

Combined Instrumentation with the Soft and Rigid Stabilizer in Degenerative Lumbar Disorders

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= Abstract =

From January 1992 to May 1993, we performed a new method of spinal instrumentation, namely the combined instrumentation with the soft and rigid stabilizer, to minimize the adverse effects induced by rigid multi-segment fixation and fusion in twenty patients with complex degenerative lumbar disorders.

By using this combined method, we were able to preserve one or two more motion segments from the fusion. And we also expect that the rate of deterioration at the adjacent motion segments to the fusion level will decrease. Though the follow-up period is short, the clinical results were satisfactory in 80% of the patients. We think that this combined instrumentation can be a choice of treatment for complex multi-segment lumbar disorders.

Key Words : Lumbar spine, Complex multi-segment lumbar disorders, Combined instrumentation

INTRODUCTION

These days various spinal instruments are used in the treatment of degenerative spinal disorders to provide stability immediately following surgery and to keep the injured segment aligned until the fusion process is complete. These devices, however, are considered too rigid. Consequently, some

authors do not recommend using these devices because of their adverse iatrogenic effects^{8,14,16,19}. For example, a number of authors have noted an increase in spinal stenosis/spondylolysis both above and below the fusion level. The side-effects of the rigid fixation may be more problematic when a long segment fixation was performed.

We therefore performed a new combined method of soft and rigid stabilization in those selected cases with multi-segmental degenerative lumbar disorders to minimize the problems induced by the long segment fixation and fusion

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with rigid instrumentations.

MATERIAL AND METHOD

During the period from January 1992 to May 1993, we've performed the combined instrumentations on 20 patients of multi-segmental degenerative lumbar disorders, and we also conducted follow-up studies from 12 months to 29 months on those patients.

1. Composition of the combined instrumentation system

We used to VSP Steffee system as a rigid stabilizer on 19 patients and the Cotrel-Dubousset system on one, while the Graf system was used as a soft stabilizer on every case(Fig. 1).

2. Method of instrumentation

The patient was placed in the prone position, and the spinous processes of the levels to be decompressed were identified and removed. After removal of the thickened ligamentum flavum, the

nerve roots were identified and traced out to the foramens. If there was further restriction, foraminotomy with partial or complete facetectomy was performed. The levels to be decompressed were determined before the operation through physical assessment and radiographic evaluations. The rigid and soft instrumentation sites were finally determined according to the severity of the lesions and the extent of the decompression during the operation. The rigid VSP Steffee system was applied on the segment that was anticipated to be unstable after extensive decompression or one the segments witholisthesis. The soft Graf system was used on the proximal, distal or both adjacent motion segments to the rigid instrumentation that were decompressed partially and measured as having instability preoperatively. On the initial several cases of combined instrumentation, the Graf bands were connected between the integral nut of the Steffee transpedicular screw and the plate. Later the Steffee/Graf connecting system was devised

Fig. 1. The combined instrumentation system is composed of the VSP Steffee system and Graf system.

and used clinically(Fig. 2).

3. Postoperative care

The Hemovac suction drainage tube was removed on the second day following the operation. The patients were encouraged to ambulate while wearing the thoracolumbosacral orthosis during the first week after the operation as tolerated. The orthosis was applied for three months.

RESULT

1. Age and sex distribution

Ten of the patients were men and ten were women. The average age at operation was 51.6 years(range, 33-72 years). The majority of the patients were in their 5th and 6th decades(Table 1).

2. Classification of the diseases

All of the patients took conventional anteropos-

terior and lateral as well as functional radiographs. Then computerized tomography with myelography or magnetic resonance imaging were employed to confirm the pathologic lesions. We reviewed the preoperative radiographs and the operative findings retrospectively. All of the patients had multiple canal stenosis or canal stenosis associated with other degenerative disorders on more than two motion segments of the lumbar spine. Five patients had multiple spinal canal stenosis, and ten patients spinal canal stenosis associated with degenerative spondylolisthesis. The others were combined with spinal instability or degenerative scoliosis. The majority of the lesions were on L3-4, L4-5 and L5-S1(Table 1).

