



2000 12

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•	.....	5
1.	.....	5
가.	.....	5
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2.	.....	5
가.	.....	5
.	.....	6
.	.....	6
.	.....	8
.	.....	8
•	.....	9
1.	.....	9
2.	.....	10
3.	.....	11
4.	.....	12
5.	.....	13
6.	.....	14

7.	.....	15
8.	.....	16
9.	.....	17
.	.....	19
.	.....	26
	.....	27
Abstract	.....	31

1.	.....	9
2.	.....	10
3.	.....	11
4.	.....	12
5.	, .....	13
6.	.....	14
7.	.....	15
8.	.....	17
9.	.....	18

1.	.....	7
2.	.....	16

가

가 . 1977

가

pyloric length(PL) 16mm , wall thickness(WT) 4mm

pyloric diameter(PD) 14mm ,

가

가

1995 1 2000 5

200

30

PL  $19 \pm 3.3\text{mm}$ ,

WT  $5 \pm 1.2\text{mm}$

PD  $13 \pm 2.7\text{mm}$

PL  $9 \pm 2.9\text{mm}$ ,

WT  $2 \pm 0.6\text{mm}$

PD  $7 \pm 1.3\text{mm}$

가

PD 14mm

, WT 3mm

PD 9mm



1 (8 ), 2 (8-16 ) 3 (16 )  
39, 42, 62 , 32, 30, 37  
3.5, 3.1, 4.0 .

PL 14mm , WT  
3mm PD 9mm ,

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< , >

•

(Infantile hypertrophic pyloric stenosis)

(nonbilious, projectile vomiting), 가 (peristaltic gastric wave) (“olive”-like palpable pyloric tumor)

,

가 .<sup>1)</sup>

, 1977

가 가

.<sup>2)</sup> Atropine

가 , 가 Ramstedt

가 가 .

(pyloric parameters)

pyloric

length 16mm , wall thickness 4mm

pyloric

diameter 14mm ,

가 .  
pyloric volume, pyloric muscle index, pyloric ratio  
(pyloric index) <sup>3,4)</sup> .

•

1.

가.

1995 1 2000 5 ,

200 .

•  
2000 1 8 9

30 .

2.

가.

( , , , , ,  
) , ( , , , , )  
(pyloric length, pyloric diameter, wall  
thickness) . ,

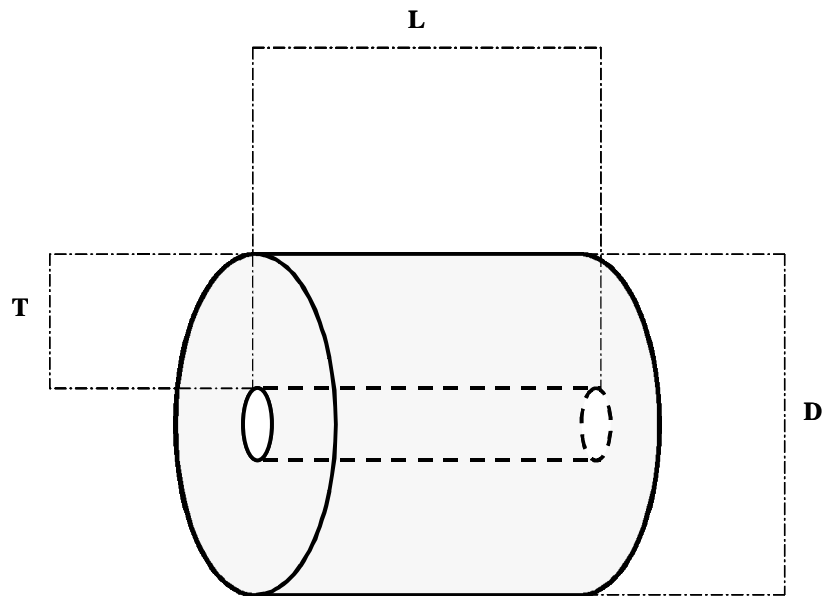
60mL full strength formula breast milk feeding 4

가 ,

,

9 30  
 1  
 Acuson 128XP/10(Acuson, Mountain view, California, USA) 7-10Mz Linear transducer 7Mz sector transducer  
 , HDI 3000(Advanced Technology Laboratories, Inc., Bothell, Washington, USA) 7Mz linear transducer  
 4 glucose  
 water feeding

pyloric length, pyloric diameter wall  
 thickness  
 pyloric volume, pyloric muscle index pyloric ratio  
 .( 1.)  
 가 pyloric length  
 16mm 13mm , wall thickness 5mm 3mm  
 pyloric diameter 14mm 8mm



1.

