

:
 : 12
 30 , 1 , 3 , 6 , 9 , 24
 [(
)/
],
 : 30
 가 , 24
 가
 ($p < 0.05$).
 ($p < 0.05$).
 :
 가
 (3-6).
 (1).
 (impedance index)가
 가(7)
 가
 (2).
 ,
 가
 가
 가
 가

atropine sulfate (Atropine; , ,) 0.5 mg/kg 10 2% xylazine hydrochloride (Rompun; Bayer Korea, Seoul, Korea) 5 mg/kg 5 ketamine hydrochloride (Ketalar; , ,) 35 mg/kg

ketamine hydrochloride (Ketalar; , ,) 10 mg/kg xylazine hydrochloride (Rompun; Bayer Korea, Seoul, Korea) 3 mg/kg

22

가

paired t test

3 - 0

(

)

가

(paired t test).

30 ,

1 , 3 , 6 , 9 , 24

24

thiopental sodium (, ,) 30 mg/kg

1/3

hematoxylin - eosin

(BH - 2, Olympus, Japan: × 100)

(interlobar vein)

3

, 3

{ } = [(-) /]

Sequoia

512 (Acuson, Mountain View, California, U.S.A.)

8 MHz

(Fig. 1A),

(Fig. 1B).

(wall

가

filter)

(Fig. 2).

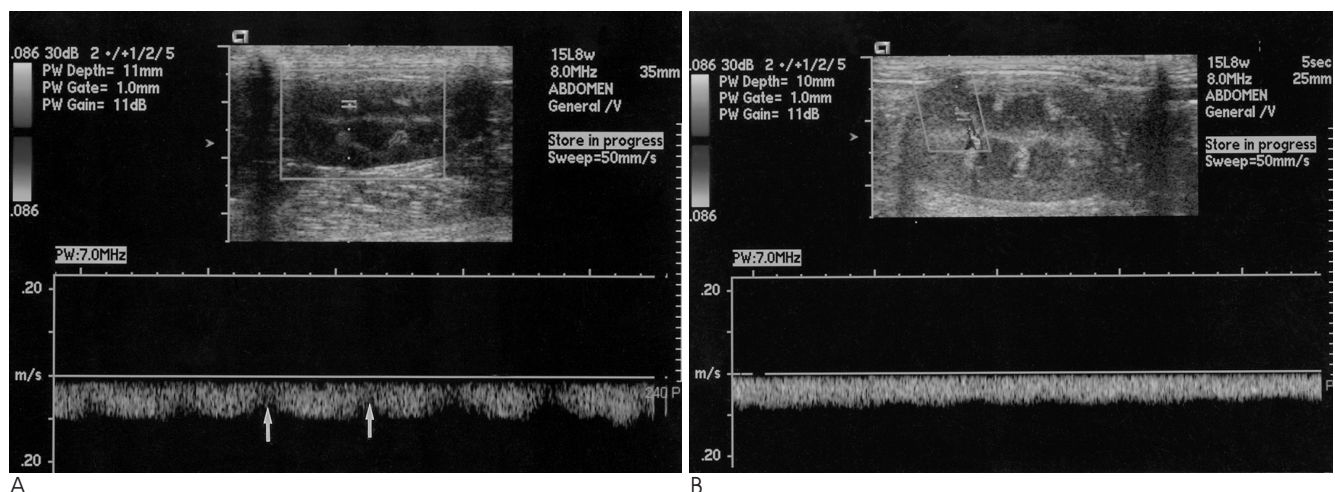


Fig. 1. A. Duplex Doppler sonogram of left kidney before ureteral ligation. Doppler sonogram on interlobar vein shows oscillating, wavy Doppler form of the renal vein with periodic reduction of the venous flow (arrows). The impedance index of interlobar vein was 0.4.

B. Duplex Doppler sonogram obtained 30 minutes after ureteral ligation shows some flattening of Doppler waveform of the renal vein. The impedance index was 0.19.

Table 1

가	($p > 0.05$).	가	12
30		가	
		가	($p < 0.05$).
			24
($p < 0.05$).	24		(Fig. 4).
9			
가	(Fig. 3).		
	12	가	

(Table

2).

