POSTERIOR INTERVERTEBRAL FUSION OF THE LUMBAR SPINE

Preliminary Report of a New Operation

ANTHONY JAMES and NORMAN W. NISBET, DUNEDIN, NEW ZEALAND

From the Departments of Neurosurgery and Orthopaedic Surgery, Dunedin Hospital, New Zealand

This is a preliminary report of a new operation by which to stabilise a segment of the lumbar spinal column by body-to-body fusion through a posterior approach. It has been used in the treatment of six patients with spondylolisthesis, the procedure in these cases including excision of the separated neural arch which we believe to be an important part of the surgical treatment of painful spondylolisthesis. It has also been used in five patients who had severe low back pain persisting after the operative treatment of prolapse of intervertebral discs. We recognise that eleven cases is a small series, and that the period of follow-up is short; but several patients have now been under review for more than two years and our experience has been so satisfying that we feel justified in publishing a preliminary report. The principle of the operation is essentially the same in each of these two groups of cases but they must be considered separately because in spondylolisthesis there are special problems.

POSTERIOR INTERVERTEBRAL FUSION IN SPONDYLOLISTHESIS

In spondylolisthesis the defect of ossification is at the isthmus of the vertebral neural arch—the slightly constricted area lying between the superior and inferior facets, and not at the neurocentral suture (Fig. 1). Usually the fifth lumbar vertebra is involved, sometimes the fourth, and occasionally the third (in our own recent series the corresponding number of cases being eleven, four and two).*

The symptoms include low lumbar backache in the midline, radiating pain in the buttocks and thighs, and sciatica. It seems probable that midline pain in the low back is the consequence of impingement of spinous processes and strain of interspinous ligaments, and that widespread pain radiating to the buttocks and thighs may arise from the stretching of anterior and posterior longitudinal ligaments and the annulus fibrosus; but the sciatica is more difficult to explain. Dandy (quoted by Mercer 1947) and Meyerding (1941) said that sciatica in spondylolisthesis was caused by herniation of the intervertebral disc, and many others have supported this view. We can say only that although this may sometimes be true it was not the cause of sciatica in any of our cases; on the contrary the intervertebral space was narrowed by degenerative changes in the disc, and great difficulty was experienced in gaining entrance.

We think that there is another explanation for the referred sciatic pain of spondylolisthesis, and the technique of our operation depends partly on this. Sciatic pain, often bilateral and symmetrical, can be induced by applying firm pressure over the spinous process of the affected

* It would be inappropriate in this communication to discuss the cause of spondylolisthesis; we refer readers to the classical studies of Manners-Smith 1909, Willis 1923, 1924, 1931, 1932, Capener 1882, Speed 1938, Batts 1939, Friberg 1939, Cleveland, Bosworth and Thompson 1948, and Harris 1951.
vertebra; indeed in one patient the pain so produced was agonising and he fell to the ground. Other patients have noticed that leaning back against a chair or rail gave rise to sciatic pain, presumably for the same reason. Our dissections, the models based upon them (Figs. 2 and 3) and the findings at operation, show that the separated Y-shaped neural arch can be so rocked on its articulations that the antero-superior margin impinges upon the nerve roots emerging below the pedicle of the defective vertebra. This surely is the explanation of the sciatic pain produced when pressure is applied to the spinous process of the affected vertebra; and it would also explain the complete relief from backache and sciatica that was gained by a dental student whose separated neural arch was excised without any other treatment at all (Fig. 4).

At first it seems remarkable that the neurological signs in spondylolisthesis are so few. There is seldom evidence of nerve root compression such as accentuation of pain by coughing, sneezing, jugular compression or straight leg raising; and although tendon reflexes are sometimes less brisk than is normal, dermatomal hypalgesia is not elicited. Even when the fifth vertebral body has slipped off the sacrum—the grade four deformity of Meyerding (1934)—there may be fewer physical signs of neurological disturbance than in milder displacements. Search of the literature has failed to reveal any clear evidence of compression of the cauda equina; even the case reported by Ryerson in 1915 was open to doubt as to the nature of the intermittent paralysis. Harris (1951) said that the neural foramen was narrowed
by vertebral displacement so that the fifth lumbar root was compressed, but we have difficulty in accepting this. As the body of the fifth lumbar vertebra slips forwards on the sacrum the neural canal and foraminae increase in size, the root tends to slacken and the canal is decompressed. The first sacral roots are vertically disposed to the lumbo-sacral joint, and in spondyloolisthesis at the fifth lumbar level they are often stretched over the top edge of the sacral canal. The deformity occurs very gradually and the nerve roots, which are well padded with fat and many veins, accommodate themselves to the new position and suffer no damage. The alarming appearance shown in many radiographs has therefore little significance except in the few cases in which there is actually root pain.

