

Lumbosacral fusion with pedicular screw plating instrumentation

A 10-year follow-up

Raymond Roy-Camille, Jean-Pierre Benazet, Jean Pierre Desauge and François Kuntz

Groupe Hospitalier, Hôpital de la Pitié-Salpêtrière, 47-83 Boulevard de l'Hôpital, 75651 PARIS Cedex 13, France
Tel +33-1 45702519. Fax +33-1 45703593.

Hibbs (18) and Albee (1) were the first in 1911 to propose a lumbar arthrodesis as a treatment of "mal de Pott." Since then numerous authors have extended their indications for lumbosacral arthrodesis to chronic back pain with or without radiculopathy (24, 32, 33, 37, 38, 39, 40). At La Pitié Hospital, today's technique advocates the implantation of plates and pedicular screws with posterior bone graft as described by Roy-Camille in 1984 (33).

43 patients with a follow-up of over 10 years were reviewed. We retrospectively studied the functional results obtained in relation to etiologies and analyzed our failures. Radiographic changes in the instrumented spine, the disc condition of the adjacent segment, as well as the development of facet joint degeneration in the level above were also studied.

Patients and method

Patients: 43 patients, 25 women and 18 men, operated on at the Pitié with a lumbosacral arthrodesis were reviewed with a follow-up of 10 years. At the time of the operation, age varied between 22 and 67 years with most of the operations performed in the age group between 40 and 50 years.

Physical and professional status: Of the patients, 8 were sedentary, 20 were active, and 15 had heavy manual work frequently subjecting their spine to heavy loads. 4 patients had had a work related accident resulting in their pathology. 20 patients had at least one year of absence from work due to their back pain and 5 patients had psychiatric problems.

Etiology: A lumbosacral arthrodesis was performed in 22 cases for degenerative disc diseases and in 13 cases for a spondylolisthesis with a flaw in the pars interarticularis (11 cases showed a Grade I slip and 2 cases a Grade II). In 6 cases, the etiology was due to a

failed operation for herniated disc. 2 patients showed lumbar stenosis from L3 to the sacrum.

Symptoms: 33 cases had back pain associated with radicular pain. 6 had only back pain and 4 had pure radicular symptoms. Preoperative neurologic symptoms were present in 8 patients. 6 had a neurologic deficit of which 4 were sensory and 2 motor. The other 2 patients, suffering from lumbar stenosis and a neurogenic claudication, were able to walk for an average 25 minutes. For 19 patients, the delay from the onset of the symptoms to the operation was beyond 10 years.

Previous operations: 6 patients had undergone a failed disc hernia surgery. For 3, it was simply a case of insufficient curettage. On two occasions herniated discs appeared in the adjacent segment and the remaining patient had developed postoperative fibrosis.

Techniques: A posterior midline approach was used. Two types of arthrodesis instrumentation have been used in the series. 21 patients received arthrodeses with 2 plates and screws and a postero-lateral bilateral bone graft. This allows a laminectomy between 2 plates (Figure 1).

For the other 22 patients, the lumbosacral instrumentation was unilateral with articular screws on one side and a plate and screws on the other. A posterior and lateral bone graft was placed, after decortication of the spinous processes, into the lateral border of the facet. The bone grafts also involved the facets. The former were prepared for placement of grafts under the plates as well as across the lamina according to the Hibbs technique.

Exploration of nerve roots were performed on 31 patients: 13 times for a degenerative disc diseases and 10 times for spondylolisthesis after the removal of the posterior arch according to the Gill technique. For the patients with re-herniated discs or spinal stenosis, exploration with decompression was systematically performed. The canal was opened in 25 cases for nerve root decompression and 6 times for discal curettage.

