Influence of caudal block on nephro-ureteral recovery after bilateral ureteroneocystostomy in infants with vesicoureteral reflux

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ABSTRACT

Influence of caudal block on nephro-ureteral recovery after bilateral ureteroneocystostomy in infants with vesicoureteral reflux

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Ureteroneocystostomy (UNC) is the treatment of choice for unresolved vesicoureteral reflux (VUR). Caudal block is widely used in children undergoing genitourinary surgery. Recently, caudal block was reported to be associated with surgical outcomes. We aim to assess the effect of caudal block in nephro-ureteral recovery on infants after bilateral UNC.

This study included 121 infants who underwent bilateral UNC, of whom 63 received caudal block (caudal block group) and 58 did not (non-caudal block group). In all study infants, a ureteral catheter was placed in one of the two ureters to relieve transient ureteral obstruction after UNC. Additionally, a urethral catheter was placed at the end of UNC. In order to evaluate short-term nephro-ureteral recovery, postoperative urinary output for each catheter was assessed for 48 hr after surgery. Durations of urethral/ureter catheter placement and hospitalization, serum creatinine levels and development of hydronephrosis were assessed to evaluate medium and long- term nephro-ureteral recovery.

Patient characteristics, VUR severity and intraoperative profiles were comparable between the two groups. The incidence of oliguria at the urethral catheter during the first 8 hr after surgery was significantly higher than the non-caudal block group (79.5% vs. 55.2%: P=0.006). Multivariate logistic regression analysis revealed that the incidence of oliguria at the urethral catheter was associated with caudal block, duration of anesthesia and intraoperative dexamethasone administration. However, there were no significant differences in medium and long-term nephro-ureteral recovery profiles between the two groups.

In conclusion, caudal block could adversely affect nephro-ureteral recovery immediately after surgery in infants undergoing bilateral UNC. Caudal block does not appear to affect medium and long-term recovery after bilateral UNC.

Key words: caudal block, nephro-ureteral recovery, oliguria, ureteroneocystostomy, vesicoureteral reflux

ureteroneocystostomy in infants with vesicoureteral reflux

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I. INTRODUCTION

Vesicoureteral reflux (VUR) is a condition in which urine flows retrograde or backward, from the bladder into the ureters or the kidney. It is one of the more important causes of nephropathy in children.[1] Medical treatment is recommended in children with low grade reflux (grades I-III) which, in most cases, resolves spontaneously. However, in children with recurrent or breakthrough urinary tract infections (UTI) and unresolved VUR, surgical management by ureteroneocystostomy (UNC) is the treatment of choice.[2] Ureteroneocystostomy which involves to reimplantation of the ureter into the bladder has been reported to have a success rate of over 95%.[2]

Caudal block under general anesthesia is widely employed in children undergoing lower abdominal and genitourinary surgery.[3] It may affect hemodynamic stability as a result of its symphatolytic vasodilating effects. Several studies have demonstrated the negative effects of caudal block. Epidural analgesia has been shown to dilate systemic vasculature in children below the age of 8 years,[4] and caudal block has been reported to increase the blood flow and diameter of the dorsalis pedis artery in children.[3] Moreover, in children undergoing hypospadias repair, caudal block has been shown to cause vasodilation and venous pooling in the penis, consequently increasing the penile volume.[5] In addition, an animal study reported that epidural block could aggravate edema at peri-anastomosis areas in mesenteric tissue.[6] Therefore we hypothesized that these effects of caudal block might affect reimplantation sites and might influence nephro-ureteral recovery in infants after bilateral UNC.

The purpose of this study was to determine the influence of caudal block on nephron-ureteral recovery after bilateral UNC in infants. In our study, nephro-ureteral recovery was defined as recovery of renal function and patency of reimplantation sites between the ureter and the bladder after UNC.

II. MATERIALS AND METHODS

1. Patients

The study retrospectively reviewed data collected from a cohort of infants below 12 months of age, who underwent bilateral UNC (Cohen cross-trigonal technique) for VUR between January 2010 and December 2014. Patients with co-existing abnormalities, including megaureter, duplex system, ectopic ureter, bladder outlet obstruction (because of posterior urethral valve or other factors), and neurogenic bladder as well as those without ureteral catheter placement or with bilateral ureteral catheter placement were excluded from this study. The study protocol was approved by the institute research committee of the Severance Hospital, Yonsei University Health System. The requirement for patient informed consent was waived because of the retrospective nature of the study.