3. Signs and symptoms

The most common subjective complaint of the multi-segmental lumbar disorders was neurogenic

Fig. 2. A : The Graf band is connected between the integral nut of the Steffee screw and the plate. B : The advanced connecting system is used for application of the Graf band recently.

Table 1. Data on the patients

Case	Age	Sex	Diagnosis	Duration (year)	Levels of stenosis	Levels of rigid/soft*	Result
1	60	female	SCS, SPL	4	L4-5, L5-S1	L5-S1/L4-5	fair
2	52	male	SCS	2	L3-4-5	L4-5/L3-4	good
3	35	female	SCS, SPL	3	L3-4-5	L3-4/L4-5	excellent
4	44	male	SCS, SPL	1	L4-5, L5-S1	L4-5/L5-S1	excellent
5	33	female	SCS, INS	5	L3-4-5	L4-5/L3-4	good
6	60	male	SCS, SPL, SCL	10	L2-3-4-5, L5-S1	L3-4-5/L2-3	good
7	58	male	SCS, SPL, INS	1	L2-3-4	L3-4/L2-3	fair
8	60	male	SCS	2	L4-5, L5-S1	L5-S1/L4-5	good
9	57	female	SCS, SPL, SCL	7	L2-3-4-5	L3-4/L2-3, L4-5	fair
10	52	female	SCS, SCL	3	L2-3-4-5, L5-S1	L3-4-5/L2-3, L5-S1	good
11	56	male	SCS, SPL	5	L3-4-5	L4-5/L3-4	good
12	58	male	SCS, SCL	2	L2-3-4-5	L3-4/L2-3, L4-5	good
13	43	male	SCS, SPL, INS	10	L2-3-4-5	L3-4/L2-3, L4-5	poor
14	49	female	SCS	1	L4-5, L5-S1	L5-S1/L4-5	good
15	50	female	SCS, SPL	2	L4-5, L5-S1	L5-S1/L4-5	good
16	46	female	SCS, SPL	5	L3-4-5	L4-5/L3-4	excellent
17	72	male	SCS, SCL	2	L3-4-5, L5-S1	L4-5/L3-4, L5-S1	good
18	47	female	SCS, SCL	3	L3-4-5, L5-S1	L4-5/L3-4, L5-S1	good
19	50	female	SCS	2	L4-5, L5-S1	L4-5/L5-S1	good
20	49	male	SCS	3	L3-4-5	L4-5/L3-4	good

SCS ; spinal canal stenosis, SPL ; degenerative spondylolisthesis, SCL ; scoliosis INS ; spinal instability

*rigid instrumentation and fusion/soft stabilization

claudication, which was noted in all patients. Buttock pain or radiating pain to the leg were also frequent complaints. Upon physical examination, sensory hypoesthesia was noted in six, decreased motor power in six, and decreased deep tendon reflex in seven(Table 2).

4. Clinical result

There were a total of 22 spinal motion segments fused and instrumented with rigid stabilizers, and 27 with soft ones. There was no metal failure or dislodgement of the Graf bands on the follow-up radiographs. The functional radiographs revealed mild laxity of the Graf bands on the hyperextension of the spine in some cases, but it didn't affect the clinical results.

The clinical result was evaluated according to the Kirkaldy-Willis' criteria⁹⁾. The proportion of excellent-to-good outcome of all patients was 80%(Table 1).

Table 2. Clinical signs and symptoms

Signs and symptoms	No. of patients
Intermittent claudication	17
Radiating pain	13
Decreased DTR	7
Sensory deficit	6
Motor weakness	6
SLR limitation	4

CASE ILLUSTRATION

Case 1.

This 57-year old man had degenerative spondylolisthesis of 20% at L4 on L5 and lumbar scoliosis. Myelogram showed a complete block of the contrast medium at L4-5, and partial obstructions at L2-3 and L3-4(Fig. 3). Following L4 laminectomy and laminotomy of L2 & L3, thorough decompression, complete reduction of the olisthesis and internal fixation were performed using the Steffee VSP system on the L3-L4-L5. The L2-3 segment was stabilized with Graf bands(Fig. 4). The post-operative result was rated to be " good" .