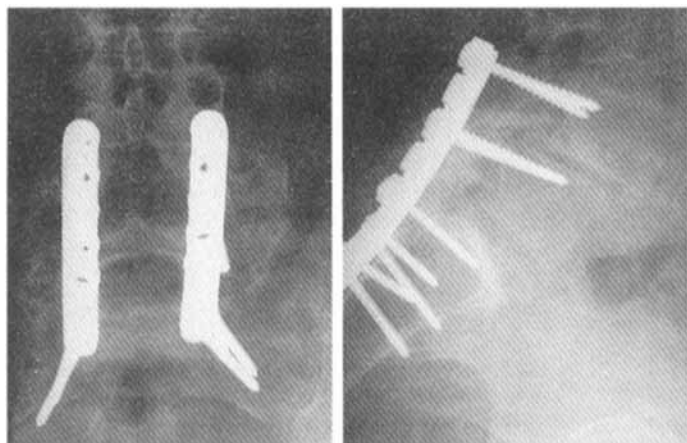


Figure 1. Spondylolisthesis L4–L5 of grade I associated with a degenerative disc diseases L5–S1. Arthrodeses L4 to sacrum and postero-lateral graft. (Lat och AP vy)

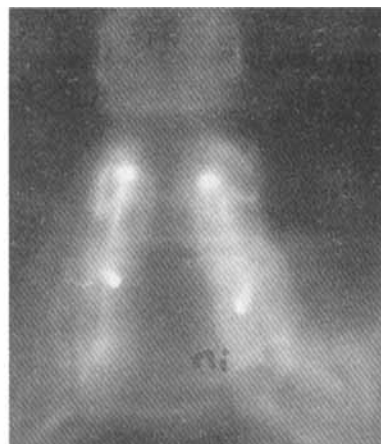


Figure 2. Pedicular screw L5 placed in the spinal canal responsible for L5 paresis.

Length of the fusion: In 24 patients, the length of the fusion was from L4 to the sacrum while in 19 cases it was performed from L5 to the sacrum. With 2 patients who had a lumbar stenosis, an arthrodesis was performed from L4 to the sacrum but the decompression went up to L3.

Follow-up: 43 patients had a mean follow-up of 11.5 (10–13.5) years.

Results

Function: The study of the global functional results was performed according to the Stauffer and Coventry criteria, modified by Friberg (14). Over a period of 5 to 10 years, the results showed good stability. 30 patients had good results but 3 cases with good results at 5 years deteriorated to a fair result 5 years later. Out of the 43 patients in the series, 13 had entirely normal function, 17 were relieved of persistent pain and returned to work with occasional pain medication. 10 patients showed fair results with reduced but persistent pain needing occasional pain medication. However, 3 patients showed no improvement and in fact complained of increased pain and resorted to the use of strong medication.

Pain: 16 patients showed no sign of pain whatsoever, 21 showed improvement while taking occasional medication and 6 were unchanged, necessitating frequent pain medication. Among the patients with chronic pain 10 were lumbo-radicular and only 9 lumbar. In 7 cases, clinical examination revealed that the back pain was linked to the iliac donor site of the graft.

Results according to the etiology were variable. The best results were obtained for spondylolisthesis: 7

patients showed no pain and 6 were significantly improved. Some good results were also achieved with disc degeneration: 9 patients showed no pain whatsoever, 9 were significantly improved while 3 were of minor benefit.

The worst results were obtained with revisions of disc herniations: 1 patient no longer had any pain, 3 were improved and 2 continued to experience significant pain. Among the 2 patients presenting a lumbar stenosis, 1 showed significant improvement while the other still had acute pain.

Type of instrumentation: The type of instrumentation, whether unilateral or bilateral, provided no significant difference.

Return to work: Of the 35 workers in this series only 15 patients were able to return to the same profession, 7 changed their line of work and 13 stopped all professional activity. Of the latter, 9 were placed in invalidity and 4 in early retirement.

Complications: 2 patients developed a deep hematoma which did not require a surgical reintervention. 1 patient needed a surgical revision for a deep *Staphylococcus aureus* infection. For these 3 patients, functional results were good. 3 dural tears were noticed intraoperatively without any consequence. 1 screw in the canal at L5 was responsible for a paresis which resolved after surgical revision (Figure 2). Among the late postoperative complications, there were 2 nonunions and 2 instrumentation failures with breakage or single screw extrusion.