2. Clinical management

In this study, all UNC procedures were performed by a single pediatric urologist, and the protocols for peri- and post-operative management were standardized. In infants, a ureteral catheter was routinely placed in one of the two ureters to avoid the clinical consequences of transient ureteral obstruction. The ureter associated with the kidney that exhibited either relatively poor function on dimercaptosuccinic acid (DMSA) imaging or a high grade of VUR was usually selected for ureteral catheter placement. Placement was performed under direct visualization of the ureter during UNC. The opposite side of the ureteral catheter was brought out percutaneously in the suprapubic area. Urethral catheter placement was also performed.

In order to evaluate short-term nephro-ureteral recovery, postoperative urinary output from each catheter was separately assessed by ward nurses at least every 8 hr until the catheters were removed. In case of patients with ureteral obstruction with clinically significant effects, such as electrolyte imbalance or increase in serum creatinine levels, dexamethasone was administered at the discretion of the urologist as an empirical treatment to resolve obstruction due to edema. The ureteral catheter was removed when urine from the urethral catheter reached a volume equivalent to that from the ureteral catheter, which indicated recovery of nephro-ureteral function to a comparable extent. Patients were discharged from the hospital after removal of the urethral catheter. Durations of urethral/ureter catheter placement and hospitalization were recorded for evaluation of medium-term nephron-ureteral recovery. Long-term nephron-ureteral recovery was evaluated by postoperative follow-up evaluations, including serum creatinine assay and renal ultrasonography, at 1, 6, and 12 months after surgery.

Anesthesia was induced according to the routine practice for pediatric anesthesia at our institution. Administration of caudal block was based on the preference or experience of the attending anesthesiologist. Caudal block was administered with 0.15–0.2% ropivacaine at a dosage of 1.0–1.5 mL/kg after induction of general anesthesia. Patients requiring additional analgesia intraoperatively or in the post-anesthetic care unit (PACU) were administered intravenous fentanyl. In addition, some of the anesthesiologists administered dexamethasone (usually at a dose of 0.1–0.2 mg/kg) intraoperatively at their discretion in order to reduce postoperative nausea/vomiting and/or the use of analgesics. Irrespective of caudal block administration, parent- or nurse-controlled intravenous analgesia (PNCIA) with fentanyl was used for pain relief in the general ward for 2 days after surgery. Patients with inadequate PNCIA were administered 1 mg/kg intravenous tramadol by the pediatric urologist.

3. Data collection

Data, including patient characteristics, VUR grade, intraoperative parameters, postoperative recovery, and surgical outcomes, were collected retrospectively from electronic medical charts. Preoperative VUR grade, serum creatinine level, and relative renal function assessed by DMSA imaging were recorded for evaluation of preoperative VUR. Intraoperative data included durations of surgery and anesthesia, fluid administration, blood loss, and dexamethasone administration.

For evaluation of nephro-ureteral recovery, renal recovery was inferred from urinary output through the ureteral catheter, and ureter recovery was inferred from urinary output through the urethral catheter. Urinary output through the urethral catheter could be directly influenced by ureteral obstruction, and urinary output through the ureteral catheter, while unaffected by ureteral obstruction, could be affected by renal function. Therefore, urinary output was assessed separately according to the draining catheter. Thus, incidence of postoperative oliguria could be an indirect substitute for nephro-ureteral recovery. The volume of fluid administered for 48 hr after surgery was also determined. Additional recovery profiles during hospital stay, including duration of urethral/ureteral catheter placement, postoperative dexamethasone administration for managing ureteral obstruction due to edema, and duration of hospital stay, were evaluated. For evaluating long-term nephro-ureteral recovery profiles, serum creatinine levels at 6 months after surgery and recurrence of UTI and development/aggravation or hydronephrosis over 12 months after surgery were assessed.

