

นิพนธ์ต้นฉบับ

## Anterior spinal fusion for spondylolysis and spondylolisthesis

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*A series of 23 cases of degenerative spondylolisthesis and 7 cases of spondylolysis, undergoing anterior interbody fusion with iliac bone graft, with a follow up period of 1-2½ years is reported. The success rate was 80% in both clinical performance and roentgenographic bony fusion, with a good correlation between these two. The study also included measurements of the disc space before and after operations and at the end of the follow-up, which showed that the successful fusion had a mild diminution (19%) of the original disc space when compared to the nonunion (49%).*

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*Spondylolysis และ Spondylolisthesis เป็นโรคที่ทำให้เกิดอาการปวดหลังเรื้อรังได้มากที่สุด การผ่าตัดรักษาโดยการเชื่อมกระดูกสันหลังทางด้านหน้าเป็นวิธีการรักษาที่ให้ผลดีชนิดหนึ่ง การศึกษาประกอบด้วย ผู้ป่วยโรคนี้จำนวน 30 คน Degenerative Spondylolisthesis 7 คน และ Spondylolysis 23 คน ผลการศึกษาปรากฏว่าภายหลังการติดตามผลระหว่าง 1 ถึง 2½ ปี การเชื่อมกระดูกสันหลังโดยวิธีนี้ให้ผลดีร้อยละ 80 ทั้งในแง่คลินิกและเอ็กซเรย์ นอกจากนี้การศึกษายังได้รวมทั้ง Intervertebral disc space ทั้งก่อนและหลังผ่าตัด ซึ่งได้แสดงให้เห็นว่าในรายที่กระดูกเชื่อมติดกันดี จะมีการแคบของ disc space น้อย (ประมาณร้อยละ 19) ส่วนรายที่ไม่เชื่อมติดกัน disc space จะแคบลงมาก (ประมาณร้อยละ 49)*

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Of all the chronic pain in lower back, spondylolisthesis patients have the highest incidence.<sup>(1)</sup> It is widely accepted that there are five types of spondylolisthesis<sup>(2,3)</sup> according to etiologies, namely ischemic, degenerative, traumatic, dysplastic and pathological, the ischemic or spondylolytic type being the most common followed by the degenerative. In a western hemisphere population there is a 6-7% incidence of spondylolysis.<sup>(1)</sup> While the exact figure is not known in Thailand, a study of 83 cases of spondylolisthesis at the Chulalongkorn hospital in 1983 by Tienboon, Pantumkomol and Itiravivong<sup>(4)</sup>, revealed that 81.93 % was of ischemic type and 16.78 % degenerative type.

Spondylolisthesis may cause only a localized low back pain from affected unstable vertebrae, as well as a leg pain if the degree of olistheses is sufficiently severe to irritate the nerve root. The severity of disease has a great influence in the prognosis, diagnosis and method of treatment.<sup>(5,6)</sup> The prognosis is regarded as worst, if it is found

in a young patient and is left untreated, for the slip will progress with time and render treatment more complicated.<sup>(5, 6, 7)</sup>

The diagnosis of spondylolisthesis is not difficult if the condition is obvious as typically shown in the oblique views of lumbosacral spinal X-rays. However, once there is neurological involvement, the problem arises of which nerve root is being compressed. Where there is slip of L4 over L5, the question is whether the L4 spinal root is compressed at the lateral recess<sup>(5,1)</sup> or the L5 spinal root at the intervertebral<sup>(5,1)</sup> disc. Obviously, such condition can not be undertaken lightly and detailed physical examination, roentgenographic studies including myelography and even computerized tomography have to be employed in the evaluation. The unstable spinal segment it-self is another problem. Olisthesis can occur if the unstable vertebrae are not stabilized and may cause a lot of painful limitation of activity, beside the awkward appearance of the lower back. The instability, if the condition is

recognized early, can be solved with reasonable ease by spinal fusion. Several methods of fusion, approaching either through the front or back of the involved spinal segment according to the preference of the surgeon, are reported in the literatures (5,6,8,9,10,11,12,13,14) with varying successes

This is a report of a study on specific types of spondylolysis and degenerative spondylolisthesis in 30 patients, all treated by anterior spinal fusion with iliac bone graft. The aims were to study, (a) the

percentage of radiological fusion rate by this technique, (b) the clinical evaluation compared to the pre-operative complaint, (c) the intervertebral disc space study before, immediate post-operatively and at the final follow-up.