Table 1. Impedance Index According to Time Difference Before and After Ureteral Ligation (mean \pm standard deviation)

	Obstruction* (n = 12)	Non-obstruction† (n = 12)	p-value
Before ligation‡	0.335 \pm 0.054	0.338 \pm 0.006	>0.05
At 30-min§	0.225 \pm 0.042	0.310 \pm 0.034	<0.05
At 1-h	0.195 \pm 0.045	0.336 \pm 0.036	<0.01
At 3-h	0.181 \pm 0.028	0.314 \pm 0.038	<0.01
At 6-h	0.161 \pm 0.026	0.316 \pm 0.053	<0.01
At 9-h	0.159 \pm 0.020	0.318 \pm 0.036	<0.01
At 24-h	0.200 \pm 0.063	0.302 \pm 0.051	<0.01

*: kidney with ureteral obstruction

†: contralateral kidney without ureteral obstruction

‡: baseline measurement before ureteral ligation

§: measurement after ureteral ligation

min : minutes

h : hour(s)

Table 2. Impedance Index Differences Between Obstructed and Nonobstructed Kidneys Following Ureteral Ligation (mean \pm standard deviation)

	Obstruction* (n = 12)	Non-obstruction† (n = 12)	p-value
At 30-min‡	0.093 \pm 0.030	-0.013 \pm 0.034	<0.05
At 1-h	0.126 \pm 0.046	-0.019 \pm 0.051	<0.05
At 3-h	0.156 \pm 0.055	0.020 \pm 0.059	<0.05
At 6-h	0.176 \pm 0.046	0.019 \pm 0.056	<0.05
At 9-h	0.178 \pm 0.066	0.017 \pm 0.062	<0.05
At 24-h	0.135 \pm 0.047	0.036 \pm 0.075	<0.05

*: kidney with ureteral obstruction

†: contralateral kidney without ureteral obstruction

‡: impedance index difference from baseline value 30-min after ureteral ligation

min : minutes

h : hour(s)

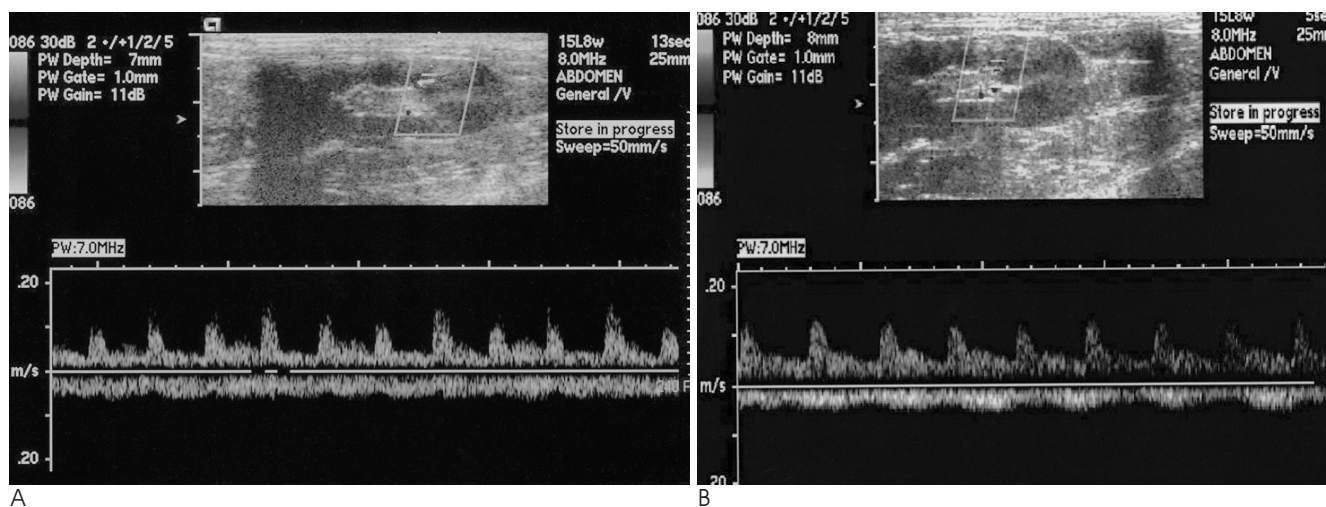


Fig. 2. Duplex Doppler sonograms of contralateral nonobstructed kidney before (A) and 30 minutes after (B) ureteral ligation. Doppler sonogram shows preserved normal oscillation in the Doppler waveform of the contralateral nonobstructed kidney after ureteral ligation.

