Postero-Lateral Lumbar and Lumbo-Sacral Fusion With and Without Pedicle Screw-Plate for Degenerative Lumbar Spinal Stenosis

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ABSTRACT

Study Design: This study retrospectively reviewed the effects of pedicle screw-plate fixation on postero-lateral fusion for degenerative spinal stenosis. The clinical results and radiographic fusion rate of a group of patients treated with decompressive laminectomy and postero-lateral fusion were studied. Two treatment groups were identified by fusion technique; the first group was treated with autogenous bone grafting supplemented with non-rigid pedicle screw-plate and a second group received autogenous bone graft only.

Objectives: The two groups were compared to determine the effects of non-rigid pedicle-screw fixation on lumbar and lumbo-sacral fusion for degenerative spinal stenosis after wide decompression.

Summary of Background Data: Whether the internal fixation can promote spinal fusion in the treatment of degenerative spinal stenosis is still controversial. A controlled study to determine the effectiveness and complications associated with internal fixation in this setting is necessary. However, the cost of the commonly used internal fixation as pedicle screw-rod system is very high. The authors have succeeded in the treatment of thoraco-lumbar and lumbar fracture with non-rigid pedicle screw plate as AO-spinal notched plate and therefore have used it in this study.

Methods: This study reviewed 40 consecutive patients operated for degenerative stenosis of lumbar and lumbo-sacral spine. Group 1 included 21 patients treated with AO-spinal notched plate and autogenous bone graft after decompression. Group 2 included 19 patients who underwent autogenous postero-lateral bone graft. There were no statistically differences between these two groups, regarding the follow-up period, age, sex, instability, severity of stenosis, and number of involved levels. Fusion status were determined via radiographs. Herkowitz's criteria were used for evaluation of the clinical results after minimum of 2 year follow-up period.

Results: The fusion rate was 90.4% in the group 1 (plated group) and 60.4% in the group 2 (control group), which was statistically significant. Clinically 90.5% of group 1 had good or excellent results and 73.7% of group 2 had good or excellent results. The difference between these two groups was also statistically significant. There were no infection or neural injury in both groups.

Conclusion: In addition to its cost-effectiveness, the use of non-rigid pedicle screw-plate as AO spinal notched plate has significantly improved the clinical results and fusion rate over the autogenous bone graft alone, without serious complication.

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INTRODUCTION

Degenerative lumbar spinal stenosis is the most common disorder of the lower back and the lifetime incidence of low back pain in the general population is estimated to be 80%[1]. Surgical decompression is indicated in patient with moderate or marked stenosis. Fusion should be combined with decompression because removal of the posterior elements may produce instability[2] and it has been shown that the clinical results of laminectomy with fusion are better than laminectomy alone[3]. However, there is still controversy about the necessity of instrumentation for promoting fusion and improving the clinical results. The purpose of the study was to verify the necessity for instrumentation in obtaining spinal fusion and better clinical results.

MATERIALS AND METHODS

A case-controlled study was designed to collect data during the period June 1990 to September 1997 in the Department of Orthopedic Surgery, Police General Hospital, Bangkok, Thailand. The patients who were enrolled had a clinical diagnosis of degenerative lumbar spinal stenosis that required surgery. The patients were divided into two groups: plated group and non-plated or control group. The exclusion criteria were conservative treatment of less than 6 weeks, additional disectomy during the procedure, and use of non-postero-lateral grafting.

The study included 48 patients. Eight patients were excluded because of insufficient follow-up, leaving 40 patients who were followed up adequately. There were 30 females and 10 males. Twenty-one patients (2 patients) were lost to follow-up in the plated group and 19 patients (6 patients) were lost to follow-up in the non-plated group. In the plated group, there were 16 females and 5 males. The mean follow-up period was 46.3 months (range 24-77 months); the mean age was 53.8 years (range 40-79 years). In the non-plated group, there were 14 females and 5 males. The mean follow-up period was 41.2 months (range 24-68); the mean age was 58.8 years (range 40-78).