4. Endpoints

The primary endpoint of this study was the influence of caudal block on postoperative nephro-ureteral recovery evaluated through urinary output from the urethral/ureter catheters in infants after bilateral UNC. According to our hypothesis, vasodilation and/or tissue edema resulting from caudal block causes obstruction of urinary flow from the ureter to the bladder. Accordingly, immediate postoperative oliguria could strongly imply an association between caudal block and nephro-ureteral recovery.

Oliguria in infants is generally defined as an output of less than 1 mL/kg/hr.[7] However, we defined oliguria as an output of less than 0.5 mL/kg/hr in each ureter because urine separated into two catheters.

5. Statistical analysis

Continuous variables are expressed as mean (standard deviation [SD]) or median (range), and nominal variables are expressed as number (n) and proportion (%). Student's t-test or the Mann–Whitney U test was used to perform intergroup comparison of continuous data after confirming normal distribution using the Shapiro–Wilk and Kolmogorov–Smirnov tests. Nominal variables were compared using the chi-square and Fisher's exact tests. Univariate and multivariate logistic regression analyses were performed to analyze the risk factors for occurrence of oliguria. Variables with a P-value < 0.10 in univariate analysis were subjected to multivariate logistic regression analysis to identify independent predictors. The odds ratios (ORs) and associated 95% confidence intervals (CIs) were also calculated. All data were statistically analyzed using the IBM SPSS software version 20 (IBM Corp., Armonk, NY, USA). A P-value < 0.05 was considered statistically significant.

III. RESULTS

Of 152 infants who underwent bilateral UNC for VUR during the study period, 121 were enrolled in this study (Figure 1). Among these patients, 63 (52%) received caudal block (caudal block group) and 58 (48%) did not (non-caudal block group).

Patient characteristics were comparable between the two groups (Table 1). Table 2 shows the results of comparison of intraoperative data between the two groups. No significant differences in the duration of surgery or anesthesia, volume of fluid administered, blood loss, or number of patients who received dexamethasone during anesthesia were noted between the two groups. Although the numbers of patients who received fentanyl in the PACU and tramadol for 2 days after surgery in the non-caudal group were greater compared to those in the caudal block group, there were no significant intergroup differences. Table 3 shows the volume of fluid administered and incidence of oliguria at each catheter, which was assessed every 8 hr after surgery, in both groups. Although no significant intergroup differences were noted in the volume of fluid administered, the incidence of oliguria at the urethral catheter in the caudal block group was significantly higher compared to that in the non-caudal block group in the first 8 hr ($P = 0.006$) after surgery as well as the subsequent 8 hr ($P = 0.009$). However, the incidence of oliguria at the ureteral catheter was similar between the two groups.

The risk factors for oliguria at the urethral catheter in the first 8 hr after surgery were only analyzed using logistic regression (Table 4) because the effect of caudal block is known to persist only for 4–6 hr.[8] In the univariate model, caudal block, duration of anesthesia, and intraoperative dexamethasone administration were associated with oliguria. These factors continued to be associated with oliguria in the multivariate model as well. Caudal block was associated with an over 3-fold increase in the risk of oliguria at the urethral catheter in the first 8 hr after UNC (95% CI, 1.303–7.228; $P = 0.010$). On the other hand, intraoperative dexamethasone administration was associated with a reduction in the incidence of oliguria (OR = 0.339).

Additional recovery profiles were not significantly different between the two groups (Table 5). After hospital discharge, 4 patients (2 of each group) exhibited newly developed hydronephrosis of grade I diagnosed by ultrasonography which persisted for over 12 months after surgery. Preoperative hydronephrosis was noted in 10 patients; however, none of these patients exhibited aggravation of hydronephrosis after surgery. Furthermore, no clinical evidence of UTI was found in the enrolled patients at 12 months after surgery.