L=pyloric length; T=wall thickness; D=pyloric diameter

Pyloric volume(PV)= $\frac{1}{4}\pi D^2 L - \pi(\frac{1}{2}D - T)^2 L = \pi T L(D - T)$

Pyloric muscle index (PMI)=PV/Weight(gram)

Pyloric ratio(PR) =T/D

.  
 3 . 1 (early feeding)  
 8 , 2 (intermediate feeding)  
 8 , 8-16  
 . , 3 (late feeding) 16  
 .  
 ,  
 .  
 .  
 , ,  
 SPSS t-test, ,  
 p-value 0.05 .

•

1.

36 ± 16 , 4:1 34 ± 17 .  
,  
( 1.)

1.

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	(n=200)	(n=30)
(male:female)	4:1	1:1
(days)	36 ± 16	34 ± 17
(kilogram)	3.94 ± 0.94	4.06 ± 1.67
(kilogram)	3.22 ± 0.57	3.14 ± 0.59
(weeks)	39 ± 1.9	38 ± 3.1



2.

13 ± 11 ,  
(non-bilious, projectile vomiting) , 14%  
39% (“olive”- like  
mass) , 15% 가 (visible gastric  
peristaltic wave) . (hypokalemia)  
(hypochloremia) 49% ,  
(metabolic alkalosis) 30% . ( 2.)

2.

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	(%)
	200/200 (100%)
	77/200 ( 39%)
가	29/200 ( 15%)
	98/200 ( 49%)
	60/200 ( 30%)
	57/200 ( 29%)
	28/200 ( 14%)

3.

pyloric length가  $19 \pm 3.3$  mm, wall thickness  
 가  $5 \pm 1.2$  mm pyloric diameter가  $13 \pm 2.7$ mm .  
 pyloric length  
 $9 \pm 2.9$  mm, wall thickness  $2 \pm 0.6$  mm pyloric diameter  $7$   
 $\pm 1.3$  mm .( 3)  
 가 .(p<0.0001)

3.

1

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---

Pyloric length*	$19 \pm 3.3$ (13- 34)	$9 \pm 2.9$ (3- 13)
Wall thickness*	$5 \pm 1.2$ (3- 10)	$2 \pm 0.6$ (1- 3)
Pyloric diameter*	$13 \pm 2.7$ (6- 20)	$7 \pm 1.3$ (5- 9)

\* p<0.0001

<sup>1</sup> millimeter (mm) ± ( )

4.

		pyloric volume
2.7 ± 1.45 mL, pyloric ratio	0.4 ± 0.09	pyloric muscle index
0.6 ± 0.29	.	pyloric volume
0.4 ± 0.02 mL, pyloric ratio	0.3 ± 0.07	pyloric muscle index
0.1 ± 0.03	.( 4)	
	가	.(p<0.0001)

4.

1

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---

Pyloric volume* (mL)	2.7 ± 1.45 (0.5-7.8)	0.4 ± 0.01 (0.1-0.7)
Pyloric muscle index*	0.6 ± 0.29 (0.1-1.7)	0.1 ± 0.04 (0.02-0.1)
Pyloric ratio*	0.4 ± 0.09 (0.2-0.9)	0.3 ± 0.06 (0.2-0.5)

\* p<0.0001

<sup>1</sup> ± ( )

5.

pyloric  
length wall thickness ,  
wall thickness pyloric diameter  
pyloric volume  
pyloric muscle index pyloric ratio ,  
( 5) pyloric muscle index pyloric ratio

5.

