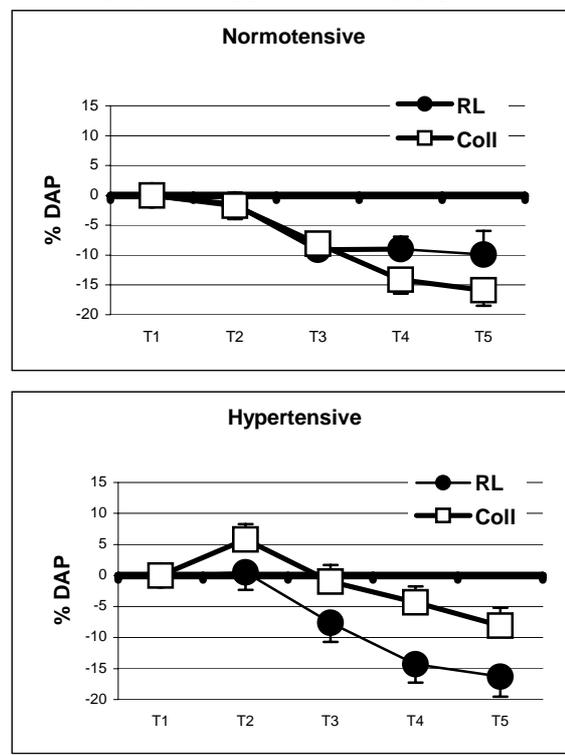
($p < 0.05$). A significant reduction of SAP at T4 and T5 intervals compared to baseline was recorded for both groups, although in Group H/RL the reduction was greater (T4: Group H/RL 15.5% \pm 14 $p < 0.01$ vs Group H/Coll 7.9% \pm 11 $p < 0.05$, T5: Group H/RL 16.7% \pm 16 $p < 0.01$ vs Group H/Coll 10.3% \pm 10 $p < 0.01$) (Figure 1B).

Diastolic Arterial Pressure measurements

In normotensive patients, the overall incidence of DAP reduction, between the two types of prehydration did not differ significantly. In both groups a significant reduction of DAP was recorded at T4 and T5 interval ($p < 0.01$ for N/RL, $p < 0.05$ for N/Coll) (Figure 2A).

In hypertensive patients the overall reduction of DAP was significantly greater in RL group compared to Coll group ($p < 0.05$). DAP reduced significantly at T4 and T5 intervals in Group RL and at T5 in Group Coll compared to base-

Figure 2. Percentage reduction of Diastolic Arterial Pressure (DAP) in elderly Normotensive (A) and Hypertensive (B) patients



Rescue treatment

Four normotensive (2 in N/RL group and 2 in N/Coll group) and 7 hypertensive patients (5 in H/RL group and 2 in H/Coll group) were needed rescue doses of ephedrine as their SAP as reduced more than 25% of baseline.

No incidence of bradycardia was recorded, so there was no need for any patient to received rescue dose of atropine.

DISCUSSION

The goal of this study was to estimate the efficacy of two different prehydration regimens (crystalloids vs colloids) in order to prevent spinal induced hypotension in elderly normotensive and hypertensive patients. The main finding in this study is that, although colloid prehydration sustained blood pressure in a smaller reduction, it did not prevent the overall

incidence of hypotension compared with crystalloid prehydration. Both regimens in elderly normotensive and hypertensive patients provoke hypotension, although in different degree.

Measurements of SAP, DAP using a Dinamap oscillonimeter are subject to variation. Hutton et al found that 95% confidence interval using Dinamap was ± 16 mmHg[10]; however the same machine was used in all patients and invasive arterial pressure measurements are not used in our practice in this kind of operations.

Hypotension during spinal anesthesia results from pharmacological denervation of the pre-ganglionic sympathetic fibers, leading to vasodilatation and reduction of systemic vascular resistance[3]. Since sympathetic block may extend two to six segments above the somatic sensory dermatome level, block height, particularly that extends above T-8 or to cardio-accelerator sympathetic fibers (T1-T4) may impair cardiovascular reflexes and contribute to spinal-induced hypotension[11]. No patient had a sensory level above T6 and in all groups the sensory block was similar without any significant difference (Table 1).

The elderly have increased resting sympathetic nervous system activity, which is associated with increased norepinephrine release from nerve terminals[12]. Normal ageing is also associated with a reduction of baroreceptor-reflex mediated heart response to hypotensive stimuli. Therefore elderly patients may not respond with the same degree of sympathetic activity as younger patients. Decreased cardiac reserves, structural changes in the arterioles and in autonomic nervous system with increasing age may also play a role. Haemodynamic instability after spinal anaesthesia, therefore might be exaggerated in elderly because of larger decreases in systemic vascular resistance. Because antihypertensive treatment could affect the activity of adrenoreceptors, whose number and sensitivity could be irregular due to disease, hypertensive patients may have a different threshold to noxious stimulation[13].