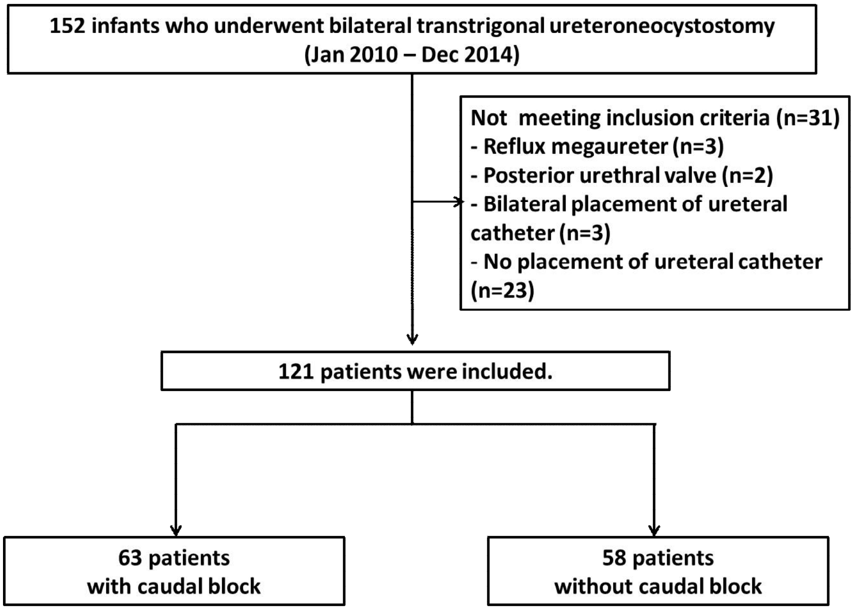

Figure 1. Flow chart summarizing patient enrolment.

Table 1. Patients' characteristics

	No caudal block (n=58)	Caudal block (n=63)	P-value
Age (months)	6.8 (2.2)	7.0 (2.3)	0.671
Weight (kg)	8.6 (1.2)	8.6 (1.2)	0.938
Height (cm)	69.7 (6.4)	69.9 (4.8)	0.876
BMI (kg/m^2)	17.9 (2.1)	17.6 (2.0)	0.550
Sex (M/F)	46/12	55/8	0.328
Serum creatinine (mg/dL)	0.31 (0.10)	0.33 (0.13)	0.308
VUR grade			
UC side	4 (3-4)	4 (4-5)	0.181
non-UC side	4 (3-4)	4 (3-4)	0.782
Split renal function on DMSA scan (%)			
UC side	47.5 (15.0)	46.8 (14.9)	0.814
non-UC side, %	52.5 (15.0)	53.3 (14.9)	0.788

Data are shown as mean (SD), median (IQR), or number of patients. VUR, vesicoureteral reflux; UC, ureter catheter; DMSA, dimercaptosuccinic acid.

Table 2. Intraoperative data and postoperative analgesic use

	No caudal block (n=58)	Caudal block (n=63)	P-value
Duration of surgery (min)	130.4 (36.2)	130.7 (32.6)	0.966
Duration of anesthesia (min)	153.3 (38.9)	160.2 (34.6)	0.304
Administered fluid (mL)	149.8 (69.4)	161.6 (67.2)	0.344
Blood loss (mL)	5.9 (12.4)	5.9 (18.1)	0.997
Intraoperative dexamethasone administration	27 (46.6%)	32 (50.8%)	0.717
Fentanyl administration in PACU	3 (5.2%)	1 (1.6%)	0.349
Tramadol administration for 2 days after surgery	19 (32.8%)	11 (17.5%)	0.060

Data are shown as mean (SD) or number of patients (proportion, %). PACU, post-anesthetic care unit.

Table 3. Fluid intake and urinary output for 48 hr after the surgery

	No caudal block (n=58)	Caudal block (n=63)	P-value
Administered fluid (mL)			
0-8 hr	230.3 (92.3)	251.4 (109.8)	0.256
8-16 hr	244.3 (89.0)	258.6 (92.8)	0.390
16-24 hr	224.1 (79.6)	250.9 (92.5)	0.090
24-32 hr	240.2 (85.3)	244.8 (79.5)	0.759
32-40 hr	230.2 (93.1)	234.8 (85.6)	0.779
40-48 hr	213.7 (72.9)	227.9 (86.7)	0.354
Oliguria frrom urethral catheter			
0-8 hr	32 (55.2%)	50 (79.4%)	0.006
8-16 hr	18 (31.0%)	34 (54.0%)	0.009
16-24 hr	15 (25.9%)	25 (39.7%)	0.077
24-32 hr	15 (25.9%)	15 (23.8%)	0.479
32-40 hr	15 (25.9%)	20 (31.7%)	0.549
40-48 hr	17 (29.3%)	16 (25.4%)	0.686
Oliguria from ureter catheter			
0-8 hr	25 (43.1%)	22 (34.9%)	0.455
8-16 hr	5 (8.6%)	2 (3.2%)	0.258
16-24 hr	1 (1.7%)	1 (1.6%)	1.000
24-32 hr	1 (1.7%)	0 (0%)	0.479
32-40 hr	0 (0%)	1 (1.6%)	1.000
40-48 hr	0 (0%)	1 (1.6%)	1.000

