Acta Med. Nagasaki 33 : 63–67

New Spinal Instrumentation for Thoracic and Lumbar Spine a Preliminary Clinical Report

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Received for publication, April 18, 1988

SUMMARY : The new system described here is a segmental square spinal instrumentation (termed 3-S) for spinal fusion. It consists of pairs of transverse bars, hooks and longitudinal rods. The hooks are inserted bilaterally to each lateral side of the inferior articular process. The paired hook are compressed by two transverse bars and a nut. Upper and lower hooks were linked by longitudinal rods. Clinically, we have performed 15 cases from 1984, seven cases of tumor and four cases of traumatic fracture-dislocation and one of tuberculous spondylitis, spinal canal stenosis, spondylolisthesis and RA. The levels were thoracic spiine in eight cases, thoraco-lumbar spine in four cases, and lumbar spine in three cases. The procedure was combined with postero-lateral fusion in six cases, and anterior spinal fusion in three cases with good results except one.

INTRODUCTION

With the development of spinal instrumentation, spinal surgery has recently made great strides. The applications of spinal surgery have also became wide, involving such spinal deformation as scoliosis and kyphoscoliosis, traumatic injuries such as fractures, dislocations, etc., spinal tumors —primary and metastatic—, and other unstable conditions of the spine.

We have produced a segmental square spinal instrument (termed 3-S instrument) by which the lamina is positioned between right and left sided hooks by the posterior approach, and the lamina is bound with two rods positioned vertically to it. The experimental test for strength has already been reported.[7] This is a preliminary report of its clinical application.

METHODS

New Spinal Instrumentation

(Segmental Square Spinal Instrumentation)

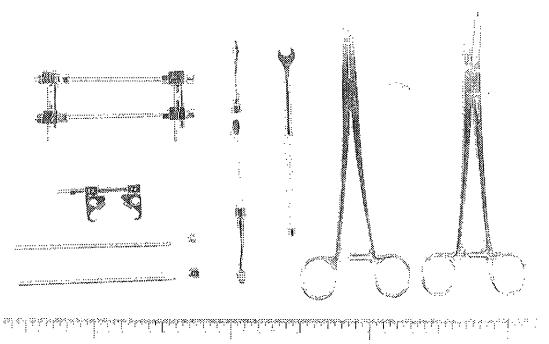

Fig. 1. New Spinal Instruments (3-S) System

The spinal instruments we have produced consist of two pairs of hooks and two pairs of interconnecting rods. The hooks are placed laterally on each side of the vertebral zygapophysis, and are connected by a horizontal bar. Each horizontal segment is then jointed to an adjacent

level above or below with paired vertical bars. The rod is threaded, and the bar is firmly fixed to it with nuts. The hooks can be fixed at several sites for every zygapophysis, and the rod and bar construction takes a square from. For this reason, the procedure using the instruments was tentatively called segmental square spinal instrumentation (termed 3-S instrumentation).

Two kinds of 3-S instruments were produced, one for the thoracic spine and one for the lumbar spine, according to the size of the hook.

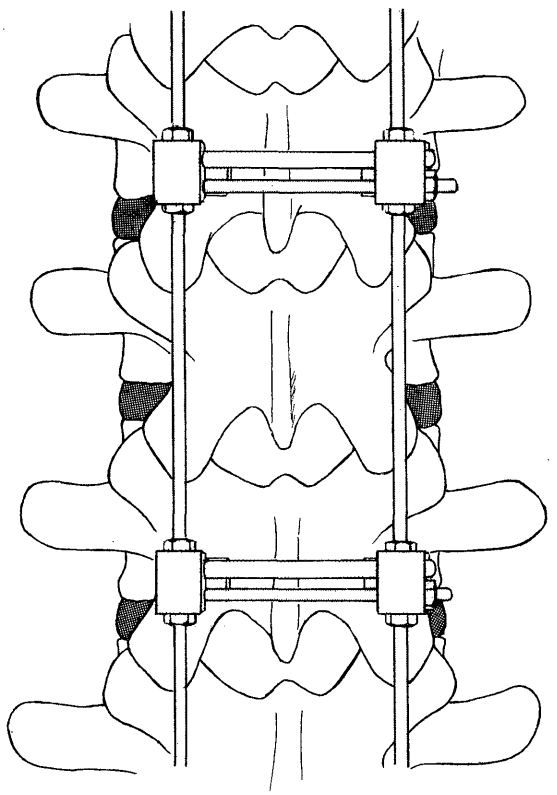

Fig. 2. Schema of fixation by New Spinal Instruments

Clinical Application

Between January 1984 and December 1987, the instruments were used in fifteen patients at Miyazaki Medical College Hospital. Their ages ranged from 23 to 79 years (with a mean age of 57 years). Seven patients had spinal tumors, four had fracrures and dislocations, and one of spinal canal stenosis, tuberculous spondylitis, spondylisthesis and RA. The instrument was applied at the following levels, eight patients had them attached at the thoracic spine, four at the thoracolumbar spine, and three at the lumbar spine. The mean follow-up period was one year and six months. Fixation bridging four intervertebral spaces in five cases. The operation was combined with laminectomy in twelve patients, with postero-lateral fusion in six cases and anterior fusion in two cases.

