

가

:

1

. 2 . 2 .

:
 , (resistive index)
 : 4.5 - 5.0 kg 가 12
 24 , 48 , 72 .

:
 가 2 가
 가 가
 가 1.38 가 , 가
 2 1.64 가 3 1.59
 48 27 (56%)
 : 가 가 ,

, , 가
 , 가
 . 가
 , 가 가 ,
 가 가
 (1 - 4). ,

가 가 (5). .

가 ,

(6).
 가 가 4.5 - 5 kg 가 12
 가 .

가 , 가
 (7, 8). . 5% Ketamine
 hydrochloride (Ketamine , Yuhan, Seoul, Korea) 2%
 Xylazine hydrochloride (Rompun , Bayer, Ansan, Korea)

1:1 kg 1.2 ml

, 가

2005 6 20

2005 8 10

.

[80% Thioglycolic acid(Neet cream , Il - Dong Pharmaceutical Co. Ltd., Seoul, Korea)]

(whole mount)

(x

. 40

HDI - 5000 3000 (Advanced Technology
Laboratories, Bothell, WA, U.S.A.) ,

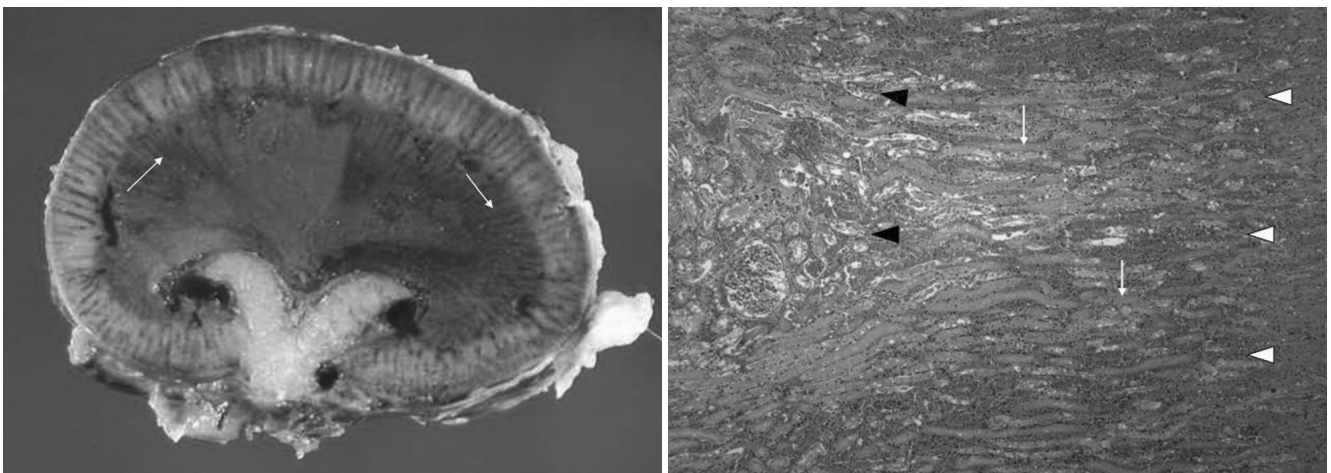
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가

(Fig. 1).

Table 1

가
8.7% 가 . 2 가
, 2 가
14.5% 가 . 3 2
(n=8)
. 3 가 14.4% .



A **B**

Fig. 1. A. Gross specimen of left kidney on 2nd day, after renal vein ligation (left: lower pole, right: upper pole). Outer medulla is red color due to hemorrhage and medullary rays (arrows) are thickened due to thickened renal tubules.

B. Microscopic specimen ($\times 40$) (dark arrowheads: corticomedullary junction, white arrowheads: inner and outer medulla junction) of the same kidney shows thickened renal tubules (arrows) and hemorrhagic stroma. These findings are predominant at outer medulla. Inner medulla is relatively well preserved.