### Material

There were 30 selected cases of the two most common types of spondylolisthesis under review. The age and sex were as given in Table 1. 23 patients were classified as ischemic

**Table 1** Age and Sex

Age	Male	Female	Total
30-40	4	7	9
41-50	4	12	16
51-60	-	2	2
>60	-	1	1
	8	22	30

or spondylolytic, of which 16 were female and 7 male. Of the 7 males, 4 had the lytic

defect in the pars interarticularis at L4 and 3 at L5. Of the 16 female patients 11 had such

defects at L4, and 5 at the L5 vertebrae. There were 7 degenerative spondylolisthesis cases, 6 females and 1 male, all with involvements at L4-5 level, except one male at L3-4.

With the exception of a few stout housewives these patients were heavy labourers. All suffered chronic low back pain for years, not responding to the routine conservative treatments, until the pain became intolerable when they sought more radical means, even in the later years of their lives. Failed laminectomies and posterior fusions were noted in 5 patients while others had no previous surgery. Concerning the degree of vertebral<sup>(5,2,3)</sup> slippage 20 were of grade I, 3 of grade II and the remainder had recognized displacements. All had evidence of unstably excessive vertebral movements in the flexion and extension views of the lumbosacral spine roentgenography. No definite root lesion was found in any of these patients except some vague complaints of leg pain. Confirming myelographic studies showed

the mild hour - glass appearance at the affected vertebrae.

### Method

The indication for surgery was a persistent low back pain which did not respond to any form of conservative treatment. Anterior spinal fusion with bone graft from the left iliac, utilizing techniques advocated by FANG et al,<sup>(15)</sup> Crock,<sup>(8)</sup> and Freebody<sup>(9)</sup> was performed in all patients. Details of levels of intervertebral fusion were shown in Table 2. The majority of cases had a Single-level fusion mainly at L5-S1 or L4-5. A selected neighbouring vertebral segment was included in the fusion, if the intraoperative discography showed evidence of severe disc degeneration and the pre-operative X-rays were in doubt. Three cases of two-level fusion were done for these reasons. No attempt was made either before or during the operation to reduce the displaced vertebra. The designed iliac bone grafts were rectangular in shape and fitted tightly into the created vertebral fusion beds for the best possible

stability. In one level cases, the patient was confined to bed postoperatively for 7 to 14 days after which a spinal jacket was applied and ambulation allowed. In the two-level fusions this period was between two to three weeks.

### Results

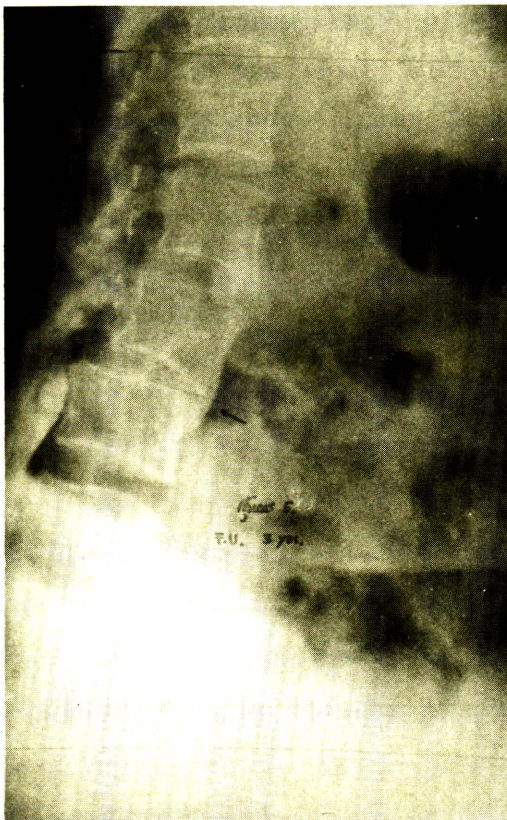
In all cases the length of observation time was between land 2½ years, during which clinical interviews and physical examinations were performed together with roentgenographic studies at regular intervals of 3,6,12,18 and 24 months. The clinical