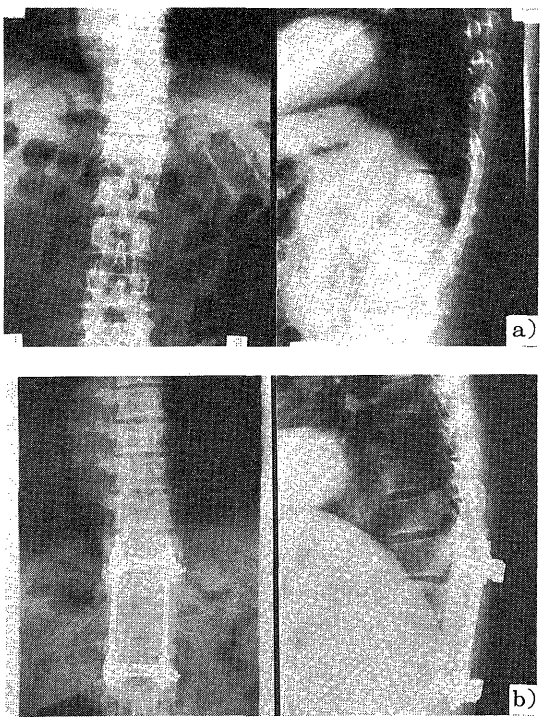

Fig. 3. Case 3 (N.T. : 54 years, male) incomplete paraplegia due to traumatic fracture

a) pre-operative feature (4th Sept., 1984) new instrumentation with laminectomy and postero-lateral fusion was carried out at 8th Oct., 1984.

b) One year and Seven months after surgery (20th May, 1986)
Postero-lateral fusion was solid.
New instruments were removed at 29th Sept., 1986.
Now, he can walk with one cane.

RESULTS

All the patients showed good stability postoperatively, except for one patient who underwent

Table 1. Subjects summaries of new instrumentation

No.	name	age	sex	diagnosis	surgical procedure	fusion area by new instruments
1	Y.I	54	M	metastatic spinal tumor (lung cancer)	new instrumentation with laminectomy, and anterior curettage and fusion	T_{1-4}
2	N.H	73	F	deg. spinal canal stenosis	new instrumentation with laminectomy and postero-lateral fusion	L_{3-5}
3	N.T	54	M	traumatic fracture	new instrumentation with laminectomy and postero-lateral fusion	T_{11}-L_2
4	K.T	23	M	traumatic fracture-dislocation	new instrumentation with laminectomy and postero-lateral fusion	T_{11}-L_2
5	K.T	66	F	metastatic spinal tumor (breast cancer)	new instrumentation with laminectomy	T_{3-7}
6	H.S	79	F	multiple myeloma	new instrumentation with removal of tumor and laminectomy	T_{6-10}
7	K.M	74	F	spondylitis tbc.	new instrumenthtion with anterior curettage and fusion	T_{8-12}
8	K.T	53	F	traumatic fracture-dislocation	new instrumentation with laminectomy and postero-lateral fusion	T_{10-12}
9	K.T	55	M	metastatic spinal tumor (malignant lymphoma)	new instrumentation with removal of tumor and laminectomy	T_{8-12}
10	K.M	42	M	metastatic spinal tumor (lung cancer)	new instrumentation with laminectomy	T_{10}-L_1
11	S.M	68	F	multiple myeloma	new instrumentation with laminectomy	T_{4-8}
12	K.K	31	M	spondylolisthesis	new instrumentation with laminectomy and postero-lateral fusion	L_{3-5}
13	M.M	76	M	metastatic spinal tumor (prostata cancer)	new instrumentation with laminectomy	T_{4-8}
14	N.S	54	M	traumatic fracture-dislocation	new instrumentation with postero-lateral fusion	T_{12}-L_2
15	I.F	55	F	pathological compression fracture (RA)	new instrumentation with anterior decompression and fusion	L_{1-3}

removal of the instrument two months after the operation because of postoperative superficial infection. At present the patient is under rehabilitation with a brace. Of the remaining fourteen patients, a second patient (case 3) with incomplete paraplegia due to compression fracture underwent removal of the instrument two years after the operation. Bone union was favorable as a result of postero-lateral spinal fusion which was carried out at the same time as 3-S instrumentation. However, four patients died due to progression of their primary tumor; lung cancer (case 1 and 10), breast cancer (case 5) and malignant lymphoma (case 9).