**Consideration of operative measures**—The vertebral displacement of spondyloolisthesis is often discovered accidentally in the course of routine radiographic examination. Post-mortem anatomical studies show that the lesion is present in more than 5 per cent of skeletons, but far less than this proportion of patients with spondyloolisthesis have clinical disability; in fact most of them have no symptoms at all. Only when there are persistent symptoms of low back pain and root pain should operative treatment be considered.

The principle of stabilising a segment of the spine by fusing the vertebral bodies rather than the laminae and spinous processes is attractive and logical (Mercer 1947, and Dandy quoted by Mercer). Animal experiments by Haas in 1946 showed that it could be accomplished in dogs. The anterior route was used successfully by Burns (1933), Jenkins (1936), Speed (1938) and Mercer (1947); but recently Law (1950) said that the anterior approach for lumbo-sacral fusion had been abandoned in favour of posterior spinal fusion. There are certainly drawbacks to the anterior approach. An abdominal operation is needed; the exact nature of the lesion cannot be seen; such primary causes of pain as nerve root adhesion, disc protrusion, or interarticular arthritis may be overlooked; and the separate neural arch cannot be excised, which we believe to be important.

Dandy, believing that the symptoms of spondyloolisthesis arose from herniation of the intervertebral disc rather than from deformity or displacement, advised that the disc should be curetted; he thought that the resulting fibrous ankylosis would suffice to stabilise the

---

**Fig. 4**

Photograph of a fifth lumbar separate neural arch excised at operation. The patient, a young dental student, was relieved completely from backache and sciatica by excision of the arch only. Pressure on the fifth lumbar root had caused sciatica...
weak segment. Mercer (1947) in quoting this, suggested that the disc space might be packed with bone chips but did not say whether or not he had done it.

Fusion of the lumbar spine by the posterior approach as described hitherto has proved to be an arduous procedure with uncertain results (Harris 1951). Cleveland, Bosworth and Thompson (1948) said that in a series of sixty-five lumbo-sacral fusions there was failure in 3 per cent, but that when the fourth lumbar vertebra was included in the fusion, as it must be in spondylolisthesis, the failures rose sharply to 17 per cent. It is true that not all patients with pseudarthrosis after spinal fusion have persistent symptoms, but there is surely room for improvement in the operative technique.

Posterior intervertebral body-to-body fusion is a neater operation; with proper teamwork it is no more exacting than the operation of curetting the intervertebral disc; and it is a

positive-pressure arthrodesis—the two vertebrae being locked together at the fulcrum of movement. The grafts are subjected to pressure and they cannot fracture. Later, weight-bearing function may assist still further in maintaining the position and promoting the fusion of the grafts. Only in one case did a graft slip backwards, with recurrent sciatica; the displacement was detected easily in radiographs and corrected by nibbling off the projecting part.

The operation of posterior intervertebral fusion for spondylolisthesis—The patient is placed in the prone position, the hip joints being flexed to reduce the lordosis. To get a bloodless field the table is broken so that the lumbo-sacral area is at the highest part. Recently, hexamethonium compounds have been used to reduce the bleeding still more. The spines and laminae above and below the lesion are exposed through a midline incision. The spine of the separate neural arch is identified by its excessive mobility, and the separate neural arch is completely excised. The disc space is then revealed by gentle retraction of

