

RESULTS AND COMPLICATIONS OF SEGMENTAL SUBLAMINAR WIRING (SSI) METHOD

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Segmental Sublaminar Wiring Method (SSI), is being used especially in the surgical treatment of idiopathic scoliosis, neuromuscular spinal deformities and vertebral fractures. There are many studies reporting high correction loss and complication rates of this system. In this study 21 patients whom were treated by Luque-SSI or Hartshill-SSI at the 1st Orthopaedics and Traumatology Clinic of Ankara Social Security Hospital between October 1991 and January 1992 were evaluated. Mean follow-up period was 13.2 (6-21 m) months. When all the patients with idiopathic scoliosis were included mean Cobb angles of the main curves were corrected by 45.2 % (28.9 % - 73.3 %). In 30.8 % of the patients in this group normal physiological kyphosis was restored. 28.2 % (26.3 % - 31 %) and 70 % of corrections were obtained in 3 neuromuscular scoliotic patients with pelvic tilt and in 1 neuromuscular scoliotic patient without pelvic tilt whom Galvestone method was used, respectively. During follow-up average-ly 17.3° (3°-45°) of correction loss in idiopathic scoliosis and 21.3° (13°-34°) of correction loss in neuromuscular scoliosis were observed. Complications occurred in 57.1 % of the patients. 14.3 % neurologic deficit and 4,8 % post-operative exitus was seen.

Based upon these findings it was thought that besides high correction rates with sublaminar wiring method, this system could be used only in selected cases as it has high neurologic deficit risk and high complication rates.

Key words: Scoliosis, Spinal fractures, Segmental Spinal Instrumentation.

INTRODUCTION

The technique of segmental spinal instrumentation (SSI) utilizing multiple sublaminar wires was developed by Eduardo Luque in Mexico City (17, 18). The internal fixation provided has been efficient enough to convince many spine surgeons that external immobilization is not needed postoperatively (8, 14, 21). Most centers, however, rarely use this system for idiopathic scoliosis and spinal trauma because of the potential complications (10).

In this study, we report the results of 21 patients with spinal deformity or spinal fractures treated by Luque-SSI or Hartshill rectangle.

PATIENTS and METHOD

From October 1991 to January 1992, 21 SSI were performed at the 1st Orthopaedic and Traumatology Clinic of Ankara Social Security Hospital. Average follow-up period was 13,2 (6-21) months. 14 of the patients were female and 7 patients were male.

In the clinical examination of the scoliotic patients, besides a systemic and detailed neurological examination, posture properties, direction and location of the curve, rib hump deformity and deviation of the weight

line from the intergluteal crease were measured. In the radiological assessment of these patients, antero-posterior, lateral and bending radiograms were taken with the patients standing up and the type of the curve was determined using the King Method. Cobb angle in the frontal plane was measured, flexibility was evaluated and type of the curve was defined.

All patients with spinal fractures underwent a detailed clinical examination and associated orthopaedic problems were treated. Besides antero-posterior and lateral radiograms, oblique views of the spine were taken when indicated. In all cases, computed tomographic examination was performed and the type of the fracture according to Dennis was determined (4). The presence of bone fragments in the canal was searched for and the percentage of compromise of the canal calculated. Compression percentage and sagittal index was also measured. A meticulous neurological examination was carried out and neurological status was graded according to the system of Frankel from A to E (10).

Except for the patient with neuromuscular scoliosis, all patients underwent a one-stage posterior procedure with hypotensive general anesthesia. In the neuromuscular curves, anterior release with or without instrumentation was performed followed by posterior instrumentation. In all of the patients, posterior fusion

was done with autologous bone grafts. Postoperatively, the patients were allowed to walk on the third day, were seated on the second day and discharged on the 10-15 days. No external support was used and patients were recalled for postoperative controls in the 1., 3., 6., 12., and 18. months.

RESULTS

Idiopathic Scoliotic Patients

13 of the patients had late onset idiopathic scoliosis. Mean age was 13,9 (8-18). Preoperative evaluation of the patients showed that, 1 patient had a Type I, 6 patients had a Type II and only 1 patient had a Type IV curve according to the King classification. Type II curves were divided in two groups according to their sagittal contour types. Of the 6 patients with Type II curves, 5 had lordosis and one had hyperkyphosis in the thoracal region.