Table 1. The Change of Longitudinal Diameter (mm) of the Kidney with Time

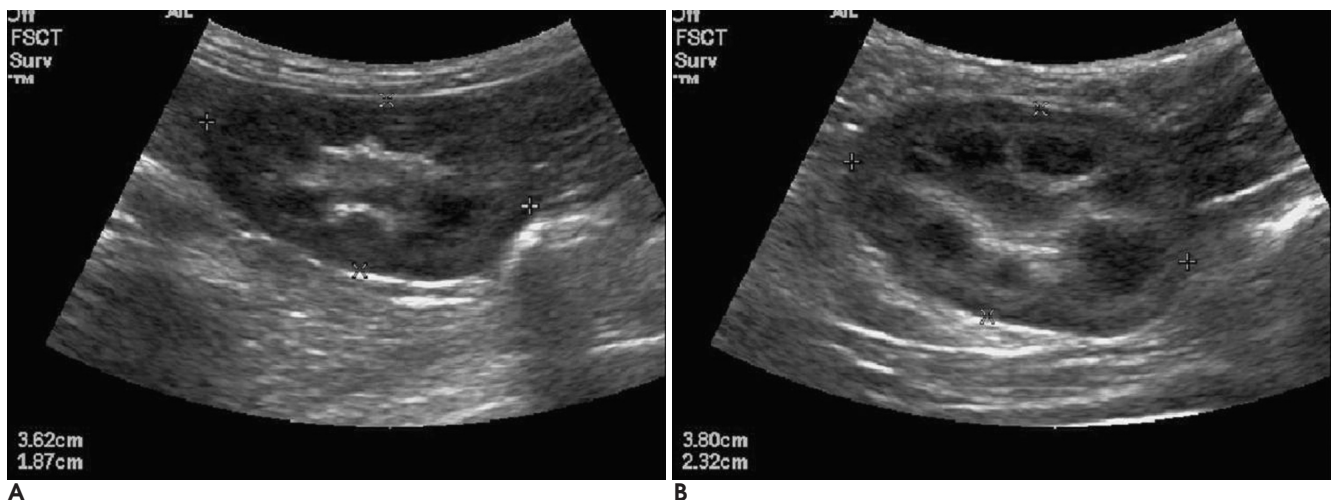
Case	Pre-Op	Immediate Post-Op	24 hrs	48 hrs	72 hrs
1	38	41	45	46	45
2	33	35	36	36	36
3	34	40	42	42	41
4	35	37	38	38	38
5	40	44	40	43	43
6	36	39	41	42	42
7	35	36	40	41	41
8	37	38	41	41	42
9	44	50	51	51	51
10	36	39	39	40	41
11	37	40	42	43	43
12	38	43	44	44	44
Average	36.9 ± 2.8	40.2 ± 3.9	41.6 ± 3.7	42.3 ± 3.7	42.3 ± 3.5

Op: renal vein ligation Unit: mm

Table 2. The Change of Resistive Index with Time

Case	Pre-Op	Immediate Post-Op	24 hrs	48 hrs	72 hrs
1	0.55	0.61	1.30	1.63	1.60
2	0.50	1.43	1.50	1.71	1.45
3	0.52	1.57	1.59	1.43	1.36
4	0.49	1.56	1.60	1.63	1.61
5	0.61	0.59	1.60	1.65	1.65
6	0.60	1.36	1.53	1.60	1.55
7	0.65	1.58	1.73	1.67	1.65
8	0.56	1.68	1.70	1.72	1.68
9	0.60	1.66	1.65	1.68	1.66
10	0.53	1.57	1.58	1.60	1.55
11	0.59	1.45	1.57	1.64	1.62
12	0.58	1.50	1.62	1.66	1.64
Average	0.57 ± 0.05	1.38 ± 0.38	1.58 ± 0.10	1.64 ± 0.07	1.59 ± 0.10

Op: renal vein ligation

**Fig. 2.** Serial follow-up of gray-scale US.**A.** Pre-ligation longitudinal US of the kidney.**B.** Post-ligation longitudinal US. The cortical echo is increased than A. Also, longitudinal and axial lengths of the kidney are significantly increased. And, the corticomedullary junction is preserved.

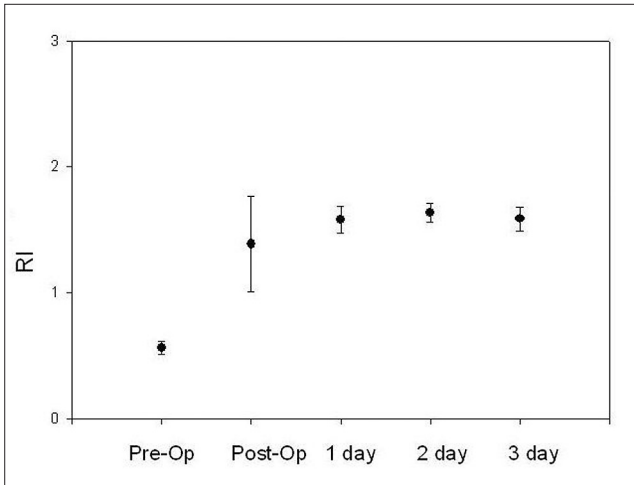


Fig. 3. Time to resistive index curve (2 standard deviation). RI is rapidly increased, just after ligation of renal vein. Thereafter, the rate of increase becomes blunt. RI attains to the peak value at post-ligation 2nd day. RI of post-ligation 3rd day is lower than that of 2nd day.