Pre-operatively, radiography of lumbo-sacral spine in AP, lateral with flexion and extension views were carried

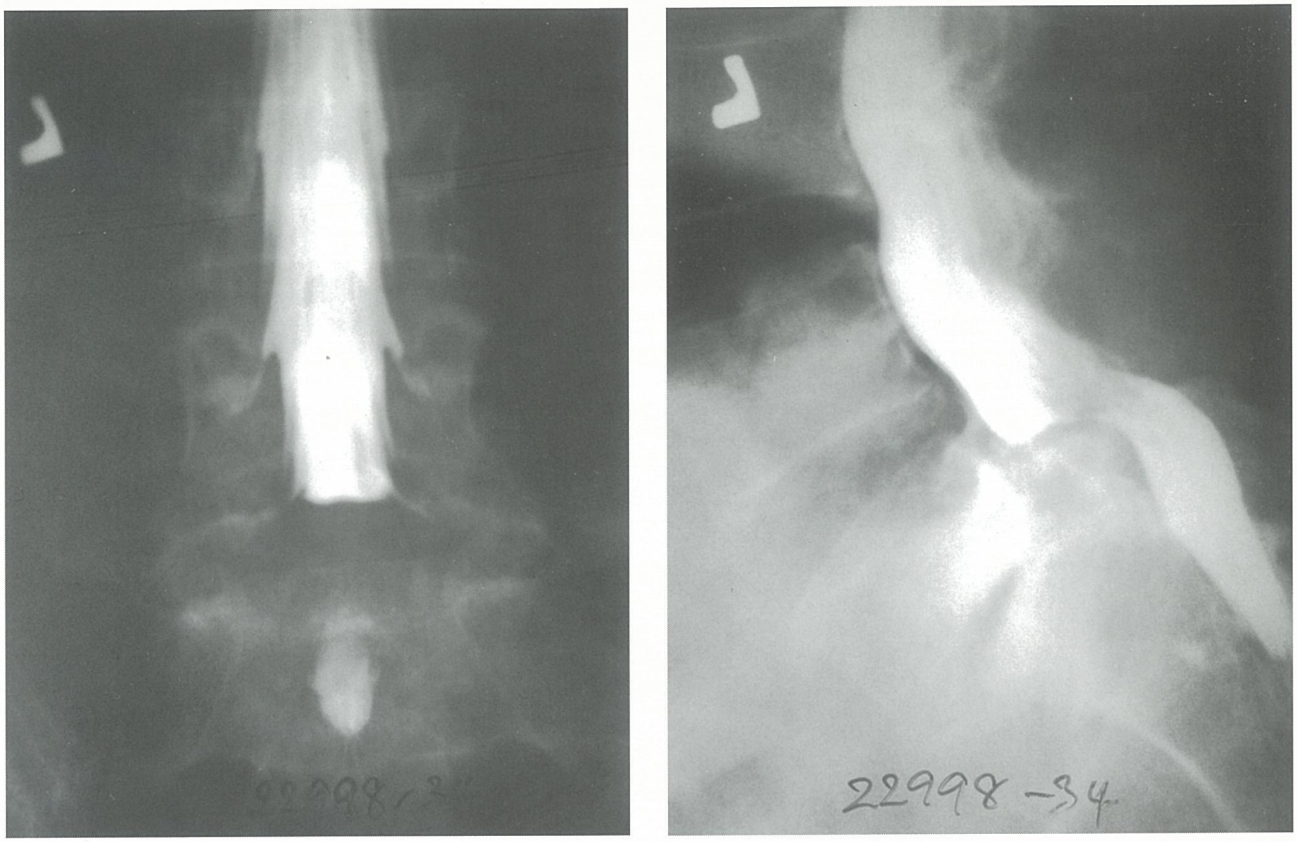


Fig. 1a and 1b - Radiogram of a fifty-two year old female with leg and back pain for many years. The myelogram demonstrated incomplete block of L5-S1.

out to determine the presence of instability, using Frymoyer's Criteria[4]. Myelography or MRI was performed to determine the level and grading of the severity of stenosis as "light" (1 point), "moderate" (2 points), and "severe" (3 points) according to Amundsen's Criteria[5]. Of the 21 patients in the plated group, 19 had instability and 15 had moderate and 6 severe stenosis. Of the 19 patients in the non-plated group, 14 had instability and 13 had moderate and 6 severe stenosis. Both the plated and non-plated groups had two or more level involvement (Table 1). Diagnosis and demographic profiles before surgery were similar in the two groups. There were no statistical differences between these two groups with regard to follow-up period, age, sex, instability, severity of stenosis, and number of involved levels. All of the patients in both groups were surgically treated by both authors and had identical protocols after surgery.