A Hartshill rectangle was used in 12 cases and the Luque-SSI system was used in the remaining case with a Type I curve.

Preoperative and postoperative Cobb and sagittal contour angles are seen Table-1 and Table-2. The patient with Type I curve treated by Luque-SSI had a 50° curve in the lumbar region preoperatively. Postoperatively 40 % of correction was obtained in this patient.

In Type II curves, preoperative mean Cobb angle was 65° in the thoracal region and a mean correction of 41,5 % was achieved after surgery. In Type III curves, mean Cobb angle was 47,4° and 58,4 % of correction was obtained postoperatively.

The patient with a Type IV curve had a 48° curve in the thoracolumbar region and 50 % correction was achieved. When all the patients with idiopathic scoliosis were included mean Cobb angles of the major curves were corrected by 45.2 %. In 30,8 % of the patients in this group, physiological thoracal kyphosis was restored (Table-3). The highest correction was achieved in Type III flexible curves by using the Hartshill rectangle in which a derotation manoeuvre had been performed and this group was followed by thoracolumbar curves (Type IV) and thoracal rigid curves (Type II).

The patients with neuromuscular scoliosis:

4 patients had neuromuscular scoliosis due to poliomyelitis. Mean age was 13(11-14). In the radiological evaluation, "C" type curves were found in all cases of this group. Three of them had a pelvic tilt. In one of the patients with pelvic tilt, the Galveston technique

was used and in the remaining 2, Luque-SSI was utilized. Preoperative mean Cobb angle was 78° (70°-90°) in the patient treated with Luque-SSI and in the remaining patient treated with the Galveston technique mean Cobb angle was 60°. Preoperatively, lumbar lordosis was decreased in the sagittal plane (mean 15°).

In the patients treated with Luque-SSI, 28,2 % (26,3 % - 31 %) of correction was achieved. In the Galveston group 70 % of correction was obtained. In all patients of the neuromuscular scoliosis group 11,8° (4°-18°) of improvement was achieved in lumbar lordosis and thus they were brought to 20° deviation from the normal limits.

Spinal fractures:

The etiology was a motor vehicle accident in all of the patients. All cases were operated on the same day of their admittance. After radiological and CT examination, 2 were found to have a burst fracture in T-12 and L-1. One of remaining patients had a burst fracture in the T-3 and dislocation between T-3 and T-4. The other had burst fracture in the T-7 and dislocation between T-6 T-7. A Hartshill rectangle was used in all of the cases.

Preoperative and postoperative percentages of compression (CP), sagittal index (SI) at level of fractured vertebra and compromise of spinal (SC) canal values are seen in Table 5.

When all the cases were included the mean preoperative SI that had been 22,3° (20°-25°) was corrected by 30,3 % (15 % - 58,3 %) averagely. In the CP, mean correction was 20,6 % (0 % - 45,5 %). Mean preoperative SC was 47,3 % (35 % - 61 %). Postoperative CT scans demonstrated a correction of 30,1 % (18,2 % - 42,9 %). Best results were achieved in patients with a burst fracture in the thoracolumbar junction.

According to the Frankel Classification, 3 patients had grade "A" neurologic deficit preoperatively. One patient had a Frankel "C" neurologic deficit. The neurological status remained unchanged in 3 cases and improved from grade C to D in one case.

Follow-up and complications:

During follow-up, averagely 17,3° (2°-45°) of correction loss in idiopathic scoliosis and 24,3° (13°-34°) of correction loss in neuromuscular scoliosis was observed.

In idiopathic scoliotic curves, averagely 63,9 % loss of correction was found. In 6 cases in this group the Cobb angles increased and reached preoperative

Table 1: According to different types, preoperative and postoperative Cobb Angles of main curves and percentages of correction. (n = number of patient).