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---

Pearson

Pyloric length	0.181*	0.213 <sup>†</sup>	0.201	0.021
Wall thickness	0.343 <sup>†</sup>	0.199 <sup>†</sup>	0.477 <sup>†</sup>	0.264
Pyloric diameter	0.176	0.175	0.534 <sup>†</sup>	0.421
Pyloric volume	0.233*	0.276 <sup>†</sup>	0.498 <sup>†</sup>	0.219
Pyloric ratio	0.085	- 0.031	0.332	0.446
PMI <sup>1</sup>	0.064	- 0.152	0.265	- 0.632

\* p < 0.05    † p < 0.01

<sup>1</sup> PMI ; pyloric muscle index

6.

pyloric length가 16mm 86.5%,  
100% 14mm 98.0%, 100% . wall thickness 4mm  
85.7%, 100%, 3mm 100%, 96.7% , pyloric diameter 14mm  
38.3%, 100%, 9mm 93.0%, 96.6% .( 6)

6.

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Pyloric Length

16 mm	86.5 %	100.0 %
15 mm	93.0 %	100.0 %
14 mm	98.0 %	100.0 %
13 mm	100.0 %	96.7 %

Wall thickness

5 mm	51.9 %	100.0 %
4 mm	85.7 %	100.0 %
3.5 mm	93.7 %	100.0 %
3 mm	100.0 %	96.7 %

Pyloric diameter

14 mm	38.3 %	100.0 %
12 mm	69.6 %	100.0 %
10 mm	87.8 %	100.0 %
9 mm	93.0 %	96.6 %
8 mm	95.7 %	69.0 %

7.

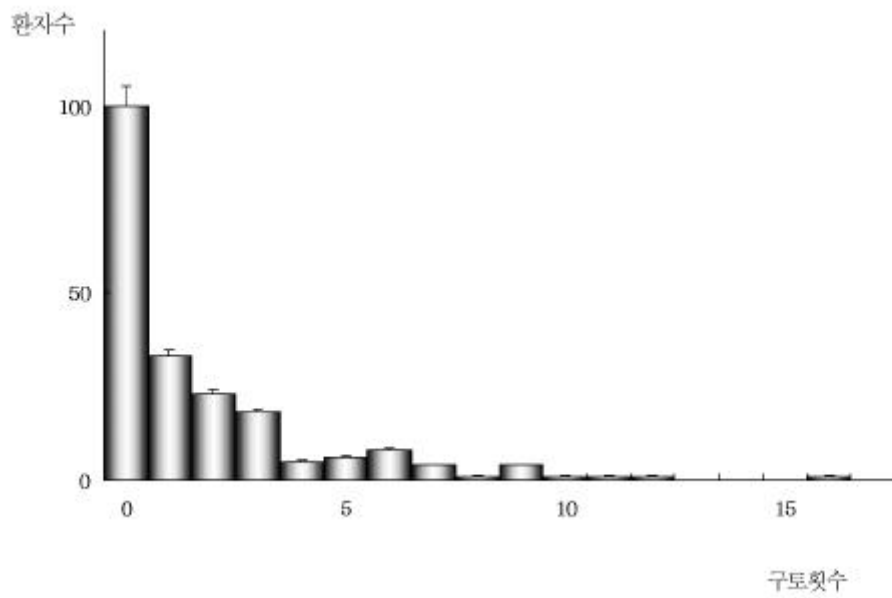
pyloric volume 1.2mL 85.3%, 100%, 0.6mL 97.1%,  
 100% , pyloric muscle index 0.4 80.4%, 100%, 0.2 94.8%,  
 100% . , pyloric ratio 0.27 97.1% ,  
 31.0% .( 7)

7.

Pyloric volume		
1.2 mL	85.3 %	100.0 %
1.0 mL	91.2 %	100.0 %
0.6 mL	97.1 %	100.0 %
0.5 mL	97.1 %	82.8 %
Pyloric muscle index		
0.4	80.4 %	100.0 %
0.3	86.6 %	100.0 %
0.2	94.8 %	100.0 %
0.1	100.0 %	80.0 %
Pyloric ratio		
0.40	51.0 %	96.6 %
0.35	73.5 %	86.2 %
0.30	94.1 %	48.5 %
0.27	97.1 %	31.0 %

8.

가  
 50% 1.7 . 90% 5  
 , 10 3 (1.5%) .(  
 2)  
 . 14 ,  
 12 . 47 ,  
 33 . ( 8)  
 5 (2.5%), 1 (0.5%) 1 (0.5%)  
 . 1 1 가  
 .



2.

8.

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---

	1.7	± 2.6	0.5
	14.3	± 10.2	12
	47.3	± 20.5	42
	33.0	± 17.1	28
( )	3.6	± 1.5	3.0

9.

