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The Causes of Metallic Failure and Loosening of MOSS Transpedicular Spinal Instrumentation

Kee-Yong Ha M.D, Myung-Sang Moon M.D, FACS*

Seung-Koo Rhee M.D, Nam-Gee Lee M.D, Han-Joong Kim M.D

Department of Orthopaedic Surgery, Ui-Jong-Bu St. Mary's Hospital, and Kang-Nam St. Mary's Hospital*,
Catholic University Medical college, Seoul, Korea

= **Abstract** =

With the increasing use of pedicular system to fix the spine, many complications are being reported. Recently many systems are available to fix the spine. However, each system has own advantages and disadvantages. The causes of metallic failure of Modular Segmental Spinal (MOSS) instrumentation on 42 consecutive patients undergone in Kang-Nam St. Mary's hospital since 1989 were reviewed. The specific aim of this investigation was to assess causes of metallic failure and loosening of this system on various spinal disorders. Of these, 8 cases had metallic failure and loosening. Breakage of screw and rod developed in 6 cases and dislodgement of rod from screw in 2 cases. In case of degenerative spondylolisthesis (unstable phase) with stenosis, however, the complications were closely correlated to expansile decompressive laminectomy to widen the narrowed spinal canal and the instrumental distraction to gain normal intervertebral disc space at the operation. Bony union and back pain were not correlated to metallic failure and loosening. Therefore, the main causes of metallic failure and loosening were (1) preoperative instability undergone expansile decompressive laminectomy including total bilateral facetectomy that aggravated preoperative instability, and (2) forceful instrumental distraction. In cases needed these requirements, combined anterior interbody fusion or posterior interbody fusion should be added, heavier rods and screws larger than 3.5mm, 4.0mm in diameter, respectively, should be used. In addition to postoperatively sufficient bed rest and immobilization using rigid braces should be recommended to reduce these complications.

Key Words : Metallic failure, loosening, MOSS.

※ Correspondence author : Kee-Yong Ha
505 Ban-Po-Dong, Seo-Cho-Ku, Seoul, 137-040
Department of Orthopaedic Surgery, Catholic University Medical College

INTRODUCTION

With the increasing use of pedicular screw system to fix the spine, many complications are being reported such as screw, rod and plate breakage and dislodgement, pseudoarthrosis, and neurologic injuries[3,5,7,13,14,15,17,18,20,22]. Several different sizes and shapes of pedicular system are now available. Each system has its own strength, weakness, advantages, and disadvantages. It is important to figure out these facts. MOSS instrument has advantage of easier insertion of the rod that can reduce operative time and reduce the chance of loosening of screws while attempting to connect them. And the adjustable heads also permit the rod to be inserted without bending which helps to prevent rod breakage.

Some authors reported that deeper screw insertion clearly results in increased strength of screw-vertebra interface and have a lower incidence of fatigue failure[10,21,22]. In contrast, Lavaste[11] concluded that depth was not an important determinant of strength. Screw loosening is also a potential problem. Roy-Camille[15] indicated that 25% of the distal screw broke five to 24 months postoperatively in a series of 84 acute lumbar fractures. Steffee et al.[18] reported eight hardware problems, including screw breakage, screw migration and screw breakage on 128 patients.

Therefore, three critical questions need to be answered: (1) What size of rod and screws is proper to fix the spine? (2) What is the cause of metallic failure following use of pedicular system? (3) Is the metallic failure correlated to certain diseases. The specific aim of this investigation was to assess causes of metallic failure and loosening of the MOSS instrumentation, consisting of 4.0 mm screws and 3.5 mm rods that were relatively smaller size than other systems, on various spinal diseases.

MATERIALS AND METHODS

Forty-two patients (7 men and 35 women) with spinal stenosis symptoms secondary to degenerative spondylolisthesis, lytic spondylolisthesis, degenerative scoliosis, failed back surgery syndrome, lumbar fracture, and pure spinal stenosis were treated with partial or wide laminectomy, subsequently transpedicular MOSS instrumentation and posterolateral fusion by autogenous bone graft from March 1989 to September 1992 (Table 1). The cases of MOSS instrumentation with anterior interbody fusion or posterior interbody fusion performed simultaneously were excluded from this study. The follow-up period was 9 months to 55 months (average: 31 months).