Fig. 3. A : Preoperative radiographs showolisthesis of L4 of L5 and lumbar scoliosis. B : Myelogram reveals a complete block of contrast medium at L4-5 and partial obstruction at L2-3 and L3-4.

Fig. 4. Radiographs, taken at 15 months after operation, show rigid instrumentation at L3-4-5 and soft stabilization at L2-3

Case 2.

In this patient, a 57-year old man, the chief complaint was intermittent claudication. The neurologic findings on admission included decreased patellar tendon reflex and weakness of the extensor hallucis longus muscles. A functional lateral radiograph showed instability at the L2-3 segment, and the computerized tomogram with myelogram showed canal stenosis at L3-4 and L4-5 (Fig. 5). Surgery included L3 and L4 laminectomy and facetectomy, followed by the rigid instrumentation with fusion on L3-4 and soft stabilization on L2-3 and L4-5 (Fig. 6). The Postoperative result was rated to be "good".

DISCUSSION

Spinal stenosis is recognized with increasing frequency as a cause of low-back and lower extremity pain, particularly in elderly patients. In lumbar spinal stenosis degenerative changes within

the facet joints including joint hypertrophy, osteophyte formation, effusion, and capsular thickening make the lateral recesses narrow and reduce the coronal diameter of the canal. Degeneration of the discs and thickening of the ligamentum flavum also cause the stenosis of the spinal canal. Spinal stenosis is commonly multi-segmental and associated with other degenerative spinal disorders such as degenerative spondylolisthesis, segmental instability of the spine and degenerative scoliosis.

Recently operations with instrumentation have become widespread for lumbar spinal disorders, because various kinds of pedicle screw systems have been developed^{2-4,15,17)}, thus broadening the surgical indications to patients suffering from lumbar disorders. Despite the controversy of the role of spinal instruments, the advantages of spinal instrumentation are thought to be able to provide rigid fixation of the spine and can be adapted to various spinal disorders.

But the rigid spinal fixation and fusion may

Fig. 5. Plain anteroposterior and functional lateral radiographs show instabilities at L2-3, L3-4 and L4-5 with degenerative changes. CT scan shows facet hypertrophy and canal stenosis at the level of L4.

Fig. 6. Postoperative radiographs show wide decompression and fusion at L3-4, and soft stabilization at proximal and distal to the fusion.

result in deterioration of the juxta-fusion segments and lead to the stress-shielding of vertebral bodies within the stabilized segments, leading to stress-induced osteopenia¹³⁾. The incidence of degeneration of the adjacent motion segments to the fusion has been discussed by some authors^{5,7,10,11)}.

Lee evaluated eighteen patients in whom new symptoms developed from the segments adjacent to a fusion after an average symptom-free interval of 8.5 years. He found that the most common pathologic condition at the adjacent segment was hypertrophic degenerative arthritis of the facet joints. Spinal stenosis was found in eight cases ; severe disc degeneration in five ; degenerative spondylolisthesis in two ; and spondylolysis in one¹²⁾. Several predisposing factors are thought to be concerned with the deterioration of the juxta-fusion segment. When distraction devices are used at the long segment of the lumbar spine, the lumbar lordosis is obliterated and the first mobile seg-

ment is placed in a hyper-extended position. Other factors that may implicate internal fixation in shortening the life of the juxta-fusion segment are increased rigidity to the fused segments, which results in a greater stress riser at the first mobile segments and weakening of the juxta-fusion to fusion facet articulation by surgical dissection²⁰⁾. We also agree with the reported pathogenesis of the juxta-fusion segment after rigid fixation and fusion. And it's evident that these adverse effects could be exacerbated after rigid long-segment fixation and fusion, especially including the lower lumbar spine. Spondylolisthesis and unstable lumbar spine usually have limited-level pathology, while lumbar degenerative spinal stenosis with or without spondylolisthesis often extends through several levels and requires multilevel decompression and fusion.