Data are shown as mean (SD) or number of patients (proportion, %).

Table 4. Analysis of risk factors for 8 hr-oliguria after ureteroneocystostomy

	Univariate analysis		Multivariate analysis	
	OR (95% CI)	P-value	OR (95% CI)	P-value
Age (months)	0.961 (0.810-1.141)	0.651	-	-
Sex (Female vs. Male)	1.132 (0.399-3.213)	0.815	-	-
BMI (kg/m^2)	1.108 (0.914-1.343)	0.296	-	-
Preoperative Cr (mg/dL)	0.431 (0.017-11.225)	0.613	-	-
Spilt renal function of non-UC side (%)	1.015 (0.989-1.042)	0.260	-	-
VUR grade of non-UC side			-	-
I	ref	ref	-	-
II	1.857 (0.293-11.756)	0.511	-	-
III	3.000 (0.489-18.415)	0.235	-	-
IV	2.077 (0.368-11.735)	0.408	-	-
V	1.667 (0.275-10.094)	0.578	-	-
Caudal block	3.125 (1.404-6.955)	0.005	3.069 (1.303-7.228)	0.010
Duration of surgery (min)	1.000 (0.997-1.021)	0.129	-	-
Duration of anesthesia (min)	1.012 (1.000-1.024)	0.043	1.017 (1.004-1.032)	0.014
Administered fluid in OR (mL)	0.998 (0.993-1.004)	0.574	-	-
Estimated blood loss and urine output (mL)[1]	0.991 (0.968-1.014)	0.449	-	-
Dexamethasone administration in OR	0.444 (0.210-0.980)	0.044	0.339 (0.141-0.815)	0.016
Administered fluid in ward (mL)	0.998 (0.994-1.002)	0.269	-	

[1]Estimated blood loss and urine output were included in the total.
CI, confidence interval; OR, odds ratio.

Table 5. Additional recovery profiles after the surgery

	No caudal block (n=58)	Caudal block (n=63)	P-value
Postoperative dexamethasone administration	5 (8.6%)	10 (15.9%)	0.277
Duration of urethral catheter (hr)	97.9 (48.5)	92.3 (48.2)	0.524
Duration of ureter catheter (hr)	69.9 (47.6)	63.4 (42.8)	0.431
Hospitalization duration after surgery (days)	4 (3-6)	4 (3-6)	0.578
Serum creatinine at 6 months after surgery (mg/dl)	0.30 (0.08)	0.31 (0.10)	0.521
Newly developed hydronephrosis	2 (3.4%)	2 (3.2%)	1.000

Data are shown as mean (SD), median (IQR), or number of patients (proportion, %).

IV. DISCUSSION

Caudal block could adversely affect short-term nephro-ureteral recovery in infants after bilateral UNC. However, there were no significant differences in medium and long-term recovery profiles between the two groups in the present study. Infants who received caudal block exhibited a greater incidence of oliguria at the urethral catheter in the first 8 hr after surgery than those who did not. The durations of urethral/ureteral catheter placement and hospital stay were comparable between the two groups. In long-term follow-up, there were no significant differences in serum creatinine levels at 6 months, nor in incidence of newly developed hydronephrosis at 12 months after surgery between the two groups. None of the patients with preoperative hydronephrosis experienced aggravation.