가 , 2-3  
 schedule feeding , 1 (early  
 feeding), 2 (intermediate feeding) 3 (late feeding) ,  
 70 (35%), 63 (31.5%), 67 (33.5%) . 1, 2 가  
 1.9, 1.6 3 1.5 , .  
 39, 42, 62, ,  
 32, 30, 37 . 3.5, 3.1, 4.0 . 1  
 2 3 ,  
 .( 9)



9.

	Early	Intermediate	Late	P value
<sup>1</sup>	70	63	67	
<sup>2</sup>	39.3	41.9	61.5	0.00*
<sup>3</sup>	31.8	29.9	37.2	0.04*
	1.9	1.6	1.5	0.74
( )	3.5	3.1	4.0	0.00*

\* Late vs Early, Intermediate

<sup>1</sup> Early: 8 ; Intermediate:8- 16 ; Late:16

<sup>2</sup> 60mL full strength formula breast milk feeding

4 가

<sup>3</sup>

( = - )

•

가 . 1717 Patrick Blair

가 , 1888 Hirschsprung

2

<sup>5)</sup>

1898 Locker가 gastrojejunostomy

. Extramucosal pyloroplasty Nicoll(1906 ), Fredet(1907 )

Weber(1908 )

. 1911 Ramstedt

, 가

<sup>6)</sup>

,

가 . , 가 , ABO

type B O

<sup>5,6)</sup>

, , gastrin

<sup>6)</sup>

가

Kobayashi

가 ,<sup>7)</sup> neural cell adhesion molecule(NCAM)

<sup>8)</sup>

1000 2.5 ,

. 가 4

<sup>9)</sup>

2-3 가 .

(nonbilious), (projectile) , 30-60

가 가

<sup>6,9)</sup>

가

(visible gastric peristaltic wave), 2cm  
(diagnostic "olive") <sup>9)</sup>

가 <sup>10)</sup> 16%

glucuronyl transferase

<sup>11)</sup>

, 'olive'

40- 100% 가 <sup>9)</sup>

39%

85% <sup>6)</sup>

가 <sup>1)</sup>

Barium

가 . 1977

가 가

<sup>2)</sup>

10%

pyloric diameter 14mm , wall thickness 4mm  
 pyloric length 16mm .<sup>12)</sup>  
 91- 100% , 100% .<sup>13)</sup> , 가  
 borderline , wall thickness가 4mm ,  
 pyloric volume <sup>14)</sup> , pyloric  
 muscle index<sup>3)</sup> pyloric ratio<sup>4)</sup> .  
 , dell'Agnola <sup>15)</sup> pyloric  
 diameter , Bouchier <sup>16)</sup> pyloric  
 diameter wall thickness 가 . ,  
 Lund Kofoed <sup>17)</sup> ,  
 muscle length 19mm , muscle diameter 10mm  
 wall thickness 4mm .<sup>17)</sup>  
 Westra <sup>14)</sup> pyloric volume  
 , 4 pyloric volume  
 1.4mL . Carver <sup>(3)</sup>  
 pyloric volume , pyloric muscle index  
 , 0.4 0.4  
 . Lisa <sup>4)</sup> pyloric ratio가 가  
 , 0.27 .  
 wall thickness, pyloric  
 diameter ,  
 wall thickness, pyloric length ,  
 , pyloric volume ,  
 , pyloric muscle

index pyloric ratio , .( 5)  
 pyloric  
 volume , , pyloric muscle index  
 pyloric ratio ,

pyloric length 14mm , wall thickness 3mm , pyloric  
 diameter 9mm 가 93- 100%, 가 97- 100% 가  
 .( 6) ,  
 , pyloric volume 0.6mL 97%, 100%  
 , pyloric muscle index 0.2 95%, 100% 가  
 . , pyloric ratio 0.27

97.1% , 가 31.0%  
 .( 7)

pyloric length가 가  
 , 6 .<sup>18)</sup> atropine  
 가 pyloric length ,  
 .<sup>19)</sup> pyloric length , ,  
 가

1960 Atropine 가 ,  
 ,  
 , atropine sulfate  
 가 .<sup>20)</sup> Atropine

<sup>21)</sup>

20)

atropine 가

21)

atropine sulfate 0.04mg/kg/day

, 가

0.01mg/kg/day

가

. 가 ,

2

, 2

21)

,

가

Fredet - Ramstedt

.