grading<sup>(11,12,14)</sup> consisted of good, fair and poor. Good meant that the patient was completely relieved of pain, fully active at work and happy with the operation. A partial relief from pain, going back to lighter employment and the occasional use of analgesics were graded as fair. Those who had no relief from pain, constantly used medication, were unable to return to work used and unhappy with the operation, were classified as poor. Summation of the clinical results is displayed in Table 3

**Table 2** Level of fusion

Levels	Degenerative	Ischemic	Total
L3-4	1	1	2
L3-4 & L4-5	1	-	1
L4-5	4	6	10
L4-5 & L5-S1	1	1	2
L5-S1		15	15
	7	23	30

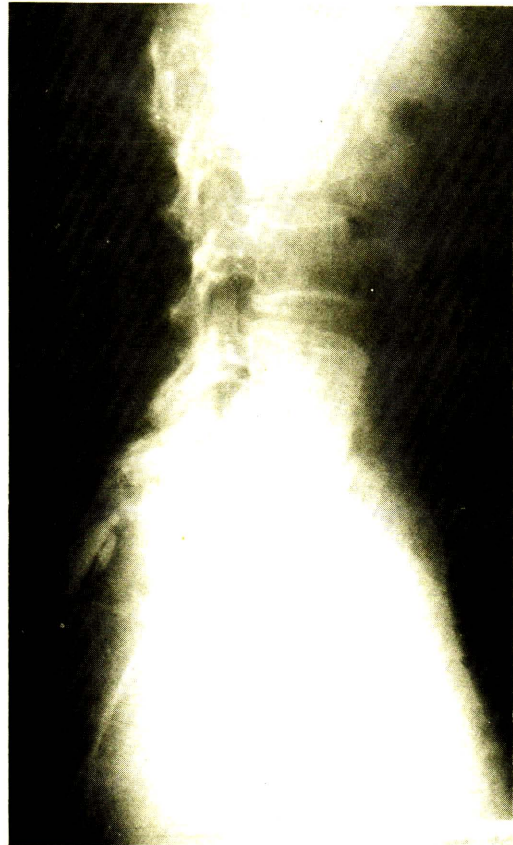
In the interpretation of roentgenographic results, the characters of the new bone formation (9,10,11,12) and the pattern of trabeculation between bone graft and the involved vertebrae (Fig. 1),



**Figure 1** Successful fusion at L3-4

were employed and summarised in Table 4. In non-unions there were obvious bone graft resorption, poor new bone formation,

lack of trabeculation and marked obliteration of disc space (Fig. 2)



**Figure 2** Non-union at L5-S1

The rate of successful fusion in degenerative spondylolisthesis was 72.5 % and in ischemic 82.6%. There was a good correlation between bony union and satisfactory clinical results, but three cases of non-union also had improved clinical performances. The three clinically poor patients

all had non-union and received a spinal fusion and Harrington second operation of posterior instrumentation.

**Table 3** Clinical results

Grades	Degenerative	Ischemic	Total
Good	3	17	20
Fair	2	5	7
Poor	2	1	3
	7	23	30

**Table 4** Roentgenographic results

	Degenerative	Ischemic	Total
Union	5 (72.5 %)	19 (82.6 %)	24 (80 %)
Non-union	2	4	6 (20 %)
	7	23	30 (100%)

The height of an intervertebral disc space was measured in the midline, between midpoints on the vertebrae above and below, each found on a line drawn

between the anterior and posterior borders, of the inferior cortex of the vertebra above and similarly of the superior cortex of the vertebra below (Fig. 3).





