Effect of colloid infusion on the fluid dynamics of the TURP syndrome

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Abstract

In 75 patients undergoing transurethral resection of the prostate (TURP), absorption volume of irrigation fluid, blood loss and changes in plasma osmotic pressure etc. were elucidated. Besides, the effect of intraoperative colloid infusion (Dextran 40 in Ringer's lactate, Saviosol™ 500 m*l*: Colloid group) on the fluid dynamics was compared with only crystalloid infusion (Non-colloid group).

Postoperative serum sodium and total protein level were lower in the Colloid group than in the Non-colloid group. Seven patients in the Colloid group and one patient in the Non-colloid group developed the TURP syndrome. There was a significant correlation between absorption volume of irrigation fluid and blood loss ($R=0.75$, $P<0.0001$). And there was also significant correlation between serum sodium reduction (ΔNa) and the volume of irrigant absorbed plus blood loss ($R=0.84$, $P<0.0001$). Consequently the volume of these two factors had an additive effect for the onset of the TURP syndrome. We conclude that intraoperative colloid infusion was not effective for prevention of developing the TURP syndrome.

Introduction

Colloid solution has shown to be more effective than crystalloid solution in attenuating spinal anesthesia-induced hypotension during transurethral resection of the prostate (TURP)[1]. During TURP, however, acute fluid dynamic and hemodynamic changes can occur, which are caused by absorption of irrigation fluid and blood loss. We previously reported that these two factors might have an additive effect on the onset of the TURP syndrome, which shows hyponatremia, hypotension and/or bradycardia and various signs of central nervous system[2]. The aim of this study is to investigate the effect of intraoperative colloid infusion on the fluid dynamics during TURP and on prevention for developing the TURP syndrome.

Materials and methods

The investigation was conducted on seventy-five male patients, scheduled for elective TURP. Patients were randomly allocated into two groups. One group received only crystalloid solution (Non-colloid group) and the other group received 3% Dextran 40 in Ringer's lactate (Saviosol™) 500 m*l*+crystalloid solution (Colloid group). Combined spinal epidural anesthesia was performed with epidural catherterization at L 2-3 interspace prior to spinal anesthesia at L 3-4 interspace using dibucaine 0.3% (Percamin S™). The TURP procedure

Table 1 Characteristics of Colloid and Non-colloid groups

	Colloid group (n=38)	Non-colloid group (n=37)
Age(yrs)	69±8	72±7
Body weight(kg)	57±9	60±7
Intraoperative Infusion volume(ml)	842±225	816±308
Duration of irrigation (min)	82±24	75±22
Prostate weight resected (g)	14.4±7.6	11.5±8.4

There were no significant differences between the two groups. mean±SD

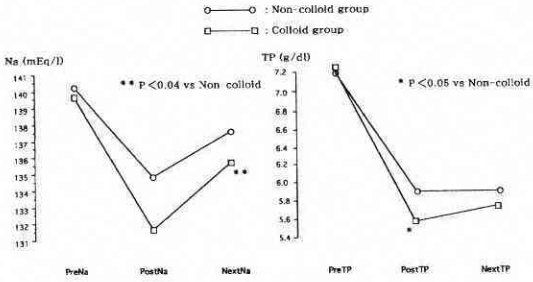

Fig. 1 Mean changes in serum sodium and total protein level before and after TURP

were carried out using Storz Iglesias continuous fiow resectoscope (26 F) and irrigation fluid was sorbitol 3% (Uromatic S™, Baxter) with a pressure head of approximately 50-70 cm above the operation table. At the end of operation, Foley three way catherter (24 F) was inserted and drawn light with continuous fiow of 0.9% saline until the next morning. The Foley catherter was removed on the 3-4 th postoperative day. Serum sodium, potassium, total protein level, hemoglobin and hematcrit etc. were measured before, immediately after the operation and on the first postoperative day. Plasma osmotic pressure were also measured immediately before and after the operation.