Table 1. Etiologic distribution

Disease\ Sex	FEMALE	MALE
Lytic olisthesis	3	1
Deg. olisthesis	22	2
Spinal stenosis without instability	4	4
Failed back syndrome	2	
Fracture	1	
Deg. scoliosis	3	
Total 35	7	

The patients ranged in age from 33 to 71 years, with a mean of 48.2 years. Most of the patients (33) underwent fusion in L4-5 ; three L3-4-5, one L2-3-4, one L2-4-5 fusion, two L4-5-S1 and two L5-S1.

The diagnosis of instability was determined by checklist criteria of White and Panjabi[19]. In this investigation, wide laminectomy was meant by total bilateral facetectomies and partial laminectomy was meant by partial laminectomy and medial facetectomy (less than 1/3 of medial facet).

The dynamic lateral flexion and extension stress roentgenograms were taken in regular interval to assess the fusions.

Fusion classified into 4 types according to Lenke's classification[12]. Type A and B mean union and type C and D mean nonunion. The clinical results were divided into four categories as follows: Excellent - no postoperative complanints; Good - improved, but having mild backache and returned to full-time work; Fair - somewhat improved but continuing backache or required narcotic medication; Poor - worse than preoperative condition or required additional surgery. Pain relief was measured by comparing the preoperative pain score with the last follow-up overall pain score. Pain scale ranges from 1 to 10, with 1-2 being "no pain at all" " and 9-10 "severe pain". For instance, some patients selected 7-8 pain scale. In these cases we determined as 6-7 of pain score instead of 7-8. Preoperative overall pain scale was always rated as 10. It does not depend on severity because each patient has different pain threshold. At last follow-up each patient selected pain scale by himself or herself.

As a after-treatment, the patient was ambulated as soon as possible when comfortable in a LSO or TLSO for 3 months.

RESULTS

There is no postoperative infection. Age range was forty-three to fifty-seven. Eight cases(19%) had metallic failure and loosening. All failure cases were in women. Breakage of screws and rods developed in 6 cases and rod dislodgement from screw in 2 cases. Breakage and dislodgement occurred between 6 months and 9 months following operation. Screw breakage occurred 3 months earlier than rod breakage. In case of degenerative spondylolisthesis (unstable stage) with stenosis, however, the complications were closely correlated to expansile decompressive laminectomy to widen the narrowed spinal canal and instrumental distraction to restore normal disc height and/or reduction of slipped vertebrae at the time of operation. There was no breakage of screws and rods in case of spinal stenosis without preoperative segmental instability through wide laminectomy and bilateral facetectomies were performed. All metallic faliure and dislodgement cases had preoperative instability. In a case of multiple spinal stenosis in conjunction with unstable stage (L4-5) and stabilization (L5-S1), wide decompression was performed from L4-S1. Rods were broken at L4-5 segment. It suggests that the stabilization segment is necessary not to fuse the segments with or without instrumentation (Fig. 1).

Bony union and back pain were not related to metallic failure and dislodgement. In one case of failed back surgery syndrome with screw breakage, severe low back pain (pain scale: 9) developed and type C of nonunion was evident in dynamic flexion and extension lateral views. Reoperation was recommended. But the patient refused surgery until now. Despite of metallic failure and dislodgement, excellent fusion in 3 cases (type A) and type B in 2 cases occurred. In degenerative scoliosis having total laminectomy and distraction to correct scoliosis, rod dislodgement occurred after 6 months of operation. In this case pain scale was 5 and overall results was fair even though bony union was excellent in lateral views (Table 2).

ILLUSTRATIVE CASES

Cases 1. This 51-year-old female was admitted because of low back pain and claudication. Wide decompressive laminectomy and total facetectomies from L4 to S1 were carried out with the MOSS pedicular system and posterolateral fusion on Jan. 1991. At the time of operation instrumental distraction and reduction to widen the intervertebral canal and to reduce the slip were performed. Some reduction of slip and regain of disc height were obtained. After 8 months of operation both rods were broken. Fusion was type C. Clinical