Wide decompressive laminectomy and postero-lateral fusion using autogenous bone graft from the resected spinous process was performed in both groups. In the plated group, simple instruments such as a sharp 2.0 mm-K-wire as an awl, a 2.0 mm-hand drill as a tract-maker, a blunt 1.2 mm-K-wire as a probe, a 3.2 mm-hand-drill as a hole-opener, and 4.5 mm-screws inserted with screw-driver with AO/ASIF spinal notched plate were used.

Surgical Technique

In the lumbar spine, the pedicle entry point is situated just above the junction between the vertical bony crest and the superior articular process and about 2 mm medial to the lateral border of the superior articular process. This point is marked with an awl (2.0 mm-K-wire) and a 2 mm drill bit is driven gently by hand-drill through the pedicles into the vertebral bodies parallel to the end plate, converging towards the midline about 15°. The drill-bit is pushed and slowly drilled to prevent penetration of the lateral or medial wall of the pedicle. By this manipulation, the tip of the drill bit glides along the medullary canal of the pedicle when it abuts against the cortical wall of the pedicle.

In the sacrum, the dorsal entry point is caudal-lateral to the lateral border of the superior facet of S1 and the direction is 35° medially in the horizontal plane, 15° cephaladly in the frontal plane. The sacral screw traverses into the lateral mass of the sacrum. The second sacral screw may be inserted with the entry point located between the first and second sacral foramen and also traverses in the antero-medial direction. Early in the study, the sacral screw was inserted in the antero-lateral direction to the lateral mass. Now the sacral screw is inserted antero-medially into the body of S1, since the most secure fixation site passes through the first sacral pedicle[6] and the depth of the antero-medial screw is longer than that of the anterolateral one[7]. In addition, with the antero-lateral orientation the sacral screw may enter the sacroiliac joint.

Post-operatively, the patients in both groups were allowed to roll in bed immediately and ambulate with lumbosacral support after removal of the sutures 10 days after surgery. Every patient was advised to have daily exercise with "William flexion exercises", consisting of back muscle stretching exercise, the abdominal muscle stretching exercise, and hamstring muscle stretching exercise[8].

Evaluation

Every patient was personally interviewed with a questionaire including presence of pain, the need for analgesics, the need for lumbo-sacral support, and the distance of walking. Clinical results were graded according to Herkowitz's criteria as "poor" (1 point), "fair" (2 points), "good" (3 points), or "excellent" (4 points).

Poor – major discomfort in the back or lower limbs or both, necessitating non-narcotic analgesics and occasional narcotic analgesics, no improvement compared with the pre-operative condition and major restriction of activity.

Fair – intermittent discomfort in the back or lower limbs or both, improvement compared with the pre-operative status, restriction of activity, and an occasional need for non-narcotic analgesics.

Good – occasional discomfort in the back and lower limbs necessitating non-narcotic analgesics, major improvement compared with the pre-operative condition, and resumption of unrestricted activities.

Excellent – normal resumption of unrestricted activity and complete relief of pain in the back and lower limbs.

Healing of fusion mass was evaluated, using Thalgott's criteria, as "frank nonunion" (1 point), "incomplete union" (2 points), or "complete union" (3 points). Incomplete union was defined as radiographic disappearance of bone graft at a single instrumented level on one side. Frank nonunion of the instrumented levels was defined as bilateral total graft resorption[9]. All data were analysed with the help of the SPSS for Windows version 6.0 programme.