For determination of fluid dynamics in

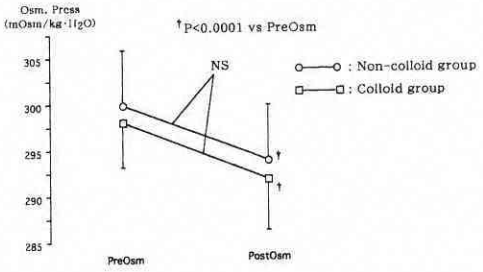

Fig. 2 Changes in plasma osmotic pressure before and after TURP

TURP patient, first ΔECF (chamge in the volume of extracellular fluid) was calculated from serum sodium change (ΔNa) between pre and post operation as described by Norris[3].

$$\Delta ECF(1) = \text{pre ECF} \times \frac{Napre - Napost}{Napost}$$

$$\text{preECF} = 0.2 \times \text{Body weight}$$

Napre: preoperative serum Na concentration (mEq/l)

Napost: postoperative serum Na concentration (mEq/l)

Next, blood loss was calculated from hematcrit changes using next formula. Because in almost patients in TURP, even developing the TURP syndrome, circulating blood volume is returned to preoperative level on the first postoperative day by endogenous homeostatic correction[4].

$$\text{Blood loss (1)} = \text{preCBV} \times \frac{Htpre - Htnext}{Htpost}$$

$$\text{preCBV} = 0.07 \times \text{Body weight}$$

Htpre: preoperative hematocrit (%)

Htpost: postoperative hematocrit (%)

Htnext: hematocrit on the next day (%)

Absorption volume of irrigation fluid was calculated as ΔECF-intraoperative infusion volume+blood loss. In addition, correlation between absorption volume of irrigant and blood loss, between serum sodium fall and some determinants were evaluated.

Table 2 Signs and Symptoms in 8 Patients of the TURP Syndrome

Patient No.	Age (yrs)	BW (kg)	Colloid or Non-colloid	Absorption Volume (l)	ΔNa (mEq/l)	Blood Loss (l)	Dyspnea	Nausea Vomiting	Abdominal Pain
1	76	54	Colloid	1.79	17	1.41		+	
2	75	50	Colloid	1.92	22	0.96	+		
3	70	50	Colloid	1.57	13	1.17	−		
4	79	58	Colloid	1.32	10	1.23		+	
5	76	48	Colloid	0.34	13	0.75			+
6	70	47	Colloid	0.78	9	1.30			+
7	66	61	Colloid	2.15	16	1.17		+	
8	83	47	Non-colloid	2.29	21	1.50		+	
mean ±SD	74±5	52±5		1.51±0.61	15±5	1.15±0.26			

Table 3 Characteristics of the Patients in Three Groups

	Age (yrs)	BW (kg)	Duration (min)	Absorption Volume (l)	ΔNa (mEq/l)	Blood Loss (l)
TURPS group (n=8)	74±5	52±5*	88±19	1.51±0.61**	15±5**	1.15±0.26**
Late TURPS group (n=9)	70±5	61±6	102±14†	2.14±1.36**	18±9**	1.30±0.44**
Asympt. group (n=58)	71±8	59±8	73±23	0.20±0.31	3±5	0.56±0.37

* P<0.02 vs Late TURPS group　† P<0.002 vs Asympt. group　mean±SD
** P<0.0001 vs Asympt. group

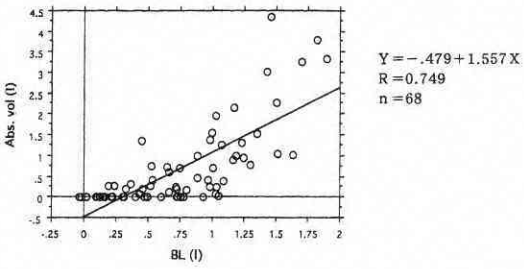

Fig. 3 Correlation between absorbed volume of irrigant (Abs. vol) and blood loss (BL)

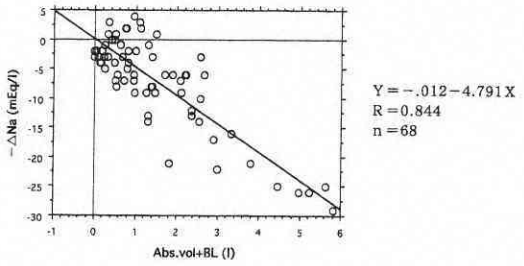

Fig. 4 Correlation between serum Na fall (ΔNa) and absorbed volume of irrigant (Abs. vol)+blood loss (BL)

The TURP syndrome was defined by three criteria as described by Ghanem and Ward[4]: ① Serum sodium fall (more than 15 mEq/*l*) ② Hypotension, bradycardia or arrythmia ③ Clinical signs of central nervous system such as nausea, vomiting, restless, confusion etc. We defined the TURP syndrome as fulfilled these three criteria. And then the "late TURP syndrome" was defined as fulfilled three criteria postoperatively in ward or fulfilled two of three criteria. All data are expressed as mean±SD. Statistical analysis included paired, nonpaired t-test and linear regression. $P<0.05$ was considered significant.