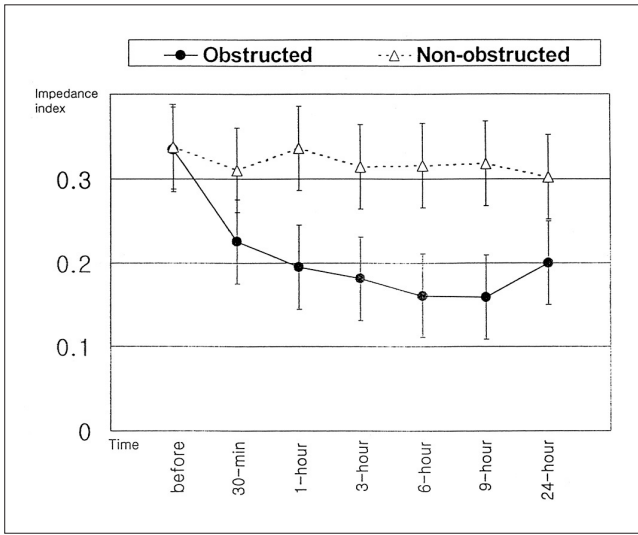


Fig. 3. Change of the impedance index of renal vein before and after ureteral ligation. After ureteral ligation, the impedance indexes were significantly lowered in obstructed kidneys than contralateral nonobstructed kidneys at all times after ligation.

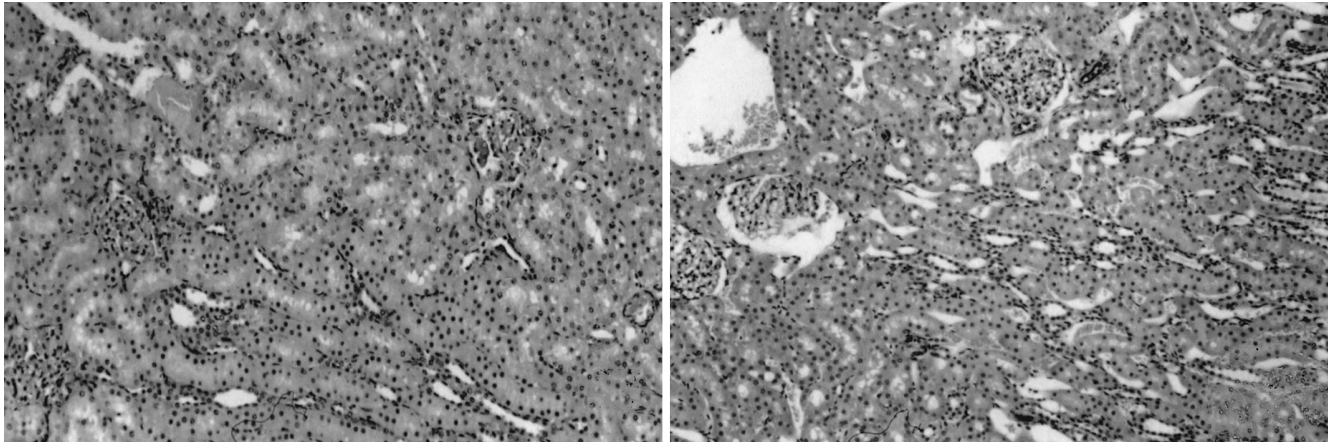


Fig. 4. Histology of the resected specimen in non-obstructed (A) and obstructed kidneys (B). The obstructed kidney showed congestion and widened Bowman's space in the glomeruli compared to non-obstructed kidney (H and E, $\times 100$).

(pulsatility)

가 가

가

가

가

가

가

가

(7).

가

가

(12, 13).

가

가

가

30

가

24

가

Bateman Cuganesan (7)

가

가

Bateman

Kim (14)

6

5

29%가

가

6

가

(15, 16)