Revisions: In 2 cases, the revisions were early. One was for a deep infection and the other was to remove the L5 screw from the canal. In both cases, in spite of these revisions, the results were good. Surgical revisions were performed at a later date in 10 cases. In 9 cases, persistent back pain required removal of the

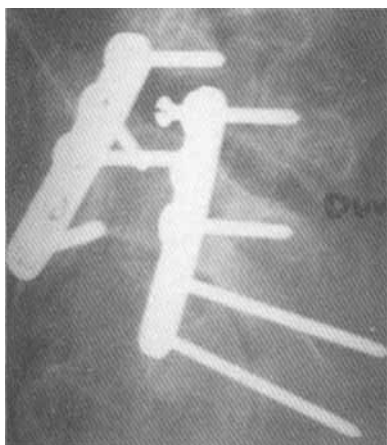


Figure 3. Lumbosacral fusion L5 to sacrum for disc diseases L5-S1; expulsion of a screw of L5 and probable nonunion of the graft.

instrumentation and exploration of the bone graft site. In all the 9 cases, the bone graft had fused but only 4 patients had improved symptoms after this surgical procedure. Of the 2 patients showing a nonunion at the graft site, only 1 showed back pain significant enough for him to accept surgical revision. In this case, the objective was to decorticate and to apply new bone graft on the site of the lumbosacral fusion.

Radiographic study

The graft site: Radiographic evaluation was always performed with standard lumbosacral, A-P, profile, and oblique views. The appearance of the graft site and the stability of the instrumentation were evaluated.

2 patients had a nonunion diagnosed from standard radiographs. 1 patient opted for a surgical revision which did indeed confirm a nonunion (Figure 3). A new graft was implanted but unfortunately did not improve the results. For 2 patients, the graft appeared to be of poor quality which was associated with changes in the instrumentation. Both patients chose not to be operated on again. In 40 patients, the graft was considered as fused, 9 having been verified during the removal of the surgical implant.

The adjacent segment: Radiographic evaluation of the level of both lumbosacral arthrodeses showed reduction of the disc space height in 7 patients and development of degeneration of the facet joints in 11 patients. These degenerative changes were in all cases responsible for persistent postoperative back pain.

Discussion

Several series on lumbosacral fusions show good results in surgical treatment of the degenerative pathology of the spine, while some authors are more reserved. Lehmann (23) showed that half of the patients continued to have postoperative back pain. The 1987 Quebec Task Force on Spinal Disorders (31) counter indicated spinal fusions in cases of pure chronic low back pain and only suggested surgical intervention in case of an associated neurological syndrome. Today, despite these controversies, most authors agree on the antalgic benefit from lumbosacral arthrodesis when patients are properly selected with precise symptoms based on documented pathology (12, 17, 28, 29, 37, 38, 47).

Feuerstein and Greenough (11, 16) insisted on an analysis of both the psychological and professional aspect of the patient. Clinical depression can precede or be a reaction to chronic pain (36, 41, 44, 48, 49). Certain authors suggest psychological tests to determine the probability of a successful operation. In our series, 5 depressed patients were operated on, 4 obtained good results and 1 continued to complain of pure back pain without any organic cause.

Kostuik and Greenough (16, 21) insist on the importance of the patients professional activity. In their series, less than 60% of the patients whose profession involves hard physical work were able to return to their original job. These results correspond to our series as only 15 patients of 35 (42%) were able to return to their original jobs and 13 (30%) had to cease their professional activities. In addition, in spite of good patient selection, based on anatomy and their corresponding clinical symptoms as well as the effectiveness of a corset test (4, 7, 8), it appears that an unfavorable psycho-social profile provides results which are only fair (11, 28).

In 1972, Stauffer and Coventry (37, 38, 39) at the Mayo Clinic achieved a 93% success rate with posterior arthrodeses. Since then, their publications show a preference for techniques with posterior and posterolateral grafts (2, 3, 5, 15, 45). Other authors, including Roy-Camille, propose an osteosynthesis based on a concept of plates and pedicular screws in order to protect the graft (24, 33, 34, 35). In our study, the fusion rate was 95%. These results are comparable to those obtained in different series using identical techniques (3, 15, 24, 26, 42, 43, 46). Like many authors (6, 19, 20) the examination of the quality of the fusion was performed using standard radiography. However, radiographic evaluation of the graft site is subjective and only a surgical evaluation can show the quality of the consolidation with absolute certainty.