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가

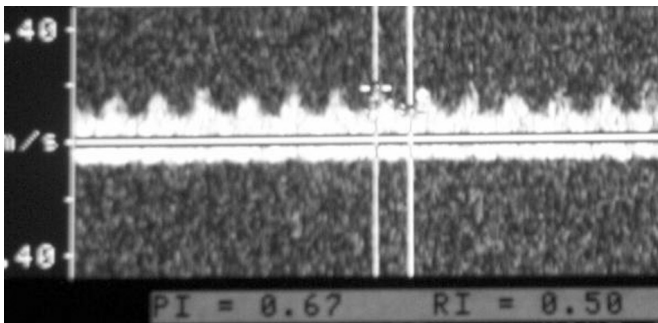
(Fig. 2).

Table 2, Fig.

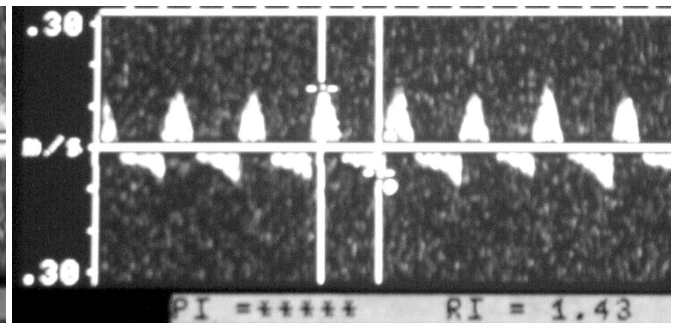
3	0.57,	1.38,	1	1.58, 2	1.64, 3
1.59	2	가		가	Fig.
3	가		가	가	
		2.5	가	2	
가			가		2
	2.9	가	가		3
	2.8	가		2	

(Fig. 4).

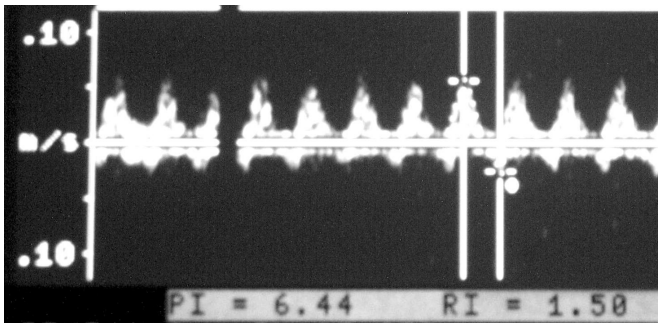
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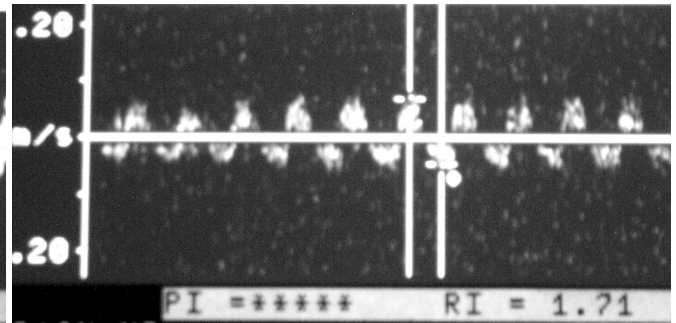
A



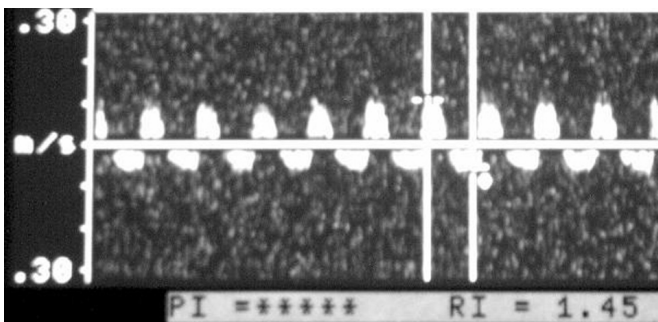
B



C



D



E

Fig. 4. Serial follow-up Doppler US.

A. Pre-ligation Doppler US Shows normal renal arterial spectral wave form (antegrade flow throughout the entire cardiac cycles). Also, continuous venous flow is seen. RI is 0.5.
B. Post-ligation Doppler US Shows retrograde 'plateau-like' diastolic frequency shifts. RI is markedly increased than A.
C. Post-ligation 1st day Doppler US. The rate of RI increase becomes blunt. RI is slightly increased rather than B.
D. Post-ligation 2nd day Doppler US. RI is the highest value.
E. Post-ligation 3rd day Doppler US. RI is decreased than D. Note retrograde 'plateau-like' diastolic frequency shift.

(Fig. 4. B - E).

($n=10/48$),
4%($n=2/48$) . 가
가 19%($n=9/48$) .

가

가

,

(9).