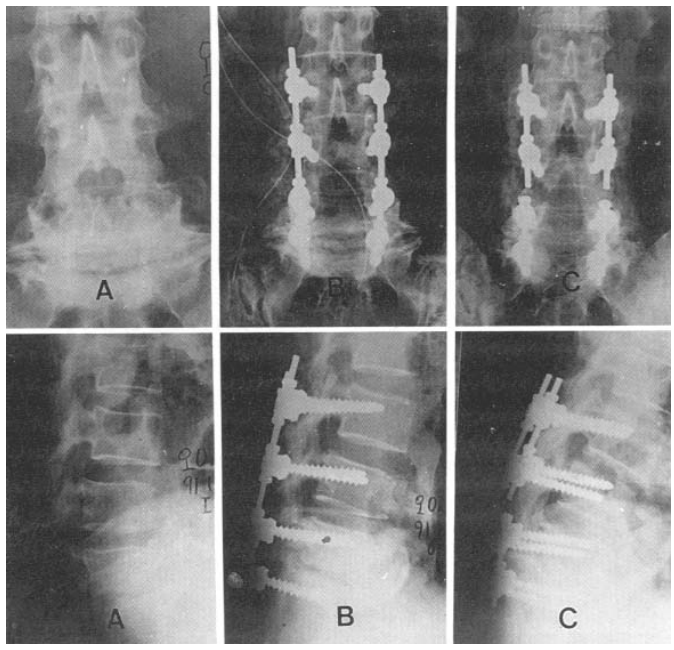

Fig. 1-A-C:
A. Showing degenerative spondylolisthesis of L4 on L5 in unstable phase and marked degenerative changes of L5-S1 in stabilization stage. B. Wide laminectomy and total facetectomy were performed from L4 to S1, and partial laminectomy was performed at L3-4. C. Both rods were fractured at unstable L4-5 segment. In spite of wide laminectomy at L5-S1, rods were not broken, not like L4-5.

Table 2. Summary of Clinical Outcome

Case	Sex/Age	Diagnosis	Operative method	Type of fusion	Failure	Time	Results	Pain scale
1	F / 51	Deg. olistheis	T/L, Distraction	C	Both rods	8 mons	Good	3
2	F / 43	Failed back synd.	Removal of plate and screw, Distration	C	Both screws	6 mons	Poor	9
3	F / 57	Deg. olisthesis	T/S, Distraction	B	One Rod	9 mons	Good	3
4	F / 51	Deg. olisthesis	P/L Both foraminotoomy	C	One screw	6 mons	Fair	4
5	F / 51	Deg. olisthesis	P/L, Distraction	A	One screw	6 mons	Good	3
6	F / 50	T/L Both foraminotomy		B	One rod	9 mons	Excellent	2
7	F / 44	Bursting Fx.	No laminectomy, Distraction	A	Dislodgement	4 mons	Exdellent	1
8	F / 48	Deg. Scoliosis	T/L, Distraction	A	Dislodgement	6 mons	Fair	5

T/L : Total laminectomy
P/L : Partial lamineectomy

result was good and pain scale 3 to 4 (Fig. 1).

Case 3: This 57-year-old female was admitted because of severe back pain and claudication. Wide decompressive laminectomy and bilateral total facetectomies were performed as well as instrumental distraction for reduction. Nine months following fusion, one rod was fractured. Fusion type was C. Clinical result was good (Fig. 2).

Case 5: This 51-year-old female suffered from disabling low back pain and intermittent claudication for which posterior decompression with total facetectomy and posterolateral fusion plus MOSS pedicular fixation were carried out. At the time of operation instrumental distraction was also performed. Postoperatively some reduction of L4 on L5 was obtained. Six months after operation one screw was fractured. At 33 months follow-up, clinical result was good, pain scale 3-4 though fusion type was B (Fig. 3).

DISCUSSION

In case of gross instability. transpedicular systems can allow immediate stabilization with increased postoperative comfort for the patient but does not guarantee successful outcome in every case. Horowitch et al[8]. reported a 5 percent incidence of screw breakage after using of Wiltes pedicle screw system. The first question concerns the size of rods and screws. Geiger et al.[4] investigated that decreasing rod diameter from 1/4 inch to 3/16 inch results in a 58% reduction in bending strength and a 68% reduction in bending stiffness secondary to the changes in cross sectional area.