Several previous studies support our hypothesis that caudal block affects urinary flow by increasing the volume of tissue. Kundra et al. demonstrated that caudal block increases penile volume by 27% in children undergoing hypospadias repair.[5] Caudal block causes an increase in penile volume because of vasodilation and pooling of blood, which could lead to postoperative edema and inadequate or delayed wound healing.[5,9] Hong et al. reported that caudal block results in increased arterial flow because of segmental sympathetic efferent block and reduced resistance of vessels.[3] Vasodilation can occur in any region where sympathetic efferent response is blocked by caudal block.[3]

The ureter is innervated by nerves that originate from the T12-L1 segments of the spinal cord. Payen et al. reported that caudal block with 0.5% bupivacaine at a dosage of 3.25 mg/kg induced spinal block at the T10 levels in infants.[10] Shin and Hong reported spinal block at the T11 and T6 levels, respectively, upon caudal block with 0.15% ropivacaine at dosages of 1.0 and 1.5 mL/kg.[3,11] At our institution, the local anesthetic dosage for caudal block, determined by the preference or familiarity of the attending anesthesiologist, was in the range of

0.15–0.2% ropivacaine (1.0–1.5 mL/kg). These doses are sufficient for inducing spinal block up to the ureter level. Therefore, caudal block could block the sympathetic efferent nerves that innervate the ureter, thus causing vasodilation and venous pooling of the ureter.

Furthermore, there is experimental evidence that epidural block increases the water content in mesenteric tissue after mesenteric resection and anastomosis,[6] which indicates that caudal block could worsen tissue edema after surgical manipulation. This phenomenon is associated with the Starling forces. Starling defined the physiologic forces governing the balance of water between two compartments, including the gradient between intravascular and extravascular hydrostatic pressures, differences in oncotic pressure between the interstitial space and plasma, and permeability of the blood vessel wall.[12-14] Neuraxial blocks produce variable cardiovascular changes by blocking sympathetic outflow. These effects cause vasodilation of venous capacitance vessels and pooling of blood in the viscera.[15] Arterial vasodilation also decreases systemic vascular resistance.[15]

In addition, sympathomimetics have been shown to modify development of edema during inflammatory reactions.[6] This mechanism is very complex, but the net effect of sympathomimetics is known to antagonize inflammation, especially by β-adrenergic stimulation.[16] Therefore, the sympatholytic effects of neuraxial block promotes inflammatory responses[6] by mediating release of inflammatory mediators such as histamine, serotonine, prostaglandin E2 and leukotriene B4,[13,14] which then cause vascular changes, including vasodilation and increased blood vessel permeability. The changes, in turn, result in the movement of plasma into tissues.[17] Thus, vasodilation and pooling of blood result in increased intravascular hydrostatic pressure, while increased permeability results in increased interstitial oncotic pressure, and these two conditions together predispose tissues to edema.

In the present study, intraoperative dexamethasone administration decreased the risk of oliguria at the urethral catheter.[18-20] Dexamethasone has been shown to be effective in reducing edema in various tissues and is used as an empirical therapy for transient ureteral obstruction after UNC at our institution. Therefore, the decrease in risk of oliguria at the urethral catheter after intraoperative dexamethasone administration indicates that oliguria at the urethral catheter was related to tissue edema in the ureter and reimplantation site. Considering these findings, caudal block could increase thickness of the ureteral wall, thus compromising patencies of the ureter and reimplantation site.

Our results indicate an association between the duration of anesthesia and oliguria at the urethral catheter. The longer the duration of anesthesia, the greater the risk one runs of oliguria at the urethral catheter. There is a possibility that prolonged duration is associated with persistence of the vasodilating properties of volatile anesthetics,[21] which can compromise urinary flow through the ureter.

In the present study, there were no differences in the parameters related to postoperative recovery between the two groups, (Table 5) possibly because our study lacked sufficient power to detect these differences. The caudal block group had a greater number of patients who received postoperative dexamethasone administration for clinically significant ureteral obstruction than the non-caudal block group, although the difference was not statistically significant. There were also no significant intergroup differences in the duration of urethral/ureteral catheter placement.[22] This was because most of the obstructions were transient and self-limited. Clinically significant ureteral obstruction can increase the duration of hospitalization as well as the time required for resolution of postoperative hydronephrosis, and cause deterioration of renal function, resulting in elevated serum creatinine levels. Further studies are warranted to clarify these associations.