DISCUSSION

The first purpose of spinal instrumentation is to obtain firm fixation. There have been various reports on the posterior approach. Harrington instrumentation by Paul R. Harrington in 1962,[3] a transverse traction system by Cotrel, a transverse locking system by Connoch *et al.*,[1] Chiba rod by Inoue *et al.*,[4] and improvement of the hook by Bobechiko. Harrington's distraction and compression system are still being used widely, with presentation of many excellent results. On the other hand, E.R. Luque presented segmental spinal instrumentation by wiring in 1977, which allowed correcting force and firm fixation.[5] Therefore, this instrumentation is also widely used.[6]

As for spinal instrumentation by the anterior approach, Dwyer used a screw and a staple to give the vertebral body flexibility in 1969,[2] and Zielke presented V.D.S. (Ventral Derotations

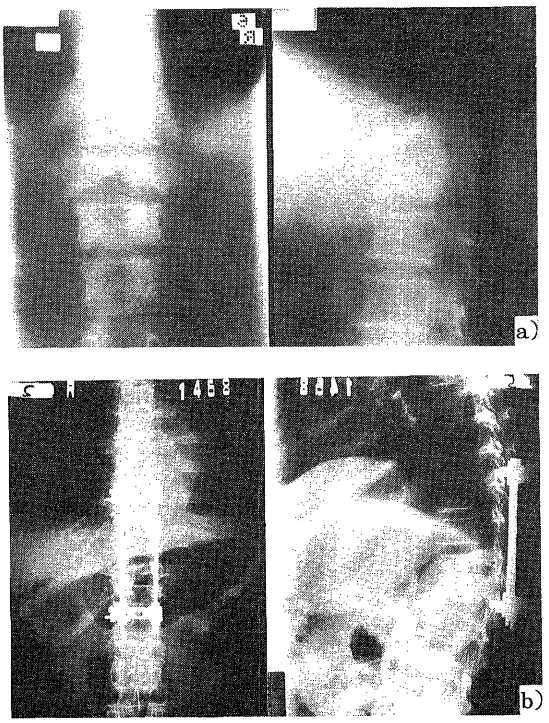

Fig. 4. Case 7 (K.M. : 74 years, female)
gait disturbance and myelopathy due to tuberculous spondylitis.
a) pre-operative tomography
Destructive change of eleventh thoracic vertebrae was observed.
Two staged operation was done, one of laminectomy and new instrumentation at 6th Oct., 1986 and next one of anterior curettage and fusion at 20th Nov.,1986.
b) Six months after second surgery (20th May., 1987)
Now, her general condition is good.

Spondylodese) as a result of improvement in Dwyer's operation.[11]

In a biomechanical study of spinal instrumentation, Wenger demonstrated that the segmental instrumentation was definitely mechanically superior to the conventional Harrington system in terms of correction of scoliosis.[8)9)] He showed the advantage of the segmental fixation for stability by conducting biomechanical tests in the following combinations: (1) Harrington distraction, (2) Harrington distraction and transverse traction, (3) Harrington distraction and segmental lamina wire, (4) Luque double L rods and segmental lamina wire, and so on.

According to M. Yamagata who carried out a biomechanical study of posterior spinal instrumentation, of various combinations, the combination of Harrington-Luque[10)] instrumentation exerted the strongest fixation force, followed by the Luque-L-rod, Harrington wiring, Harrington transverse system, and Harrington instrumentation, in that order.

Previously we conducted stress tests of our new type of posterior spinal instrumentation in order to study the basic strength of the instrument, and compared it with various standard models.[7)] From these results, our new instrument was considered to be strongest for bending test, with the least deformation produced. The improved strength of the 3-S instrumentation make it well suited clinically for obtaining spinal stability.

Although we applied the instrumentation clinically to only fifteen patients in the present trial, a relatively strong fixation force could be obtained after operation. Seven of the fifteen patients had had spinal tumors, and even if bone destruction had advanced considerably, stability could be obtained by fixation of the intact upper and lower vertebral bones. The present instruments yield firm fixation, not only transversely but also longitudinally by positioning the lamina between the sides of the instrument, and by tightening the upper and lower points of the rod with laminectomy and postero-lateral fusion, they can be applied to treatment of spinal tumors, and they can be used fixation for dislocation fractures. From these features it is probable that the range of their application will increase.

The disadvantage of the instruments is their slightly large size. They can occasionally protrude posteriorly in slender patients, those with muscular atrophy, etc. The fact that the new instruments yield firm fixation for the thoracic and lumbar spine, suggests can be widely applied for the purpose of stabilbty of the spine.

CONCLUSION

New spinal Instrumentation (segmental

square spinal; 3-S instrument) was applied in our first clinical trial of 15 patients.

It has been experimentally demonstrated that the instrumentation yields a fixation force as firm as that of any conventional instrument, and was clinically confirmed in this study. In the present trial, it was effective for patients with spinal tumors and dislocation fractures in whom laminectomy was used together with instrumentation. The range of the applications of the instruments will be further increased in the future.

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