. 가

가 가

. , aspiration

5%

KCl 20mEq/L

.

,

,

2ml/ Kg/hr

가

HCO3- 가 30mEq/L

5,6,9)

Fredet - Ramstedt

,

1

2

1mm

가

90- 180

6)

가 ,

<sup>5,22)</sup> 5 (2.5%)

1

1

6-8

glucose water ,half strength, full-strength formula breast

milk schedule feeding <sup>5,6)</sup>

Scharli <sup>23)</sup> 24

가 ,

schedule feeding ad lib feeding 가 <sup>24,25,26)</sup>

가

<sup>25)</sup> 65-90%

<sup>24,27,28)</sup>

가 ,

가 <sup>25,26)</sup> Carpenter

schedule feeding ad lib feeding , ad lib feeding

<sup>24)</sup> Gollin

1 full- strength formula breast milk feeding

가 schedule feeding

<sup>26)</sup>

schedule feeding 4 ad lib feeding

schedule feeding ,

feeding 3 (early, intermediate,  
late) . early feeding intermediate feeding  
late feeding , ,

가 .( 9) ,

schedule feeding  
가 ad lib feeding

가 ad lib feeding

26)



.

1995 1 2000 5 ,

200 30

.

pyloric length 14mm

, wall thickness 3mm pyloric diameter 9mm .

pyloric volume 0.6mL , pyloric muscle index 0.2

pyloric ratio 0.27 .

early feeding

late feeding ,

.

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Abstract

Ultrasonography in diagnosis of infantile hypertrophic pyloric  
stenosis and its clinical features

Suk Woo Son

*Brain Korea 21 Project for Medical Sciences*

*The Graduate School, Yonsei University*

(Directed by Professor Eui Ho Hwang, Seung Hoon Choi)

Infantile hypertrophic pyloric stenosis(IHPS) is a relatively common entity seen by pediatric surgeons. The clinical diagnosis of IHPS is made by a history of projectile, nonbilious vomiting and physical findings of gastric hyperperistalsis and palpable pyloric tumor. A palpable pyloric tumor is sufficient indication to proceed with surgical intervention without obtaining a diagnostic study to confirm the existence of IHPS. However, because of an increase in early diagnostic evaluation and a reduction of the diagnostic physical examination in infants, the radiologic studies have increased. Ultrasonography(US) was introduced in 1977 as a diagnostic method for IHPS. The diagnostic criteria are a pyloric length(PL) more than 16mm, a wall thickness(WL) more than 4mm and a pyloric diameter(PD) more than 14mm, regardless of the difference of pyloric measurement, patient's age and

weight. The number of studies for the postoperative feeding schedule has increased because of the need of earlier hospital discharge and the cost-effectiveness in the treatment of IHPS. The purpose of this study was to determine a new criteria of the sonographic diagnosis in IHPS and to assess the factors that have influence on the recovery of patients.

The records of 200 infants who underwent pyloromyotomy were retrospectively studies. And 30 normal infants were done US for the comparison with IHPS. Patients with IHPS had a mean of PL 19mm( $\pm$  3.3), WT 5mm( $\pm$  1.2) and PD 13mm( $\pm$  2.7). In control group, those were 9mm( $\pm$  2.9), 2mm( $\pm$  0.6) and 7mm( $\pm$  1.3), respectively. The guideline of PL 14mm, WT 3mm and PD 9mm yielded the most appropriate sensitivity and specificity. Three separate groups could be identified: E, early feeding( 8 hours feeding): I, intermediate(>8 hours nothing by mouth, feeding 16 hours): L, late(>16 hours feeding). Time to normal feeding in E, I and L were 39, 42 and 62hours, respectively. Days of hospital-stay in E, I and L were 3.5, 3.1 and 4.0, respectively.

Diagnostic criteria of US in IHPS for Korean infants should be PL 14mm, WT 3mm and PD 9mm. Earlier postoperative feeding has reduced the time to feeding, hospital stay and may become more cost-effectiveness.

**Key Words** : pyloric stenosis, pyloromyotomy, ultrasound, pyloric ratio, muscle index, ANOVA