The present study has some limitations. First, since this is a retrospective study, there could have been differences in anesthetic care between the two study groups. At our institution, caudal block for UNC is generally administered by anesthesiologists specialized in pediatric anesthesia, and not by those without the relevant specialization. This might have resulted in intergroup differences in anesthetic care. However, given that there was no difference in the incidence of oliguria at the ureteral catheter between patients with and without caudal block, it is unlikely that the difference in the incidence of oliguria at the urethral catheter resulted from intergroup differences in perioperative anesthetic care.

Second, we could not confirm the cause of oliguria at the urethral catheter because the patencies of the ureter and reimplantation site were not assessed. In fact, it is possible that, in a few cases, oliguria resulted from mechanical obstruction of the ureter, such as that of ureteral kinking, which resolved spontaneously. This is an inherent limitation to retrospective data analysis.

V. CONCLUSION

Caudal block increases the risk of oliguria in infants immediately after UNC. However, no detrimental effects of caudal block on the durations of urethral/ureter catheter placement and hospitalization, renal function, or hydronephrosis were noted. Given that the present findings demonstrate an association between caudal block and immediate postoperative oliguria, the underlying mechanism and impact on surgical outcomes should be clarified in future studies.

REFERENCES

1. Dogan HS, Bozaci AC, Ozdemir B, Tonyali S, Tekgul S. Ureteroneocystostomy in primary vesicoureteral reflux: critical retrospective analysis of factors affecting the postoperative urinary tract infection rates. Int Braz J Urol 2014.
2. Routh JC, Bogaert GA, Kaefer M, Manzoni G, Park JM, Retik AB, et al. Vesicoureteral reflux: current trends in diagnosis, screening, and treatment. Eur Urol 2012;61:773-82.
3. Hong JY, Ahn S, Kil HK. Changes of dorsalis pedis artery flow pattern after caudal block in children: observational study using a duplex sonography. Paediatr Anaesth 2011;21:116-20.
4. Patel D. Epidural analgesia for children. Continuing Education in Anaesthesia, Critical Care & Pain 2006;6:63-6.
5. Kundra P, Yuvaraj K, Agrawal K, Krishnappa S, Kumar LT. Surgical outcome in children undergoing hypospadias repair under caudal epidural vs penile block. Paediatr Anaesth 2012;22:707-12.
6. Fedder A, Dall R, Laurberg S, Rodt SA. Epidural anaesthesia with bupivacaine does not cause increased oedema in small gut anatomoses in pigs. Eur J Anaesthesiol 2004;21:864-70.
7. Arant BS, Jr. Postnatal development of renal function during the first year of life. Pediatr Nephrol 1987;1:308-13.
8. Lonnqvist PA. Adjuncts to caudal block in children--Quo vadis? Br J Anaesth 2005;95:431-3.
9. Baltogiannis DM, Charalabopoulos AK, Giannakopoulos XK, Giannakis DJ, Sofikitis NV, Charalabopoulos KA. Penile Erection During Transurethral Surgery. Journal of Andrology 2006;27:376-80.
10. Payen D, Ecoffey C, Carli P, Dubousset AM. Pulsed Doppler ascending aortic, carotid, brachial, and femoral artery blood flows during caudal

anesthesia in infants. Anesthesiology 1987;67:681-5.

