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## Learning Curve for the Thoracoscopic Correction of Spinal Deformities

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– Abstract –

**Study design** : Twenty-six consecutive cases were prospectively studied by chart review and radiography.

**Objectives** : The aim of this study was to find the learning curve of spinal thoracoscopy in spinal deformity surgery.

**Summary of Literature Review** : Although the efficacy and learning curve of thoracoscopic deformity spinal surgery are well documented in many countries, there is no report in Korea.

**Methods** : Twenty-six consecutive patients who were underwent VATS were studied. Idiopathic scoliosis was diagnosed in 23 patients (King type II in 15, type III in 5, type IV in 3), neuromuscular scoliosis in 2 and kyphotic deformity in one. In 14 cases of idiopathic scoliosis VATS for anterior release, bonegraft and instrumentation were performed. In the remaining 12 cases of anterior release, bone graft by VATS was done without instrumentation.

**Results** : The average number of discs excised was  $5.2 \pm 0.97$ . The average time of surgery for the 14 cases was  $7.3 \pm 1.3$  hours, which represented  $1.37 \pm 0.25$  hours per disc. Excluding the time of instrumentation in the 26 cases, the average time for anterior release and bone grafting was  $3.87 \pm 0.87$  hours, which represented  $0.76 \pm 0.18$  hours per disc. The average operation time diminished as the series continued. Average blood loss was  $748.9 \pm 254$  mL, which represented  $152.6 \pm 65.6$  mL per disc. The Cobb's angle was corrected by 62% on average. Complications were found in 11 cases: screw cap breakage in 3, atelectasis in 4, and intercostal nerve injury in 4. There was no serious complication.

**Conclusions** : VAST for spinal deformity is a safe and effective alternative to thoracotomy, however, the learning curve for this procedure is quite difficult.

**Key Word** : Scoliosis, Thoracoscopy, Learning curve

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14 (King type II ;11 , III ;3 ) , 9  
 (II ;4 , III ;2 , IV ;3 ) , (2  
 ), 1 .  
 (video-assisted thoracoscopic surgery, VAST) 1920 Cobb's 40  
<sup>1)</sup> 가 , 50 ,  
 1980 가 , 35 .  
 (open thoracotomy) 가 1  
<sup>2,3,4)</sup> (torticollis) Cobb's 38  
 (VAST) , 18 3  
 가 , 가 Cobb's  
<sup>5,6,7)</sup> 50 .  
 (VAST) (end vertebra)가 3-12  
 , , , 25 , II III  
 , , ,  
<sup>8)</sup> Cobb's 35 ,  
 (annular fibrosis) (anterior longitudinal lig- (stages operation)  
 ament) 가 가 .  
 (working arm) (全) Cobb's  
 , 2 12  
 , , ,  
<sup>9)</sup> 가 , , ,  
 , 가 가 , (extubation time),  
 (learning curve) (chest tube) ,  
 10 : 26  
<sup>10)</sup> 30 kg 가 가 가 가 가  
<sup>11)</sup> 14 가  
 (double lumen)  
 가  
 (collapse) ,  
 가 (single lung anesthesia)  
 44.3 ± 10.6 ,  
 (portal)  
 (mid-axillary line)  
 10 mm 3 (portals) (ante-  
 rior axillary line) 2 (working portals)  
 (Fig. 1).  
 2  
 (portal) 2 (working portals)

surgery, VAST) 1920

1980

(open thoracotomy)

<sup>2,3,4)</sup>

(VAST)

<sup>5,6,7)</sup>

(VAST)

(annular fibrosis)  
 ament)

(anterior longitudinal lig-  
 ament)

(stages operation)

(working arm)

(全)

1

Cobb's

2 12

<sup>9)</sup>

(learning curve)

10

<sup>10)</sup>

30 kg

<sup>11)</sup>

14

(double lumen)

(collapse)

(single lung anesthesia)

44.3 ± 10.6

(portal)

(mid-axillary line)

10 mm

3

(portals)

(ante-

rior axillary line)

2

(working portals)

(Fig. 1).

2

(portal) 2

(working portals)

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26



**Fig. 1.** The portals of the thoracoscopic spinal deformity surgery should be located in the axillary line.



**Fig. 2.** Harmonic Scalpel is very useful and convenient device for bleeding control.



**Fig. 3.** The K-wire can be used as the marker in the intra-operative fluoroscopy exam.

0  
30  
(pleura) (longitudinal)  
(Ethicon Endosurgery, NJ) (Harmonic Scalpel, segmental artery)  
(Fig. 2).

(gauze)

가

, K- (頭)  
(Fig. 3), 6.5 mm

, 1 가

가

1 가  
(Fig. 4). 7  
(Endostich device, US Surgical Corp, NJ)

가 ( , , SAS 8.1 )

version 가 가 The REG procedure p<0.05



Fig. 4. Two instruments were invented for rod de-rotation and screw wing cutting under the thoracoscopic guide.



Fig. 5. The screw cap was broken during the wing cutting.

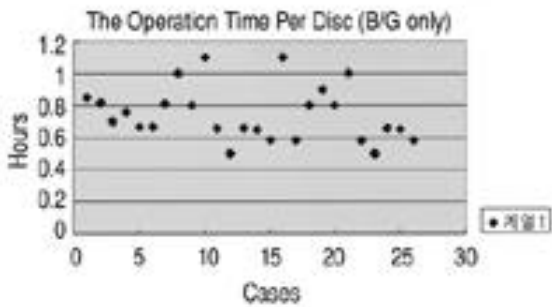


Fig. 6. The operating time per disc by case number in total case (n=26).