If there is any delay after preloading in performing spinal anesthesia, much of this fluid preload will redistribute to the extracellular

fluid hence reducing the potential benefits of preloading[14]. Literature refers to the use of moderate preloading up to 7 ml/Kg[15]. We choose to administrate prehydration of only 5 ml/Kg in a period 15 min, because of the age of our patients as it is known that in elderly the practice of preloading with large fluid volumes may be poorly tolerated due to their greater vulnerability to decompensation from rapid fluid shifts, haemodilution and haemodynamic instability[8].

This study showed that crystalloid administration before spinal block does not reduce the incidence of hypotension when compared with colloid solution, although colloid solutions have modulated the degree of hypotension compared to crystalloid solutions. These findings may be partially explained by the short intravascular half-life of crystalloids since about 75% of any crystalloid rapidly diffuses into the interstitial space[14]. Administering larger volumes of crystalloids may increase the efficacy of fluids administered before spinal block, but such practice includes increased risk of pulmonary oedema and urinary retention[3]. Additionally, it was found that volume preloading with 0.8 or 16 ml/kg of Ringer's solution had minimal effect on the incidence of hypotension during intrathecal anesthesia in elderly[7]. The results of the present study conflict with the above findings and are in agreement with the study of Baraka et al[15], in which gelatin prehydration reduced the incidence of hypotension compared with crystalloid in elderly patients undergoing transurethral resection of the prostate.

Concerning the spinal anaesthesia induced hypotension, generally it can be supported the argument that colloids produce a more sustained and more effective expansion of the intravascular space in hypertensive patients with long-term persistent vascular hyperactivity.

Blood loss was another potentially important factor not included in our analysis, because it was difficult to measure blood loss accurately because of endoscopic nature of surgery.

In conclusion, hypotension after spinal anaesthesia cannot be prevented by 5 ml/Kg prehydration, both in normotensive and hyper-

tensive elderly patients regardless of the kind of i.v administered fluids. In hypertensive patients the hypotension seems to be better palliated by prehydration with colloid compared to crystalloids fluids administration.

REFERENCES

1. Carpenter RL, Caplan RA, Brown DL, Stephenson C, Wu R. Incidence and risk factors for side effects of spinal anesthesia. *Anesthesiology* 1992; 76:906-16.
2. Juelsgaard P, Sand NP, Felsby S, Dalsgaard J, Jakobsen KB, Brink O, Carlsson PS, Thygenen K. Perioperative myocardial ischaemia in patients undergoing surgery for fractured hip randomized to incremental spinal, single-dose spinal or general anaesthesia. *Eur J Anaesthesiol* 1998; 15:656-63.
3. McCrae AF, Wildsmith JAW. Prevention and treatment of hypotension during central neural block. *British Journal of Anaesthesia* 1993; 70:672-80.
4. Wollman SB, Marx S. Acute hydration for prevention of hypotension of spinal anesthesia in parturients. *Anesthesiology* 1968; 29:374-80.
5. Marx GF, Cosmi EV, Wollman SB. Biochemical status and clinical condition of mother and infant at Cesarean section. *Anesth Analg* 1969; 986-93.
6. Clark RB, Thomson DS, Thomson CH. Prevention of spinal hypotension associated with Cesarean section. *Anesthesiology* 1976; 45:670-4.
7. Coe AJ, Revanas B. Is crystalloid preloading useful in spinal anaesthesia in the elderly? *Anaesthesia* 1990; 45:241-3.
8. Buggy D, Higgins P, Moran C, O'Brien D, O'Donovan F, McCarroll M. Prevention of spinal anesthesia-induced hypotension in the elderly: comparison between preanesthetic administration of crystalloids, colloids, and no prehydration. *Anesth Analg* 1997; 84:106-10.
9. Bromage PR. Epidural analgesia. Philadelphia: WB Saunders Company, 1978, pp:142-147.
10. Hutton P, Dye J, Prys Roberts C. An assessment of the Dinamap 845. *Anaesthesia* 1984; 39:261-7.
11. Critchley LAH. Hypotension, subarachnoid block and the elderly patient. *Anaesthesia* 1996; 51:1139-43.
12. Ebert TJ, Morgan BJ, Barney JA, Denahan T, Smith JJ. Effects of ageing on baroreflex regulation of sympathetic activity in humans. *Am J Physiol* 1992; H:789-803.
13. Fukuda T, Dohi S, Naito H. Comparisons of tetracaine spinal anesthesia with clonidine or phenylephrine in normotensive and hypertensive humans. *Anesth Analg* 1994; 78:106-11.
14. Rout CC, Akoojec SS, Rocke DA, Gows E. Rapid administration of crystalloid preload does not decrease the incidence of hypotension after spinal anesthesia for elective cesarean section. *Br J Anaesth* 1992; 68:394-7.
15. Baraka AS, Taha SK, Ghabach MB, Sibaii AA, Nader AM. Intravascular administration of polymerized gelatin versus isotonic saline for prevention of spinal-induced hypotension. *Anesth Analg* 1994; 78:301-5.

Address for correspondence:

Papagiannopoulou Pinelopi, MD, PhD, Anesthesiologist
Adelfon Emanouil 3, 54454 Thessaloniki/ Greece

Tel. +302310-917666

E-mail: papagpop@otenet.gr

Key words: Anesthesia: Regional, Spinal; Crystalloids; Colloids; Prehydration