가

24

가

가

1. Anderson KR, Weiss RM. Physiology and evaluation of uretero-pelvic junction obstruction. *J Endourol* 1996;10:87-91
2. Laing FC, Jeffrey RB Jr, Wing VW. Ultrasound versus excretory urography in evaluating acute flank pain. *Radiology* 1985;154:613-616
3. Cole TC Jr, Brock JW 3rd, Pope JC 4th, et al. Evaluation of renal resistive index, maximum velocity and mean arterial flow velocity in a hydronephrotic partially obstructed pig model. *Invest Radiol* 1996;32(3):154-160
4. Palmer JM, DiSandro M. Diuretic enhanced duplex Doppler sonography in 33 children presenting with hydronephrosis: a study of test sensitivity, specificity and precision. *J Urol* 1995;154:1885-1888
5. Tublin ME, Dodd GD 3rd, Verdile VP. Acute renal colic: diagnosis with duplex Doppler US. *Radiology* 1994;193:697-701
6. Lee HJ, Kim SH, Jeong YK, Yeun KM. Doppler sonographic resistive index in obstructed kidneys. *J Ultrasound Med* 1996;15:613-618
7. Bateman GA, Cuganesan R. Renal vein Doppler sonography of obstructive uropathy. *AJR Am J Reontgenol* 2002;178:921-925
8. Platt JF, Rubin JM, Ellis JH, Dipietro MA. Duplex Doppler US of the kidney: differentiation of obstructive from nonobstructive dilatation. *Radiology* 1989;171:515-517
9. Platt JF, Rubin JM, Ellis JH. Distinction between obstructive and nonobstructive pyelocaliectasis with duplex Doppler sonography. *AJR Am J Reontgenol* 1989;153:997-1000
10. Bude RO, Rubin JM. Relationship between the resistive index and vascular compliance and resistance. *Radiology* 1999;211:411-417
11. Krumme B, Grotz W, Kirste G, Schollmeyer P, Rump LC. Determinants of intrarenal Doppler indices in stable renal allografts. *J Am Soc Nephrol* 1997;8:813-816
12. Bolondi L, Li Bassi, Gaiani S, et al. Liver cirrhosis: changes of Doppler waveform of hepatic veins. *Radiology* 1991;178:513-516
13. Britton PD, Lomas DJ, Coulden RA, Farman P, Revell S. The role of hepatic vein Doppler in diagnosing acute rejection following pediatric liver transplantation. *Clin Radiol* 1992;45:228-232
14. Kim KM, Bogaert GA, Nguyen HT, Borirakchanyavat S, Kogan BA. Hemodynamic changes after complete unilateral ureteral obstruction in the young lamb. *J Urol* 1997;158:1090-1093
15. Perlmutter A, Miller L, Trimble LA, Marion DN, Vaughan EDJ, Felsen D, Toradol, an NSAID used for renal colic, decreases renal perfusion and ureteral pressure in a canine model of unilateral ureteral obstruction. *J Urol* 1993;149:926-930
16. Frokiaer J, Nielsen AS, Knudsen L, Djuruus JC, Pedersen EB. The effect of indomethacin infusion on renal hemodynamics and on the renin-angiotensin system during unilateral ureteral obstruction of the pig. *J Urol* 1993;150:1557-1563

Renal Vein Doppler Sonography in Rabbits with Acute Ureteral Obstruction: Usefulness of Impedance Index of Renal Vein¹

Kyung-Myung Sohn, M.D., Su-Kyo Chung, M.D., Sung-Yong Lee, M.D.

¹Department of Radiology, The Catholic University of Korea, College of Medicine, Seoul, Korea

Purpose: To evaluate the usefulness of the impedance index of the renal vein for the diagnosis of acute obstructive uropathy in rabbits.

Materials and Methods: Ligation of the left ureter was done in 12 rabbits. Doppler sonography of the interlobar veins in both kidneys was checked before and 30 minutes, 1, 3, 6, 9 and 24 hours after ureteral ligation. The venous impedance index [(peak flow signal-least flow signal)/peak flow signal] was compared between the obstructed and non-obstructed kidneys for all periods. The change in the impedance index after ureteral ligation was also compared between the obstructed and non-obstructed kidneys.

Results: A decrease in the impedance index of the intrarenal vein was observed starting from 30 mins after ureteral ligation, and the index remained low up to 24 hours after ureteral ligation. The obstructed kidneys had a significantly lower impedance index than the contralateral kidneys for all six of the postligation measurements ($p < 0.05$). There were significant differences in the change of impedance index after ureteral ligation between the obstructed and non-obstructed kidneys ($p < 0.05$).

Conclusion: The impedance index of the intrarenal vein was significantly decreased in the obstructed kidneys. The measurement of the impedance index of the intrarenal vein using Doppler sonography could provide a useful method of diagnosing obstructive uropathy.

Index words : Kidney
Obstruction
Renal veins
Ultrasound (US)

Address reprint requests to : Kyung-Myung Sohn, M.D., Department of Radiology, Our Lady of Mercy Hospital,
665, Bupyung-dong, Bupyung-gu, Incheon 403-010, Korea.
Tel. 82-32-510-5531 Fax. 82-32-519-8557 E-mail: mogulkor@medimail.co.kr