11. Shin SK, Hong JY, Kim WO, Koo BN, Kim JE, Kil HK. Ultrasound evaluation of the sacral area and comparison of sacral interspinous and hiatal approach for caudal block in children. Anesthesiology 2009;111:1135-40.
12. Cho S, Atwood JE. Peripheral edema. The American Journal of Medicine 2002;113:580-6.
13. Claesson-Welsh L. Vascular permeability—the essentials. Upsala Journal of Medical Sciences 2015;120:135-43.
14. Nagy JA, Benjamin L, Zeng H, Dvorak AM, Dvorak HF. Vascular permeability, vascular hyperpermeability and angiogenesis. Angiogenesis 2008;11:109-19.
15. Veering BT, Cousins MJ. Cardiovascular and pulmonary effects of epidural anaesthesia. Anaesth Intensive Care 2000;28:620-35.
16. Pongratz G, Straub RH. The sympathetic nervous response in inflammation. Arthritis Research & Therapy 2014;16:504.
17. Holte K, Sharrock NE, Kehlet H. Pathophysiology and clinical implications of perioperative fluid excess. British Journal of Anaesthesia 2002;89:622-32.
18. Markovitz BP, Randolph AG. Corticosteroids for the prevention of reintubation and postextubation stridor in pediatric patients: A meta-analysis. Pediatr Crit Care Med 2002;3:223-6.
19. Siasios I, Fountas K, Dimopoulos V, Pollina J. The role of steroid administration in the management of dysphagia in anterior cervical procedures. Neurosurg Rev 2016.
20. Kaal EC, Vecht CJ. The management of brain edema in brain tumors. Curr Opin Oncol 2004;16:593-600.
21. Izumi K, Akata T, Takahashi S. The action of sevoflurane on vascular smooth muscle of isolated mesenteric resistance arteries (part 1): role of

endothelium. Anesthesiology 2000;92:1426-40.

22. Rosman BM, Passerotti CC, Kohn D, Recabal P, Retik AB, Nguyen HT. Hydronephrosis following ureteral reimplantation: when is it concerning? J Pediatr Urol 2012;8:481-7.

ABSTRACT (IN KOREAN)

방광요관역류 환아의 양쪽 요관방광재문합술에서
미추차단이 신장-요관 회복에 미치는 영향

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이현정

방광요관역류는 소변이 상부 요관으로 비정상적으로 역류하는 현상으로, 역류의 등급이 높거나 열성 요로감염이 반복되는 경우 수술적 치료가 필요하다. 요관방광재문합술은 방광에 요관을 심어주는 수술로서 소아의 방광요관역류의 치료로써 널리 이용되고 있다. 미추차단은 소아의 비뇨생식기 수술에 흔히 쓰이는 부위마취로, 최근 연구에 따르면 미추차단과 수술적 예후가 연관이 있다고 한다. 따라서 본 연구는 이러한 현상이 양쪽 요관방광재문합술을 받는 환아의 신장-요관 회복에 미치는 영향을 알아보고자 한다.

본 연구는 방광요관역류로 양쪽 요관방광재문합술을 받는 12개월 이하의 환아를 대상으로 미추차단 군과 미추차단을 받지 않은 군으로 나누어 후향적 연구를 진행하였다. 모든 환아는 수술 후 요관 폐쇄를 막기 위해 한쪽 요관에 카테터를 거치하였고, 동시에 요도 카테터도 거치하였다. 술 후 48시간 동안 소변량을 조사하여 요도/요관 폐쇄로 인한 단기 신장 –요관 회복을 평가하였고, 각 카테터들의 거치기간, 재원일수, 수술 후 혈중 크레아티닌 농도, 수술 후 수신증 발생 유무 등을 수집하여 중, 장기 신장-요관 회복을 평가하였다.

환자군의 기본정보, 수술 전 방광요관역류 등급, 마취와 수술

항목에서 두 군간 큰 차이는 없었다. 수술 후 첫 8시간동안 요도관에서의 핍뇨의 발생률은 미추차단을 시행한 군에서 현저히 높았다. (79.5% vs. 55.2%, P=0.006) 수술 후 미추차단 군에서 핍뇨가 발생하는 관련인자로 미추차단, 마취시간, 수술 중 덱사메타손 정주 등이 작용했다. 각 카테터들의 거치기간, 수술 후 혈중 크레아티닌 농도, 재원일수, 수술 후 수신증 발생 유무 등 중, 장기적 신장-요관 회복에서 두 군간 의미 있는 차이는 없었다.

결론적으로, 미추차단은 양쪽 요관방광재문합술을 받는 12개월 이하의 소아에서 수술 직후 신장-요관 회복을 저해한다. 중-장기적인 회복 정도는 두 군 간 큰 차이는 없었으나, 추후 더 심도 있는 연구가 진행되어야 할 것이다.

핵심되는 말 : 미추차단, 방광요관역류, 요관방광재문합술, 신장-요관 회복, 핍뇨