Type of curve	Preoperative	Postoperative	Percentage of Correction
Type I n = 1	50°	30°	40,0
Type II n = 6	65° (52°-75°)	42,5° (35°-50°)	41,5 (28,9-38,7)
Type III n = 5	47,4° (42°-50°)	19,6° (12°-25°)	58,4 (40,5-73,3)
Type IV n = 1	48°	24°	50
TOTAL n = 13	61,9° (42°-75°)	31,4° (12°-50°)	45,2 (28,9-73,3)

Table 2: According to different type of curves, thoracal and lumbar sagittal contours (T: Thoracal, L: Lumbar, LR: Lordotic, K: Kyphotic)

Type of curve		Preoperative	Postoperative	Amount of Correction
Type I n = 1	T L	20° 30°	25° 45°	5° 10°
Type II LR n = 6	T L	13,2° ((-6°)-20°) 25° (16°-30°)	27,5° (16°-40°) 36,4° (22°-50°)	13,6° (2°-22°) 11,4° (3°-20°)
Type II K n = 1	T L	65° 30°	38° 45°	27° 15°
Type III n = 5	T L	9,6° (6°-12°) 23,6° (18°-30°)	23° (16°-25°) 32,8° (25°-40°)	13,4° (10°-15°) 9,2° (5°-15°)
Type IV n = 1	T L	30° 30°	30° 45°	0° 15°

Table 3: Thoracal sagittal contour angles of the patients according to normal limits, postoperatively

	Type I	Type II	Type III	Type IV	Total
Within normal limits	-	3 (% 50)	-	1 (% 100)	4 (% 30,8)
Deviation less than 10°	1 (% 100)	1 (% 16,7)	4 (% 80)	-	6 (% 46,2)
11°-20° deviation	-	2 (% 33,3)	1 (% 20)	-	3 (% 23,0)
Total	1 (% 100)	6 (% 100)	5 (% 100)	1 (% 100)	13 (% 100)

levels and in 2 of them progressed to levels higher than the preoperative values.

In the neuromuscular curves, an average of % 55,8 loss of correction was observed. In one of the patient, the Cobb angle returned to the preoperative level and in one of them even increased to a value more than the preoperative level.

A 61,2 % loss of correction was observed in the sagittal index of the patients with a spinal fracture. In two cases the SI values came to their pre-operative levels.

Complications occurred in 12(57,1 %) of the cases. In 6(28,6 %) patients, rod migration was seen. Wire breakage was found in the 2(9,5 %) patients. A lominar tear occurred in one case. One superficial and one deep infection was encountered.

A patient (% 4,8) with a T-3 burst fracture and dislocation between T-3 and T-4 died of the cardiopulmonary insufficiency.

In 3 (% 14,3) patients an iatrogenic neurologic deficit occurred resulting in total paraplegia bilaterally.

DISCUSSION

The idea of wiring the spina is not new. Posterior segmental wiring of the spine has been popularized by Luque. Since then the technique has spread rapidly (16, 17). This instrumentation system offers more rigid fixation than the Harrington distraction system, with the possibility by superior correction of sagittal plane deformities of the spine (10).

The Luque technique and its modifications can achieve a good correction and stable internal fixation. By bending the rod sagittal contours can be provided (4-7, 16, 17). However, Leatherman et al (14) Winter and Anderson (21), Moore and Eilest (18), Herring and Wenger (11) have observed a significant loss of correction without the use of postoperative external support in their series of Luque instrumentation.

Hullin et. al. found the Luque instrumentation to be an effective method of correcting thoracic and thoracolumbar curves in the frontal plane with a 59 % and 63 % respective reductions in the preoperative Cobb angle. Despite the frontal plane correction, however, the rib hump was reduced in only 6 patients (12).

Biomechanical testing of system has shown its resistance to compression is equal to Cotrel-Dubouset system, but is lower than CDI in ventral flexion, posterior flexion, lateral bending and rotational forces (13, 19).

In this study, 21 patients treated with Luque-SSI or

Hartshill-SSI were evaluated. When all the patients with idiopathic scoliosis were included mean Cobb angles of the major curves were corrected by 45,2 %. In 30,8 % of them physiological thoracic kyphosis was restored. But, during the follow-up period, averagely % 63,9 loss of correction was found.

In the patients with neuromuscular scoliosis, treated by Luque-SSI 28,2 % correction was obtained, but 70 % of correction was achieved in the Galveston group. In this group; an average % 55,8 loss of correction was observed. SSI is less commonly used in spinal fractures than scoliotic deformities. Physiological sagittal contours can be provided by bending the rods but as no distractive force can be applied, no significant correction in vertebral height is expected. In our study although a 30,3 % correction was obtained in the sagittal index in cases with burst fractures, there was no significant correction in spinal compromise and neurological improvement was seen in only one case. The best results were obtained in fractures involving the thoracolumbar junction. A 61,2 % loss of correction in the sagittal index was observed during the follow-up period.