RESULTS

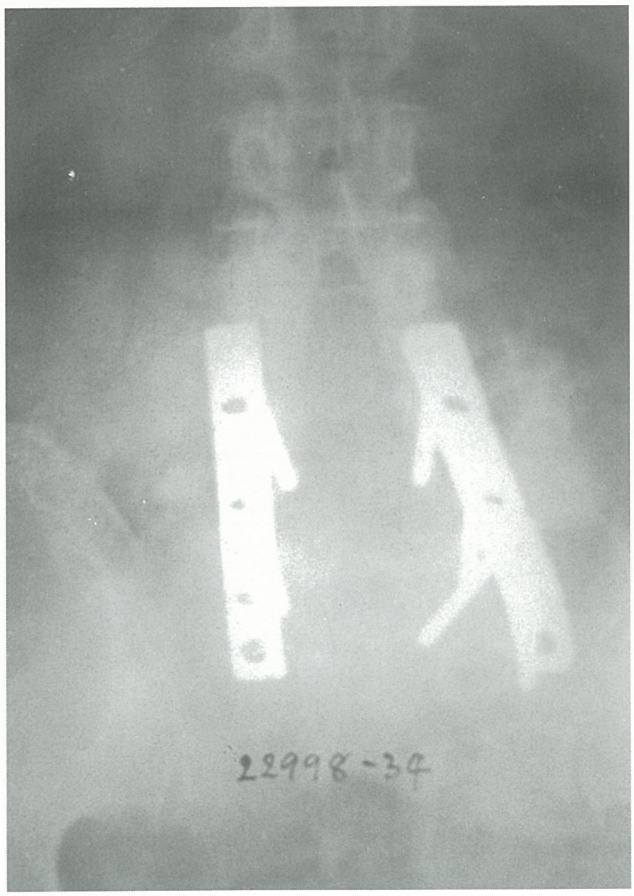
In the plated group, 2 patients had a fair result, 9 patients good result and 10 had an excellent result (90.5% good and excellent results). In the non-plated group, 3 patients had poor, 2 fair, 10 good and 4 had an excellent result (73.7% good and excellent results). The difference of the good-and-excellent results between the two groups were statistically significant ($p<0.03$). The fusion rate in the plated group was 90.5% (19/21) and 68.4% in the non-plated group (13/19). This difference was also statistically significant ($p<0.002$). Using the Spearman correlation, only fusion rate and clinical results were statistically significant ($p<0.001$) (Figures 1a - 1f).

COMPLICATIONS

Screw loosening before healing of fusion mass was encountered in 2 patients and led to nonunion because of inadequate bone grafting. One patient had screw breakage. One patient had transitional retrolisthesis and recovered after the plates had been removed (Transition Syndrome of Burton)[10]. There was no infection or neural injury in both groups. The complications in the non-plated group included one case with a missing level, one case of massive bleeding and one case of failed-back that needed re-operation.

DISCUSSION

Bernhardt et al[11] has shown in a comparative study that bilateral postero-lateral lumbar or lumbo-sacral fusion without internal fixation is as effective as fusion with VSP



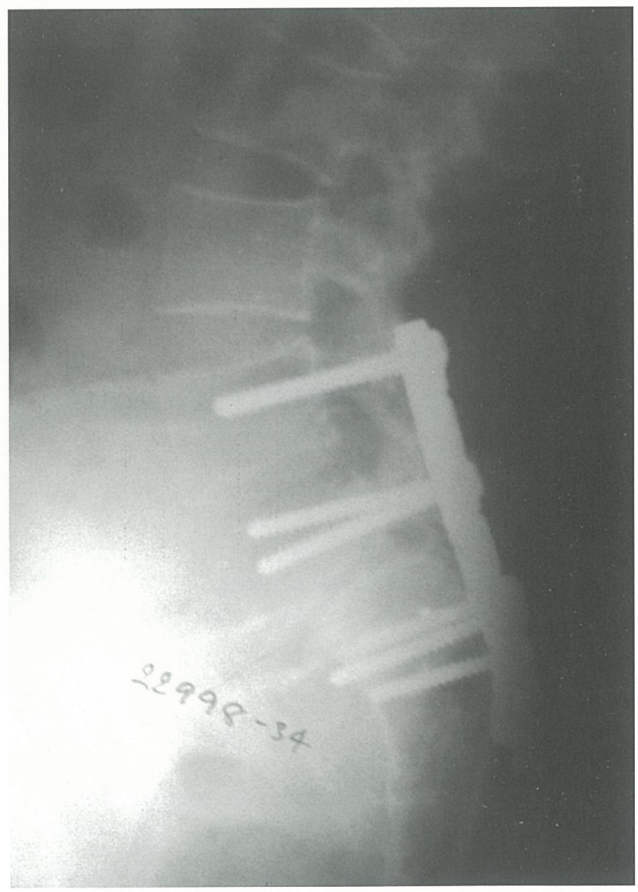


Fig. 1c and 1d - After wide decompressive laminectomy and fusion with AO-notch plate augmentation the patient had excellent clinical result.

(Variable Screw Placement Plate) instrumentation, with respect to fusion rate (74% vs 78%) and clinical results (70% vs 67%). However, patients fused without internal fixation needed a thoracic-lumbar-sacral-one-half spica cast for six weeks post-operatively, which is very cumbersome and uncomfortable.