**Figure 3** Disc space measurement

Measurements were made pre-operatively, immediately after the operation and from the final X-ray examinations. The pre-operative disc space width ranged from 3 mm to 13 mm according to patients' built, severity and type of disease. Immediately after the insertion of bone graft, the width may remain the same or increase, from 1 mm to 6 mm.

The final X-ray measurements were more distinctive. Of the 33 disc space measurements, 23 had slight decreases in width, 6 marked decreases and 4 retained their original widths. The average disc space measurement in all the levels studied is shown in Table 5.

### Discussion

There are three mechanisms that can produce a failure of the neural arch with or without the displacement of the pathological vertebral body. Of all the forces<sup>(16,17)</sup> acting on the lumbar spine, namely flexion overload, unbalanced shearing force, and forced rotation, torsional violence is the most disruptive to the neural arch. Beside causingolisthesis, it is capable of producing lysis of the pars<sup>(16,17)</sup> which is what might have happened to the patients in this series. They were heavy workers, male and female, or very busy traditional housewives. After years of continuous work without rest, spondylolysis and spondylolisthesis occurred. Movement is an important factor in the production of pain, not only the



pain due to instability of the vertebral body but also due to the nerve root compression.<sup>(5)</sup> The elimination of movement by a successful fusion is sufficient to relieve the symptoms. This applies to the buttock pain, leg pain, sciatica, as well as to the low back pain.<sup>(5,6,7)</sup> Because the etiological factor of such condition is mechanical, anterior intervertebral fusion seems to be the most reasonable method of treatment. Beside providing

mechanical stability, the procedure can also control the progression of the displacement,<sup>(17)</sup> if it were to occur. A progression of displacement can not always be controlled by posterior fusion<sup>(6)</sup> especially in young patients. The success rate of fusion in this series was 80 %, with none showing progressive displacement, a result comparable to those reported by Freebody,<sup>(9)</sup> Harman,<sup>(12)</sup> Goldnor,<sup>(11)</sup> Fujimaki,<sup>(10)</sup> et al.

**Table 5** Average width of disc space in mm.

Group	Pre-operative	Immediate Post-OP.	Final-Evaluation
Union	8.8	11.0	7.1
Non-union	9.3	9.3	5.0

Little have been said about the intervertebral disc space. Some<sup>(5,11,12,6)</sup> mentioned the change in the disc space when they talked about the progressive slip of spondylolisthesis. To the authors knowledge, none has studied in detail the condition of the disc space before and after an anterior spinal fusion in spondylolisthesis. From the study,

it could be convincingly stated that no matter what the original pre-operative disc space was, the size of the bone graft during the operation would determine the outcome of the width of the disc space. If the bone graft is oversized when inserted into the vertebral bed. it will distract the vertebrae and thus increase the disc space and vice versa.

However, during the healing process and the incorporation of the bone graft to the vertebral bodies, part of the bone itself must be absorbed, so that when solid union appears and the architecture of bony trabeculation is as strong for weight bearing as the vertebral bodies above and below, some diminution of the disc space must occur. An average diminution of disc space in the 23 solidly fused levels studied was 1.7 mm. (19 %). In the 6 cases of non-union the disc widths were greatly decreased, to 49 % of the original, perhaps due to the bone graft acting like avascular bone, allowing the trabeculations to disorganise and collapse. The disc space would be unable to maintain its former width and decrease greatly later on. Hence, the intervertebral disc space measurement might be used as a clue or criterion in the interpretation of the fusion especially

in doubtful cases.

### Summary

Anterior intervertebral fusion was performed in 30 cases of spondylosis and spondylolisthesis with a follow up of 1 to 2½ years. Solid fusion was accomplished in 5 (72.5 %) of the 7 degenerative spondylolisthesis and in 19 (82.6 %) of the 23 ischemic type. The overall fusion rate was 80 % and non-union rate 20 %, with good correlation between clinical performance and radiological appearance. The intervertebral disc space was either maintained or increased depending on the size of the bone graft inserted. The final radiological studies revealed that, in the successful fused levels, the width of the disc space was slightly diminished (19 %) in contrast to the non-union group, where the width was greatly decreased to nearly a half (49 %) of the original.

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