Our correction rates were in accordance with the literature. The maximum amount of correction was obtained in cases with neuromuscular scoliosis treated with the Galveston technique followed by Type III curves instrumented with the Hartshill System in which a derotation manoeuvre had been performed. Although high rates of correction were obtained, the high rates of loss of correction led us to advocate the use of an external support for 4-6 months postoperatively.

The major disadvantage of the system is the potential for neurologic complications (2, 9, 11, 15). Indeed, Wilber et al reported neurological injury to be as prevalent as 17 % (20). In a survey of members of The British Scoliosis Society the prevalence of neurological complications was in the order of 4 percent and that figure is still too high (5). The iatrogenic neurological deficit rate in our study was 14,3 %.

Rod migration, wire breakage as a result of bending or torsional forces during activity or trauma have been reported (1, 10, 11, 18). In 1989 Johnston and Ashman began seeking a mechanical solution to the problem of rod migration in SSI. They determined that during weight bearing loss of fixation and correction was inevitable, especially in the osteopenic patients and when posterior elements weren't fixed with wires. They developed the TSRH crosslink plates which in-

Table 4: According to type of the surgical technique, preoperative and postoperative Cobb angle of the patient with neuromuscular scoliosis

	Preoperative	Postoperative	Percentages of Correction (%)
Luque-SSI n = 3	78° (70°-90°)	55,7° (48°-65°)	38,2 (26,3-31,4)
Galveston n = 1	60°	18°	70,0
Total n = 4	73,5° (60°-90°)	44° (18°-65°)	38,7 (26,3-70)

Table 5: According to type of the fracture preoperative and postoperative percentag as of compression (CP), sagital index (SI) at level of fractured vertebra and compromise of spinal canal (SC)

		Preoperative	Postoperative	Percentages of Correction (%)
Burst n = 2	CP (%)	57,9° (55°-60°)	40° (30°-50°)	31,1 (16,7-45,5)
	SI	24,5° (24°-25°)	16° (14°-18°)	43,2 (28-58,3)
	SC (%)	39,5° (35°-44°)	38° (20°-36°)	30,6 (18,2-42,9)
Fracture - Dislocation n = 2	CP (%)	50° (50°-50°)	45° (40°-50°)	10,0 (0-20)
	SI	20° (20°-20°)	16° (15°-17°)	17,5 (15-20)
	SC (%)	55° (49°-61°)	38,5° (36°-41°)	29,7 (26,5-32,8)
Total n = 4	CP (%)	53,8° (50°-60°)	42,5° (30°-50°)	20,6 (0-45,5)
	SI	22,3° (20°-25°)	16° (14°-18°)	30,3 (15-58,3)
	SC (%)	47,3° (35°-61°)	30,8° (20°-41°)	30,1 (18,2-42,9)

Table 6: Loss of correction (LC) during the follow-up period

		Preoperative	Amount of LC	Percentages of LC (%)
Idiopathic Scoliosis n = 13	Cobb Angle	61,9° (42°-75°)	17,3° (2°-45°)	63,9 (18,2-180)
Neuromuscular Scoliosis	Cobb Angle	73,5° (60°-90°)	21,3° (13°-34°)	55,8 (20-80)
Spinal Fractures	Sagital Index	22,3° (20°-25°)	7,7° (4°-13°)	61,2 (23,5-100)

Table 7: Complications

	Number of Patients	%
Rod migration	4	19,0
Rod migration and wire breakage	2	9,5
Tearing of lamina	1	4,8
Superficial infection	1	14,3
Deep infection	1	4,8
Iatrogenic neurologic deficit	3	14,3
Total	12	57,1

creased the resistance to upwards-downwards sliding forces (13). In our series, 28,6 % of rod migration and an important rate of wire breakage was noted.

In most clinics the SSI is now used solely in the treatment of neuromuscular scoliosis with pelvic obliquity where pelvic fixation is indicated (9). Our results demonstrate that although high correction rates can be obtained in idiopathic scoliosis with Hartshill-SSI or Luque-SSI, a significant amount of correction loss is inevitable if no external support is used postoperatively. The instrumentation is not suitable for the treatment of vertebral fractures and complications such as rod migration, wire breakage and neurological deficit potential are other major disadvantages.

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