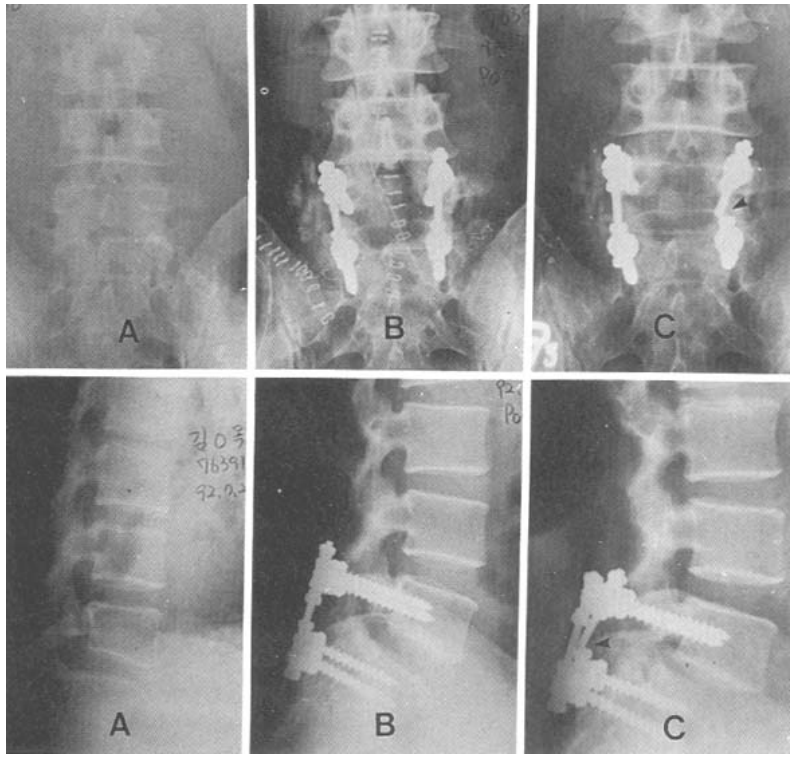

Fig. 2-A-C:
A. X-ray showing a degenerative spondylolisthesis of L4 on L5. B. The patient had extensive posterior decompressive laminectomy and bilateral facetectomies as well as instrumental distraction to reduce a slipped vertebra. C. Six months following fusion, one screw was fractured.

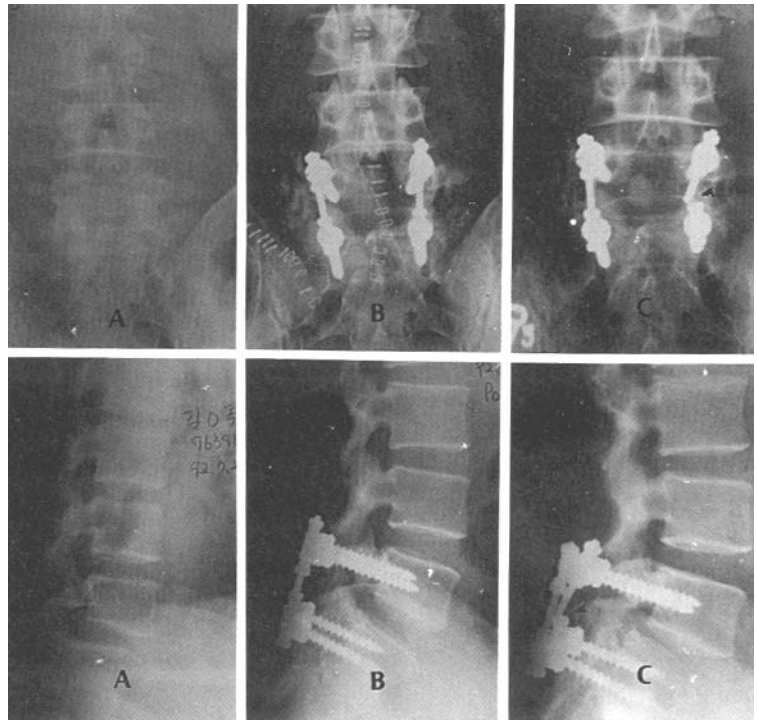

Fig. 3-A-C:

A. X-ray showing a degenerative spondylolisthesis of L4 on L5 in unstable stage. B. The patient underwent posterior decompression and instrumental distraction. C. Fracture site, grafted bone was well united in contrast to intact rod site.

Simmons and Capicotto[17] stated that only one rod fracture occurred in the immediate postoperative interval and no late breakage occurred even though they uesd 3.2 mm Zielke rod. And in case of using 4 mm rod there were no report of breakage. They also reported that the heavier rod like the Cotrel-Dubousset transpedicular instrumentation in more adequate for young patients ratker than Zielke rod consisting of 3.2 mm or 4.0 mm rod. In our series, rod and screw breakage occurred in 14 percent even though MOSS instrumentation consisting of 4.0 mm screw and 3.5 mm rod were used for old patients. It was found not to be correlated to daily activity and sex. In our series, all cases who had metallic failure were women. Sienkiewicz and Flatley[16] explained that the degenerative female spine may be inherently less stable than the male spine. Carson et al.[3] reported that the bending moment of the screw increases posteriorly, with the maximum occurring at the rod. And an increase in the inner diameter of the screw improves the fatigue life of construct.