Like Gerard, Thomassen and Freebody (10, 14), our

best results were obtained in the treatment of spondylolisthesis of Grade I and II while our worst results were revisions of disc herniations. Other authors have obtained favorable results with spondylolisthesis but these were associated with different surgical techniques (39, 42). Like Nachemson and Peek (27, 30), we did not attempt to reduce the spondylolisthesis of Grade I and II. These maneuvers are at times risky and progressive slips among adults are rare (13, 25). Arthrodeses performed for disc herniation revisions give the highest proportion of poor functional result at 33%.

Spinal canal exploration is often difficult. One must look for a disc sequester or a compressive osteophyte which one must know how to remove. In their absence the existence of fibrosis can be responsible for a radiculopathy.

Scar tissue is difficult to remove and removal does not always improve the results as it can recur and provoke recurrent pain. Thus, we suggest an arthrodesis for the prevention of the recurrent fibrosis. For disc degeneration, lumbosacral arthrodeses showed a 86% success rate which is comparable to those found in other studies (8, 22). In relation to the disc, we propose two approaches in performing an arthrodesis. For a thoroughly collapsed disc, pedicular instrumentation can create a compression effect. Thus a nerve root decompression with a foraminotomy is suggested. For a less collapsed disc, the instrumentation will result, on the contrary, in a distraction of the disc space, thereby opening the foramen and achieving a semi-rigid construct. In these cases, we propose a posterolateral interbody fusion.

Functional results at 5 and 10 years follow-up were stable except for 3 patients where results later became fair. Radiographic evaluation showed no nonunion but in 3 cases, there was a disc collapse of over 50% of the adjacent segment which provoked significant degeneration of the facets. No patients in our series who presented this pathology were completely free of pain. An arthrodesis in hyperlordosis, with its resulting forces on a posterior disc and facets, promotes this type of degenerative disorder.

Conclusion

For the patients with spondylolisthesis of Grade I and II or a disc degeneration, the functional benefit of the lumbosacral arthrodesis is favorable (85% good results). On the other hand, fewer good results were obtained for re-herniated discs.

Fusion of the graft is achieved in 95%. A surgical revision associated with a new graft can be proposed each time there is a non union. A change of instrumentation or a patient with one year post operative follow

up always shows back pain in the case of a bone graft of poor quality.

Bilateral or unilateral instrumentation does not seem to show a significant difference in results.

A good anatomoclinical correlation is essential. It enables the surgeon to choose the correct operative indication and remains the best guarantee of a good result.

The surgeon must know how to estimate psychological and socio-professional problems when evaluating the probability of a successful operation.

Faced with the failure of a lumbosacral fusion, one must look for the problem whether within in the canal (discal sequester, osteophyte, screw), outside of the canal (degeneration of the adjacent segment, posterior arthrodesis, nonunion) or see if the cause is essentially functional.

Acknowledgement

We would like to thank R. Lange (NEXIS) for help with the translation.