In recent years, transpedicular screw fixation has permitted segmental internal fixation of the

spine for a number of disorders, and may allow instrumentation over shorter spinal segments than traditional hook and rod type systems. To reduce the adverse effects of the rigid device many experimental studies are being done. Some authors have been trying to use a viscoelastic washer between the integral nut of the screw and the Steffee plate, while they have also been trying to use a polymer plate⁶⁾. They reported that it was advantageous to decrease the adverse effects of the rigid instrumentation on the bone quality.

Among the numerous spinal fixation devices the Graf system, composed of pedicle screw and polyester bands, is being used for providing a posterolateral tension in the treatment of various degenerative spinal disorders. This therapeutical proposal could help to avoid numerous intervertebral fusions and improve patients' long-term result by reducing iatrogenous risks. The short-term results were reported as favourable in patients with degenerative spinal disorders^{1,18)}, but it has its own relative indications.

Our goal of treatment was to achieve enough stability on the decompressed spinal segments, and to preserve more motion segments simultaneously. We, therefore, performed the combined instrumentation using both soft and rigid fixation systems in order to obtain the advantage of each systems of cautiously selected cases.

Primary indications of the combined instrumentation are multilevel canal stenosis which requires decompression at several levels and canal stenosis combined with other segmental disorders, such as degenerative spondylolisthesis, segmental spinal instability and degenerative scoliosis. By using this combined method, we were able to preserve one or two more motion segments from the fusion. The surgical risk was also lowered because of shortened operation time, reduced blood loss and minimal requirement of the autogenous bone graft. The rigid fixation with fusion was performed only on the segments that hadolisthesis, or that

required extensive decompression including more than half of the facet joints. The soft stabilizer was used on the segments which revealed remarkable instability on the functional radiographs, or which required limited decompression preserving more than half of the facet joints.

This type of instrumentation can be classified into three categories. In type 1, the soft stabilizer is connected with the rigid fixation device above the fusion level. In type 2, the soft stabilizer is connected with the rigid fixation device below the fusion level. In type 3, the soft stabilizers are connected with the rigid fixation device above and below the fusion level.

The connecting system was devised and used in our later cases. The connecting system is made of the same material as the Steffee system, and the benefits of using this system are to prevent the failure of the bands and to be able to adjust proper tension of the bands more effectively.

Even though there is a few problems to be resolved, we think that the combined instrumentation should be the choice of treatment for extensive degenerative lumbar disorders. So, we propose the combined method of instrumentation for the treatment of complex multi-segmental degenerative lumbar disorders to avoid long segment fixation and fusion, therefore preserving more motion segments and minimizing the adverse iatrogenic effects on the motion segments adjacent to the fused segments.

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다분절 퇴행성 척추질환의 치료에 있어서 연성 및 강성 내고정기기의 복합사용법

광주 기독교병원 정형외과

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최근 척추질환 및 외상의 치료에 있어서 다양한 내고정기기들이 널리 사용되고 있으나 지나치게 견고한 내고정기기의 사용으로 인해서 인접 운동분절에 스트레스의 집중과 이에따른 퇴행성 변화의 가속화, 그리고 유합분절내의 골감소등이 임상적 또는 실험 연구결과 보고되고 있다. 이러한 현상은 특히 여러 척추운동 분절에 대한 압박술 및 내고정술을 시행해야 할 필요가 있을 경우에 더욱 문제가 될 수가 있다. 따라서 본병원 정형외과에서는 다분절 압박술후 충분한 안정성의 유지와 동시에 가능한 한 운동분절을 보존해주기위한 방법의 하나로 1992년 1월부터 1993년 5월까지 20례의 다분절 퇴행성 척추질환 환자를 대상으로 연성 및 강성 내고정기기를 복합 사용하였다. 이 수술방법은 각각 다른 내고정기기를 연결하여 사용하는데 있어 일부 개선해야 할 부분이 있지만 적응증에 해당하는 환자를 잘 선택하면 여러분절의 압박술을 요하는 일부 퇴행성 척추질환의 치료에 있어서 좋은 방법으로 사료된다.