10.5 cm       $17 \pm 4.04$       ,       $156.9 \pm$   
 Cobbs       $49.4 \pm 12.3$  kg      .      26  
              $54.5 \pm 13.9$  ,       $20.6 \pm 12.2$  ,  
              $24.0 \pm 13.9$  .      62% .  
                             가 가  
 44.3 .

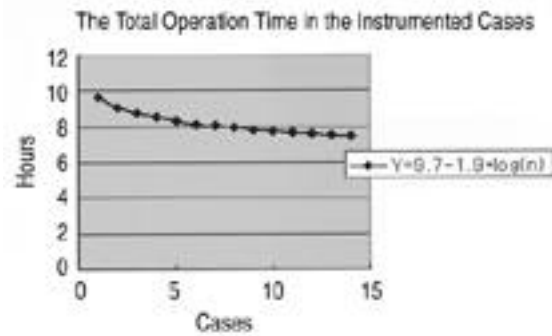


Fig. 7. Total operation time in instrumented cases (n=14).

$5.2 \pm 0.97$  ,  
 ,  
 14       $7.3 \pm 1.3$  ,       $1.37 \pm 0.25$   
 .  
                             27       $3.87 \pm 0.87$  ,  
                              $0.76 \pm 0.18$  .  
                             14  
                             ,  
                             ,  
                             (Fig. 6, 7, 8).  
                             12      (stages operation)  
                             2 .  
                             가  
                             ,  
                             ( , ,

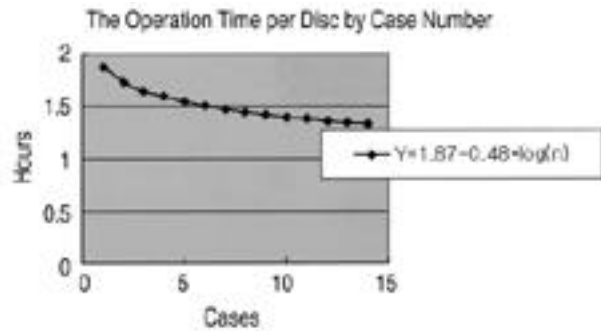
**Table 1.** Equation of Learning Curve in Instrumentation Cases (n=14)

				p
Formula I	$y=9.7 - 1.9 \times \log(n)$	r=0.52	Adj-r=0.54	p<0.01
Formula II	$y=1.87 - 0.48 \times \log(n)$	r=0.48	Adj-r=0.46	p<0.05

y: , n: , r: , Adj-r:

, p:

) SAS 8.1 version  
 The REG procedure  
 , 14  
 (formula ), (formula )  
 가 가  
 가  
 (Table 1). 26  
 가 가



**Fig. 8.** Operating time per disc by case number in instrumented case (n=14).

748.9 ± 254 mL, 152.6 ± 65.6 mL  
 2 4  
 12.8 1  
 2 가  
 2 가

가 26 1  
 가 2  
 가 3 1 , 1  
 8.5 ± 3.0 , 100  
 1407.9 ± 502.1 mL  
 mL 2 가 1~3 (parameters)

(screw cap)가 가 3 가 가  
 가 (Fig. 5), 4  
 (sing lung ventilation)  
 (mucus plug)  
 , 3 38 . 4  
 . 4  
 3 가 가 가  
 38. 7. 3  
 1 가  
 가 가 가

gle lung ventilation) (sin-  
 가 가 (Fig. 6).  
 10 30  
 (working length) 30 cm 54.5 62  
 7 가 5<sup>13)</sup>  
 Newton<sup>13)</sup>  
 1, 2 366 ± 393 mL 748.5 ± 254 mL (152.6 ±  
 65.6 mL per each disc)  
 (log) 1, 2  
 1 r, p 0.05 가  
 (y=9.7 Neilipovitz<sup>14)</sup> Cobb's<sup>56</sup>  
 -1.9 × log.n) 10 7.8 1784 ± 733 mL  
 8 30 9  
 가 3 30  
 20 270 ± 154 mL<sup>14)</sup>  
 5 30 가  
 100 가  
 30 가  
 가, 30 가  
 가 5 가  
<sup>13)</sup> Huang<sup>12)</sup> 가  
 25 가  
 40<sup>15)</sup>  
 1407 ± 502 mL Newton<sup>13)</sup>  
 (skill), 733 ± 438 mL  
 (single lung anesthesia) 3.5 8.5  
 1 (醫)가 10 30  
 (VAST) 2  
 (Harmonic Scarlpel, Ethicon Endosurgery, NJ) 1  
 가 가 가 10 가 4  
 1~3  
 가 3 가 10.1  
 45 가 .3  
 30 가 가 1 가

가 가

(醫)

(醫),

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	:		
	:	2002 07	2003 02
	:	23 (King type II ;15 , III ;5 , IV ;3 ) ,	26
1	:	14	2
11	:	1	
	:	5.2 ± 0.97	
14	:	7.3 ± 1.3	26
	:	1.37 ± 0.25	
	:	3.87 ± 0.87	가 가
	:	0.76 ± 0.18	
	:	748 ± 254 ml (	Cobb 's 54.5
	:	152.6 ± 65.6 ml)	(screw cap)가
	:	± 13.9%, 20.6 ± 12.2%,	
	:	24.0 ± 13.9%, 62%	
	:	(n=3), (n=4), (n=4)	
	:		
	:		
	:		

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