References

1. Albee F H. Transplantation of a portion of the tibia into the spine for Pott's disease. A preliminary report. *J Am Med Ass* 1911; 57: 885-886.
2. Andrews T A, Brooks S, Pigott H. Long term follow-up evaluation of screw and graft fusion of the lumbar spine. *Clin Orthop* 1986; 20: 113.
3. Bitan F, Bex M, Lassale B, Rocolle J, Deburge A, Cafiñiere J Y de la. Facteurs de réussite de l'arthrodèse postero-laterale du rachis lombo-sacré. *Rev Chir Orthop* 1984; 70: 465-472.
4. Buchalter D, Kahanovitz N, Viola K, Dorsky S, Nordin M. Three dimensional spinal motion measurements. Part two: a non-invasive assessment of lumbar brace immobilization of the spine. *J Spinal Dis* 1989; 1: 284.
5. Castaing J, Janvoie L, Lannelongue J, Lechevallier P L, Vacat J P, Videgrain M. Le traitement des lombalgies et lombo-sciatiques par greffes postero-laterale. *Rev Chir Orthop* 1974; 60: 517-521.
6. Cloward R B. Spondylolisthesis. Treatment by laminectomy and posterior inter-body fusion. Review of 100 cases. *Clin Orthop* 1981; 154: 74-82.
7. Colhoun E, McCall I W, Williams L, Cassar-Pullicino V N. Provocative discography as a guide to planning operations on spine. *J Bone Joint Surg (Br)* 1988; 70-B: 267.
8. Esses S I, Botsford D J, Kostuik J P. The role of external skeletal fixation in the assessment of low back disorders. *Spine* 1989; 14: 594.
9. Farfan H F, Kirkaldy-Willis W H. The present status of spine fusion in the treatment of lumbar intervertebral joint disorders. *Clin Orthop* 1981; 158: 198.
10. Fassio B. Technique de la greffe trans-sacro-lombaire dans le traitement du spondylolisthésis dysplasique. *Rev Chir Orthop* 1983; 69: 573.