Results

There were no significant differences in age, body weight, surgical duration, prostate weight resected and intraoperative infusion volume between the two groups (Table 1). There were also no significant differences between the groups in preoperative serum electrolytes level, total protein level, hematocrit and plasma osmotic pressure. Total protein level immediately after TURP and serum sodium level on the first postoperative day were significantly lower in the Colloid group than in the Non-colloid group (Fig. 1). Although plasma osmotic pressure were reduced significantly after TURP in both groups, there were no significant differences between the groups (Fig 2).In calcuated variables, there were no significant differences in absorption volume of irrigant and blood loss between the groups.

Seven patients in the Colloid group and one in the Non-colloid group developed the TURP syndrome (Table 2). Likewise four patients in

the Colloid group and five patients in the Non-colloid group developed the late TURP syndrome. In the patients in these two syndromes, the volume of irrigation fluid absorbed and blood loss were significantly greater than in asymptomatic patients group (Table 3).

In all patients, there was a significant correlation between absorption volume of irrigation fluid and blood loss ($R=0.75$, $P<0.0001$) (Flg 3). There was also significant correlation between serum sodium fall (ΔNa) and the volume of irrigant absorbed plus blood loss ($R=0.84$, $P<0.0001$) (Fig 4).

Discussion

This report shows that intraoperative colloid infusion diminishes postoperative serum sodium and total protein level as compared with crystalloid infusion undergoing TURP. Baraka et al[1]. found that colloid prehydration (3% gelatin) reduced the incidence and degree of postspinal hypotension compared with crystalloid prehydration undergoing TURP. Colloid solution can retain for a longer period in the vascular space and hence can more effectively expand the blood volume. During TURP, however, intravascular volume rapidly changes from hypervolemia to hypovolemia[5]. This change depends on the volume and speed of absorption of irrigation fluid and blood loss. In this study, blood loss over 600 m*l* in elderly patients might induce hypovolemia. As concerns blood loss, intraoperative colloid infusion might be more effective than crystalloid infusion. Colloid solution 500 m*l* would expand the vascular space to compensate for intravascular volume loss. However, seven of eight patients who developed the TURP syndrome was in the Colloid group. And only one patient in Non-colloid group developed the syndrome. And then four of nine patients who developed the late TURP syndrome were in the Colloid group. These results suggest that colloid solution is not effective for prevention of developing the TURP syndrome. Moreover, these results show that the cause of the TURP syndrome are not only blood loss but also other factors.

Hypotension in the TURP syndrome may result from hypovolemia and/or a disturbance of capillary circulation, Irrigation fluid absorbed has been reported to retain in the vascular space initially and then leak into the interstitial space 30-60 minutes after the start of absorption[5]. Besides, blood loss makes intravascular volume reduce to hypovolemia. Many previous reports pointed out that various signs of the TURP syndrome were related to a disturbence of capillary circulation, which induced interstitial edema[4,6]. We also reported that one of initial signs of the TURP syndrome was low Spo_2 probably because of interstitial edema[2]. Ghanem and Ward[4] pointed that hypo-albuminemia lowered the oncotic pressure and disturbed Starling's forces across the capillary membrane to cause interstitial edema. Our results of this study showed that intraoperative colloid infusion lowered total protein level immediately after TURP compared with crystalloid. As colloid expands and retains in the vascular space for a longer period, more profound hemodilution may occur to lower serum protein and sodium level. Futhermore, subclinical intravascular coagulopathies are observed more often in prostatic surgery because of high content of prolytic enzymes in the prostate[7]. The hypoproteinemia may also accelerate this coagulopathy. Above all, probably transient hemodilution with hypoproteinemia in the Colloid group may be related to developing the TURP syndrome. Arai et al.[9] reported similar results that colloid solution (6% hydroxyethylstarch, Hespander™) in TURP

diminished plasma sodium level and plasma osmotic pressure compared with crystalloid solution (0.9% saline). And then they reported that there was a few cases of developing water intoxication in the colloid infusion group due to hypoosmolality and increase in ECF[9].

Many reports have shown that hypoosmorality is a main cause of developing the TURP syndrome[4,8]. Especially, the delayed signs of central nervous system in the TURP syndrome are caused by hypoosmorality when using glycine as irrigation fluid. In our results, although plasma osmotic pressure significantly decreased after TURP, there was no significant differences between symptomatic and asymptomatic patients. There was also no significant differences between in the Colloid and the Non-colloid group. The reason for this may be using sorbitol, osmotically active as irrigation fluid. In summary, intraoperative colloid infusion was not effective for prevention of developing the TURP syndrome, which was caused by not only blood loss but also hemodilution with hypoproteinemia.

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