[($-$
) /] ($10, 11$).
가 0.7 , 0.9
가 (7).

가 ,

,
(8, 10,
12, 13). 가

가

.

가

가 , 가

(8, 10).

(2, 7, 14).

(8, 12, 15 - 18).

가

가가

. 가 Fig. 5

가

가

가

가 2 3

17) 3

(13, 14, 19, 20).

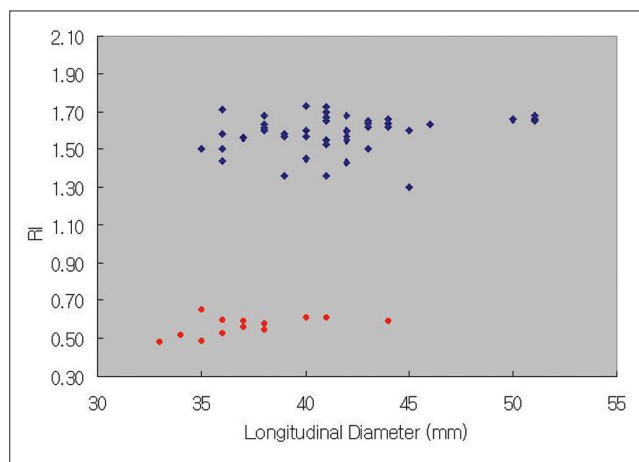


Fig. 5. Comparative graph of renal size to RI. RI is divided into two major groups (red dots: pre-Op group, blue squares: post-Op group). The major factor of increased RI is as considered to renal venous outflow obstruction.

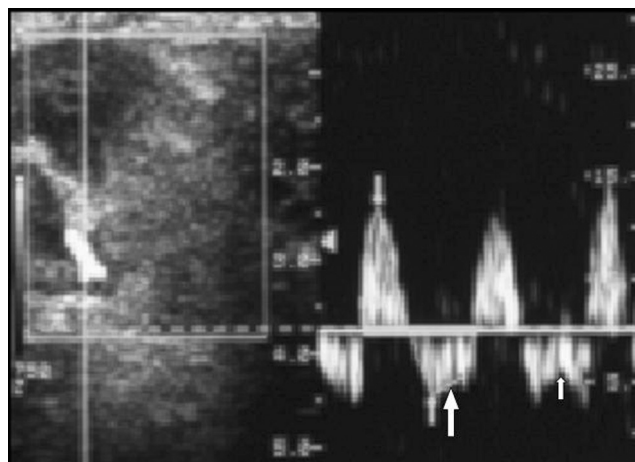


Fig. 6. Doppler US at 2nd day shows reverse 'plateau-like' diastolic frequency shift (large arrow) and reverse 'inverted M' diastolic frequency shift (small arrow). Two patterns could be broadly regarded as the same pattern.

(20, 21) (Fig. 1).
 1989 Reuther (12) (peaked
 antegrade systolic frequency shift),
 (retrograde 'plateau-like' diastolic frequency shift)
 (missing venous Doppler signal)

, 1991 Baxter (17) (inverted M)
 (retrograde plateau-like)
 가
 (reverse peak)

(Fig. 6). , 48
 27

Reuther (12) 가
 1990 Kaveggia (16) 가

가 (8, 17).

가
 (17).

가

가

, 72

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Ultrasonographic Findings of Acute Renal Vein Thrombosis in Experimental Rabbit Model: Focus on Renal Doppler Sonography¹

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Purpose: To evaluate Doppler sonographic findings of acute renal vein thrombosis in rabbit model induced by renal vein ligation, with an emphasis on the changes in resistive index (RI) on serial follow-up.

Materials and Methods: Conventional and Doppler sonographies were performed immediately after ligation and 24, 48, and 72 hours after ligation in 12 rabbits weighing 4.5 - 5.0 kg. We focused on changes in kidney size and echogenicity with conventional sonography and resistive index by time interval and Doppler waveforms with Doppler sonography.

Results: Kidney size increased markedly immediately after ligation, and increased slowly until 48 hours after ligation with no change observed afterwards. Echogenicity increased both in the renal cortex and the medulla. RI increased remarkably to an average of 1.38 immediately after ligation, and increased to a peak average of 1.64 48 hours after ligation. After 72 hours RI decreased slightly to 1.59. Reverse 'plateau-like' diastolic waveform was seen in 27 trials (56%) on follow up Doppler sonograms.

Conclusion: The increase in RI was thought to be due to the increase in renal arterial vascular resistance caused by venous outflow obstruction. The decrease in RI with time suggested adaptation of intrarenal circulation to renal vascular change. Also, the reverse 'plateau-like' diastolic waveform was the predominant waveform.

Index words : Renal vein thrombosis
Doppler sonography
Experimental studies

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