11. Feuerstein H L, Wiesel S W, Cuckler J M, Rothman R H. Environmental stressors and chronic low back pain: Live events, family and work environment. *Pain* 1985; 22: 295.
12. Finnegan W J, Fenlin J M, Marvel J P, Nardini R J, Rothman R H. Results of surgical intervention in the symptomatic multiply-operated back patient. Analysis of sixty-seven cases followed for three to seven years. *J Bone Joint Surg (Am)* 1981; 64-A: 1077.
13. Fredrikson B E, Baker D, McHolick W J, Yuan H A, Lubicky J P. The natural history of spondylolysis and spondylolisthesis. *J Bone Joint Surg (Am)* 1984; 66-A: 699.
14. Friberg S. Studies on spondylolisthesis. *Acta Chir Scand (Suppl 55)* 1939.
15. Gerard Y, et al. Résultats des greffes postréro-latérales de la charnière lombo-sacrée. *Acta Orthop Belg* 1981; 47: 636-641.
16. Greenough C G, Fraser R D. The effects of compensation on recovery from low back pain injury. *Spine* 1989; 14: 947.
17. Greenwood J, McGuire T H, Kimbel F. A study of the causes of failure in the herniated intervertebral disc operation. *J. Neurosurg.* 9: 15, 1952.
18. Hibbs R A. An operation for progressive spinal deformities. *N Y Med J* 1911; 93: 1013.
19. Inoue S E, Watanabe E A, Sabatelle P E. Postero-lateral spine fusion with and without nerve root decompression. A primary procedure for low back pain. *South Med J* 1974; 67: 177.
20. Kornblatt M D, Casey M P, Jacobs R R. Internal fixation in lumbo-sacral spine fusion. *Clin Orthop* 1986; 203: 141.
21. Kostuik J P, Errico T J, Gleason T F. Techniques of internal fixation for degenerative conditions of lumbar spine. *Clin Orthop* 1986; 203: 219.
22. Kostuik J P, Huler R J, Heggenes M, Jarzem P. Long term outcome of lumbar fusions for degenerative disease. Unpublished data.
23. Lehmann R, La Rocca H S. Repeat lumbar surgery: A review of patients with failure from previous lumbar surgery treated by spinal canal exploration and lumbar fusion. *Spine* 1981; 6: 615.
24. Louis R. Fusion of the lumbar and sacral spine by internal fixation with screw plates. *Clin Orthop* 1986; 203: 18-33.
25. Lowe J, Libson E, Ziv I, Nyska M. Spondylolysis in the upper lumbar spine. *J Bone Joint Surg (Br)* 1987; 69-B: 582.
26. MacNab I, Dahl D. The blood supply of the lumbar spine and its application to the technique of intertransverse lumbar fusion. *J Bone Joint Surg (Br)* 1971; 53-B: 628-638.
27. Nachemson A, Wiltse L L. Editorial comment: Spondylolisthesis. *Clin Orthop* 1976; 117: 2.
28. Nachemson A, Bigos S J. The low back. In: *Adult Orthopedics* (Eds. Cruess R L and Rennie W R). New York. Churchill Livingstone 1984: 877-939.
29. O'Brien J P. The role of fusion for chronic low back pain. *Orthop Clin North Am* 1983; 14: 639.
30. Peek R D, Wiltse L L, Reynolds J B. In situ arthrodesis without decompression for grade III or IV isthmic spondylolisthesis in adults with severe sciatica. *J Bone Joint Surg (Am)* 1989; 71-A: 62.
31. Quebec task force on spinal disorders (Ed. Le Blanc F E): Scientific approach to the assessment and management of activity-related spinal disorders. *Spine* 1987; 12: 59.
32. Roy-Camille R, Roy-Camille M, Demeulenaere C. Ostéosynthèse du rachis dorsal, lombaire et lombo-sacré par plaques métalliques vissées dans les pédicules vertébraux et les apophyses articulaires. *Press Med* 1970: 1447-1448.
33. Roy-Camille R, Soulas P H. L'arthrodèse lombo-sacrée dans les lombalgies. In: *Quatrièmes journées de la Pitié* (Ed. Roy-Camille R). Paris, Masson 1984: 16.
34. Roy-Camille R, Saillant G, Mazel C. Internal fixation of the lumbar spine with pedicle screw plating. *Clin Orthop* 1986; 203: 7.
35. Saillant G. Etude anatomique des pédicules vertébraux, applications chirurgicales. *Rev Chir Orthop* 1976; 2: 151.
36. Southwick G, White A. The use of psychological tests in the evaluation of low back pain. *J Bone Joint Surg (Am)* 1983; 65-A: 560.
37. Stauffer R N, Coventry M B. A rational approach to failures of lumbar disc surgery. The Orthopedist's approach. *Orthop Clin North Am* 1971; 2: 533-541.
38. Stauffer R N, Coventry M B. Postero-lateral lumbar spine fusion. *J Bone Joint Surg (Am)* 1972; 54-A: 1195-1204.
39. Stauffer R N, Coventry M B. Anterior interbody lumbar spine fusion. *J Bone Joint Surg (Am)* 1972; 54: 756-768.
40. Steffee A D, Sitowski D J. Posterior lumbar interbody fusion and plates. *Clin Orthop* 1988; 227: 99-102.
41. Strassberg S S, Reimherr R F, Ward M. The MMPI and chronic pain. *J Consult Clin Psychol* 1981; 49: 220.
42. Suezawa Y, Benoski F, Jacob H. A comparison of the long term results of three types of posterior fusion of the lumbar spine for spondylolisthesis. *Int Orthop* 1981; 45: 291-297.
43. Tunturit T. Cost benefit analysis of posterior fusion of the lombo-sacral spine. *Acta Orthop Scand* 1979; 50: 427-432.
44. Turner R S, Leiding W C. Correlation of the MPI and chronic pain lumbosacral spine fusion results. *Spine* 1985; 10: 9232.
45. Vincent A. Arthrodèse postéro-latérale du rachis lombaire. *Acta Orthop Belg* 1981; 47: 619-635.
46. West J L, Ogilvie J W, Bradford D S. Complications of the variable screw plate pedicle screw fixation. *Spine* 1991; 16 (5): 576-579.
47. Wilkinson H A. The role of improper surgery in the etiology of the failed back syndrome. In: *The failed back syndrome. Etiology and therapy* (Ed. Wilkinson H A). Philadelphia, J B Lippincott 1983.
48. Wiltse L L, Rocchio P D. Preoperative psychological tests as predictors of success of chemonucleolysis in the treatment of the low back pain syndrome. *J Bone Joint Surg* 1975; 57-A: 478.
49. Wine P C. The use of psychological tests in the evaluation of low back pain. *J Bone Joint Surg (Am)* 1983; 65-A: 156.
50. Witt I, Vestergaard A, Rosenklint A. A comparative analysis of the X-ray findings of the lumbar spine in patients with and without lumbar pain. *Spine* 1984; 9: 298.