**Fig. 5**
Drawings illustrating the operation. The separate neural arch has been excised. In Figure 5 the dura mater is shown constricted to display the tibial grafts, seen end on, between the vertebral bodies. In Figure 6 the spine is represented diagrammatically as seen from the side. Care must be taken to ensure that the grafts penetrate the intervertebral space far enough. Note how the depth of the intervertebral space is maintained. The area formerly occupied by the separate neural arch is indicated.
the dural sac and nerve roots. The lumbo-sacral space slopes at such an acute angle from the 
vertical that entry is often difficult and the prominent margin of the sacrum may need to be 
removed with an osteotome. The disc contents are then curetted thoroughly. A mortise is 
cut into each vertebral body with a narrow chisel and, while the spine is flexed with the 
vertebral bodies levered apart, the size of the mortise is measured carefully. Two tibial 
grafts cut to this dimension are driven into the disc space, one on each side of the posterior 
longitudinal ligament (Fig. 5). Care should be taken to ensure that the grafts penetrate the 
intervertebral space deeply enough (Fig. 6); backward projection of the grafts can easily be 
removed with rongeurs. Once the grafts are in position this segment of the spine should 
become completely rigid. The nerve roots fall back into their normal position and do not lie 
in contact with the grafts. After haemostasis has been secured the wound is closed in layers. 
After-care—The patient remains in bed for three weeks and is then allowed up in a plaster 
which is retained for two months. In earlier days some of our patients were immobilised 
in a plaster bed for three months but no advantage seems to have been gained by this. 
Radiographic examinations were made at three- and four-monthly intervals. The compact 
bone showed almost no absorption and the grafts retained their depth and position remarkably 
well. The appearance of bony striae between the vertebral bodies and grafts was long delayed 
and at first it seemed that only sound fibrous union would be gained; but as time passed the 
grafts became incorporated into the vertebral bodies, more readily into the body above than 
the one below (Figs. 7 to 9). We do not yet know that the grafts will always fuse soundly by 
bone to both vertebrae—but in the "movement studies" we have made, taking lateral 
radiographs in the positions of full flexion and full extension, there has always been complete 
stability of the segment even when evidence of continuity of bone striae between graft and 
vertebra was equivocal. 
Clinical assessment of results—Of the six patients with spondyloolisthesis who were treated 
by posterior intervertebral fusion, four gained complete relief from all symptoms and were 
able to pursue their ordinary duties; one still had slight pain but was much improved and 
able to do housework; one continued to complain of many symptoms and the result was bad — 
but there were complicating factors of a drawn-out claim for compensation and many of the 
symptoms were thought to have a neurotic basis, although it must be admitted that 
radiographic studies in this patient cast doubt on the soundness of fusion.

POSTERIOR INTERVERTEBRAL FUSION AFTER CURETTING A 
PROLAPSED INTERVERTEBRAL DISC

From the reports of many series of cases of prolapsed intervertebral discs treated by 
curettage alone it is becoming evident that spinal fusion is seldom needed. O'Connell (1950), 
reporting a series of 500 operations, showed that cure, or at least very great alleviation 
of symptoms, was gained by excision and curettage of the disc alone in more than 90 per 
cent of patients; there was usually sound fibrous ankylosis of the intervertebral joint. From 
this and many other reports it is evident that recurrence of low back pain and sciatica usually 
arises from incomplete removal of the disc material, herniation of another disc at a different 
level, or post-operative adhesions. An increasingly small number of patients with prolapse 
of an intervertebral disc seem to need spinal fusion as well as curettage of the disc. We have 
done the operation of posterior intervertebral fusion by driving two grafts into the adjacent 
vertebral bodies through a posterior approach in five patients—all men. In this group of 
cases the results have been very satisfying. Every patient has been relieved of his symptoms 
and all are now back at work.

SUMMARY

1. A new operation of body-to-body intervertebral fusion by grafts introduced through a 
posterior approach is described. This is a preliminary report of early results, with follow-up 
to two years, which seems to be encouraging.
Fig. 7
Radiograph one year after intervertebral grafting for spondylolisthesis. The grafts were rather too short but nevertheless they have become soundly fused to both vertebral bodies and the symptoms are completely relieved.

Fig. 8
Post-operative radiographs in a case of L.4-5 intervertebral fusion for fourth lumbar spondylolisthesis. The grafts are not yet soundly incorporated with the fifth lumbar vertebra.
2. In spondylolisthesis, abnormal mobility of the loose posterior neural arch is believed in
to itself cause nerve root pressure, and excision of the arch is an important part of the operation.
3. In the few cases where spinal fusion is needed after removal of a prolapsed intervertebral
disc—and the proportion is now very low—posterior intervertebral fusion has proved very
satisfactory.

We take pleasure in thanking Mr Murray A. Falconer, the first Lecturer in Neurosurgery, University
of Otago, who allowed us to use his early cases; Mr Renfrew White, Mr J. C. McNeur, and Mr H. Walden
Fitzgerald, who have performed several of the orthopaedic steps of the operations and have assisted with the
selection of the patients. We are grateful to Dr Charles A. Hegg, who undertook the special radiographic
examinations, to Miss D. Marshall and staff of the Photographic Unit of the Otago Medical School for the
reproductions, and to Miss L. North and Miss E. Madigan for their capable secretarial aid.

REFERENCES

Dandy, W. E. (Quoted by Mercer, W.).
and Joint Surgery, 28, 544.
Royal College of Surgeons of England, 6, 64.
Meyerdinger, H. W. (1941): Low Backache and Sciatic Pain Associated with Spondylolisthesis and Protruded
O'Connell, J. E. A. (1950): The Indications For and Results of the Excision of Lumbar Intervertebral
Surgery, 33-B, 8.
of the American Medical Association, 64, 24.
American Journal of Anatomy, 32, 95.