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

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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 spine 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 become 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)

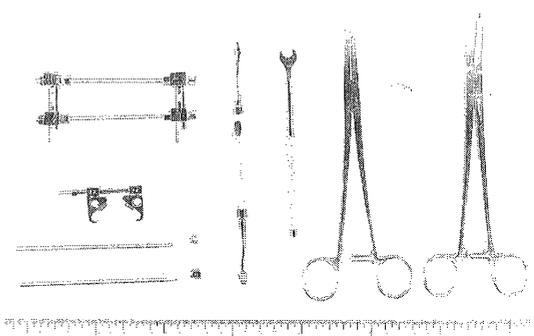


Fig. 1. New Spinal Instruments (3-S) System

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 form. 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.

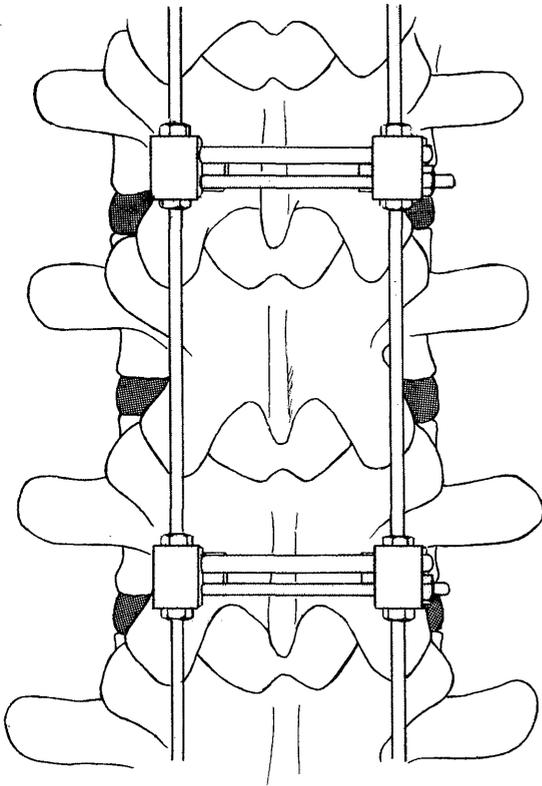
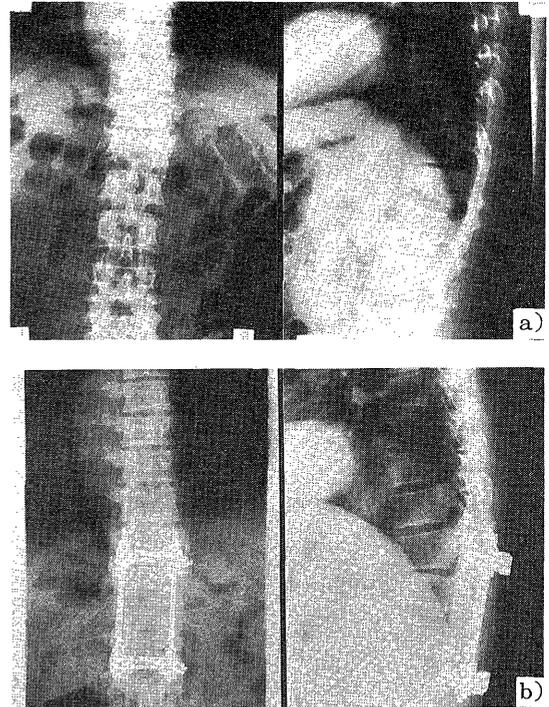


Fig. 2. Schema of fixation by New Spinal Instruments

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 fractures and dislocations, and one of spinal canal stenosis, tuberculous spondylitis, spondylolisthesis 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-L₂}
4	K.T	23	M	traumatic fracture-dislocation	new instrumentation with laminectomy and postero-lateral fusion	T _{11-L₂}
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 instrumentation 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-L₁}
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 (prostate cancer)	new instrumentation with laminectomy	T ₄₋₈
14	N.S	54	M	traumatic fracture-dislocation	new instrumentation with postero-lateral fusion	T _{12-L₂}
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

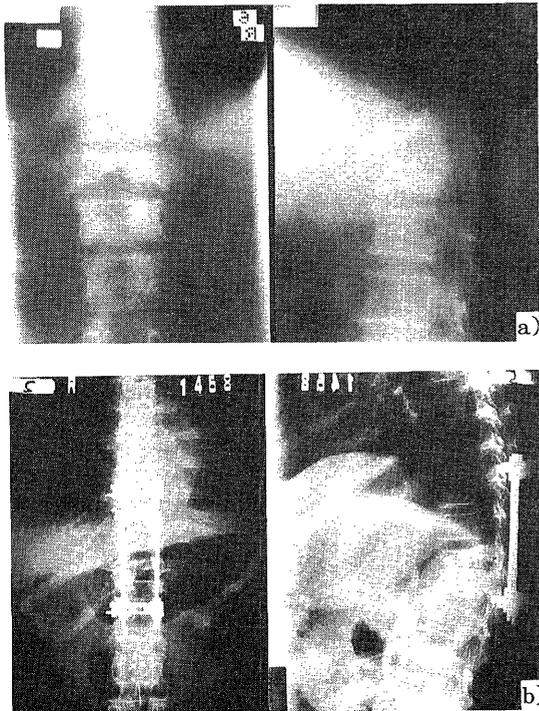


Fig. 4. Case 7 (K.M.: 74 years, female)
 gait disturbance and myelopathy due to
 tuberculous spondylitis.

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 cu-
 rettage 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 instrumen-
 tation, Wenger demonstrated that the segmen-
 tal 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 dis-
 traction, (2) Harrington distraction and trans-
 verse 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 in-
 strumentation, of various combinations, the
 combination of Harrington-Luque¹⁰⁾ instrumen-
 tation exerted the strongest fixation force, fol-
 lowed 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 in-
 strument, and compared it with various stand-
 ard models.⁷⁾ From these results, our new in-
 strument was considered to be strongest for
 bending test, with the least deformation pro-
 duced. The improved strength of the 3-S in-
 strumentation make it well suited clinically for ob-
 taining 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 fif-
 teen 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 pro-
 trude 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 ap-
 plied for the purpose of stability 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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