The second question concerns the cause of metallic failure following use of pedicular systems. Distraction to reduce the slip and regain normal intervertebral space is one of the cause of metallic failure in our series. Bernhardt et al.[1] reported fusion in situ for load sharing by the vertebral bodies can prevent fatigue failure of implant. It was agreement with their report. In our case of attempting distraction of the segments, metallic failure had a higher incidence.

The third question concerns whether or not the metallic failure is correlated to certain conditions. Many authors postulated that preoperative instability enhance the risk of postoperative slipping and a poor outcome[2,9,16]. Gurr et al.[6] observed in an experimental study that after laminectomy and dis-

cectomy, the instrumented spine was unstable in rotation and flexion. Therefore, some hard braces were recommended to prevent excessive spinal motion such as flexion and rotation and some period of bed rest was also recommended. Roy-Camille et al.[15] indicated that 25% of the distal screw broke five to 24 months postoperatively in a series of 84 acute lumbar fracturs. He did not mention the cause of metallic failure. But it suggested in his paper that higher incidence of metallic failure can occur in gross instability resulting from fractures even though heavier rod and screw were used. In our study most of metallic failure occurred 6 to 9 months postoperatively in case of preoperative gross instability undergone total bilateral facetectomy which might aggravate preoperative instability. The incidence of metallic failure of our case were higher than other reports[5,8,14,17]. It suggested that the MOSS system was not strong enough to maintain reduction of the intervertebral space. Although this investigation has the limitation regarding metallic failure, the MOSS system could not maintain immediate postoperative reduction and normal lumbar curvature until the fusion consolidated.

In conclusion, this study suggests that the main causes of metallic failure and loosening could be correlated to preoperative instability of the lumbar spine undergone expansile decompressive laminectomy and distraction. In case needed these requirements, 1) combined anterior interbody fusion or posterior interbody fusion should be added, and 2) rod and screw larger than 3.5mm and 4.0mm in diameter, respectively, should be used, and 3) sufficient postoperative bed rest and immobilization using brace should be recommended to reduce these complications.

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= 국문 초록 =

MOSS 척추경 나사기기의 실패와 이완에 대한 원인분석

가톨릭대학교 의과대학 의정부성모병원, 강남성모병원*

하 기 용 · 문 명 상* · 이 승 구 · 이 남 기 · 김 한 중

척추고정을 위하여 척추경 나사기기의 사용의 증가에 의한 많은 합병증이 발생, 보고되어 왔다. 특히 최근 많은 종류의 척추경나사기기가 개발이 되어 사용되고 있으나 각 기기의 장단점을 잘 파악하여 적합한 기기를 선택시 합병증을 최소화 시킬 수 있다. 이에 저자들은 ① 어떤 기기의 rod와 나사가 척추고정에 적당한가? ② 척추경 나사의 파손 및 이완의 원인은 무엇인가? ③ 기기의 파손과 이완이 어떤 질환과 관련이 있는가에 대하여 연구하였다. 따라서 이 연구의 목적은 rod를 나사에 삽입하기 편하여 수술시간을 단축시킬수 있고, 또한 rod의 구부림이 없이 나사에 삽입할수 있게 나사머리를 특수하게 만든 Modular Segmental System (MOSS) 기기를 택하여 이 연구를 하였다. 이 MOSS 척추경나사기기의 크기는 rod가 3.5mm이며 나사는 4.0mm로 되어 있다.

이에 저자들은 1989년 9월 부터 시행한 42예에 대하여 분석한 결과 나사 및 rod의 파손과 이완은 8예(19%)에서 일어났으며, 이중 나사 및 rod의 파손은 각각 3예씩 이었고 나사로 부터 rod의 2예에서 발생하였다. 기기의 파손 혹은 이완은 술후의 통증과 골유합과는 밀접한 관계가 없었다. 그러나 술전 불안정성이 있는 퇴행성 전방전위증에서 광범위 후궁절제술과 후관절 절제술을 시행한 경우, 혹은 추체 전위를 정복하기 위한 추간간 신연(distraction)예에서 나사의 파손과 이완이 많았다. 이러한 경우에는 추체간 전방유합술(AIF)혹은 추체간 후방유합술(PLIF)을 동시에 시행하거나, 4.0mm의 나사와 3.5mm rod보다 더 큰 나사 및 rod을 사용하여야 하며, 또한 술후 충분한 기간 안정가료나 보조기를 착용케 하여야 할 것으로 사료된다.

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