In contrast to this finding, Kornblatt et al[12] demonstrated a 76.3% fusion rate without internal fixation and 89.5% fusion rate with internal fixation, which was statistically significant. The results in the current study have also shown that the plated group had a statistically higher rate of fusion than the control or non-plated group.

Schwab and his associates published a large data on lumbosacral fusion examining non-instrumented and semi-rigidly instrumented patients. A significantly higher rate of fusion and better clinical results were obtained with semi-rigid instrumentation than without instrumentation[13].

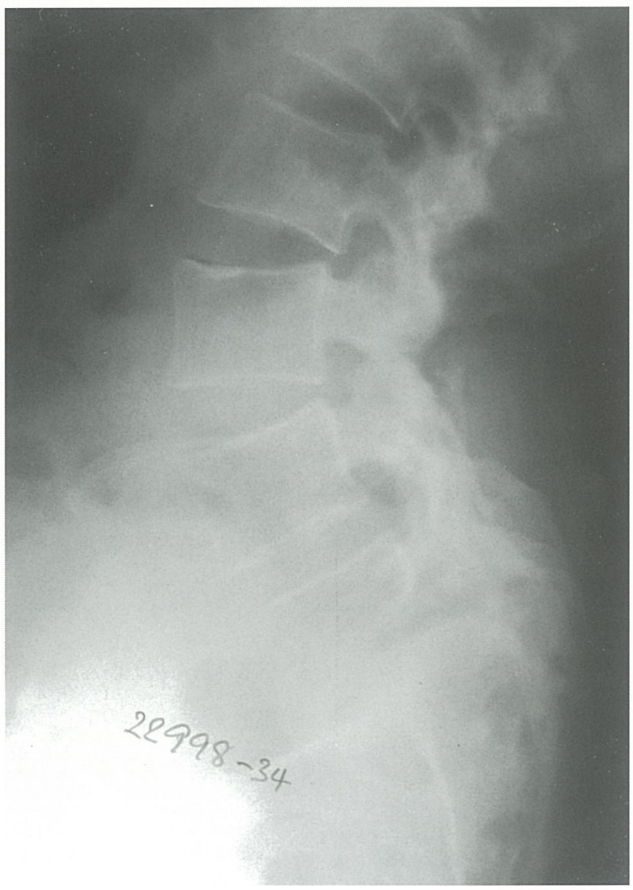
The results of meta-analysis support the clinical impression that in the surgical management of degenerative spinal instability, spinal fusion significantly improves patient satisfaction and adjunctive spinal instrumentation enhances fusion rates[14].

Likewise, the present study suggests that the use of internal fixation resulted in the fusion rate and the clinical result being superior to fusion without internal fixation. AO DCP plate, which also has a non-rigid plate-screw interface as the AO notched spinal plate, has been used by Thalgott and his associates for lumbar degenerative disease with canal decompression and fusion[9]. The fusion rate of 87% is similar to our results (90.5%).

To reduce the medical expenses, particularly in the financial crisis in our country, we routinely use the short-segment AO notched spinal plate instead of the more expensive rigid pedicle-screw rod or plate system. We have succeeded in the treatment of thoraco-lumbar and lumbar fractures with the use of non-rigid pedicle-screw plate such as the AO spinal notched plate and therefore have used it in this study[15]. To the best of our knowledge, there is no study comparing the results of short-segment AO notched plate with those without implant for the surgical treatment of degenerative spinal stenosis.

It is noteworthy that the fusion rate of 90.5% in our study is comparable to those of other studies using rigid internal fixation, ranging from 78% to 95%[16,17]. Although internal fixation is used frequently to stabilise the spine during the healing phase, the ideal rigidity for a spinal implant remains unknown[18]. It has been shown in animal experiments that, "for spinal fixation devices, the least stiffness that will bring about union with attempted arthrodesis is ideal". The displacement and strain in the fusion mass can be limited by a posterior fixation device: - if it is too stiff and weak it will break but if it is too stiff and strong, it will lose fixation at the bone-device interface[19]. It is advantageous to decrease the rigidity of the implant to promote healing of the fusion mass and to prevent stress induced osteoporosis secondary to stress-shielding effect[20].

Hsu et al have conjectured that the rate of degeneration of motion segments adjacent to lumbar spine fusion may increase due to implant stiffness. This was based on a short time interval between surgery and onset of clinically



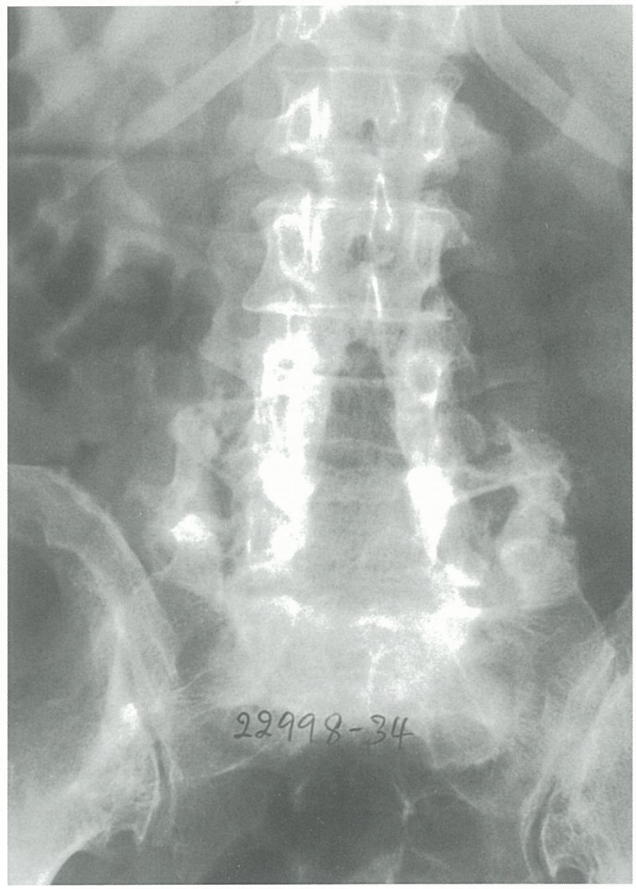


Fig. 1e and 1f - Thirty-four months after plate removal there is solid fusion from L4 to S1.

apparent degeneration in the patients with Steffee or VSP plates compared to those having bone graft alone[21].

Therefore, we are of the opinion that by using the AO-notched plate, in addition to its cost-effectiveness and comparable high fusion rate, the disadvantages of the rigid internal fixation can be avoided. In this study, not only higher fusion rates but also a higher percentage of good or excellent clinical results were obtained in the plated group. The correlation among many variable factors could be demonstrated only between the fusion rate and clinical results ($p<0.001$). These support the findings of Zdeblick and Schwab et al.

CONCLUSION

Higher fusion rate, better clinical results and fewer complications can be obtained with the use of AO notched spinal plate compared with autogenous bone grafting alone for degenerative spinal stenosis in the lumbar and lumbosacral region. AO notched spinal plate is a useful adjunct in reconstructive surgery of the lumbar spine. In addition to its cost-effectiveness, the implants are readily available at all centres equipped with AO large-fragment sets.

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Table 1. Comparing between plated group and non-plated group. There were no differences in gender, age, month of FU, instability, severity, and level of stenosis. There were statistical differences in the outcome of fusion and clinical result ($p < .03$).

	Plate gr.	Non plate gr.	Value	Significant
Female Male	16 5	14 5	X^2=.03	p>.85
Age	X=53.80	X=58.84	t=-1.48	p>.14
Month of FU	X=46.33	X=41.15	t=0.79	p>.43
Preop. Instability	19:2	14:5	X^2=1.94	p>.16
Moderate Stenosis Severe Stenosis	15 6	13 6	t=--.20	p>.849
2-level 3-level 4-level	16 3 2	10 7 2	t=-1.15	p>.257
Fusion rate 1 Frank non-union 2 Incomplete union 2 Complete union	X=2.71 2 (9.5%) 2 (9.5%) 17 (80.9%)	X=1.94 6 (31.5%) 8 (42.1%) 5 (26.3%)	t=3.4 0	p<.002
Result 1 Poor 2 Fair 3 Good 4 Excellent	X=3.38 0 2 (9.5%) 9 (42.8%) 10 (47.6%)	X=2.79 3 (15.7%) 2 (10.5%) 10 (52.6%) 4 (21.0%)	t=2.25	p<.03

df = degree of freedom, t = t-value, p = p-value, X^2 = chi-square, X = mean

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