Thomas Niemeyer · Albert Schulze Bövingloh ·
Henry Halm · Ulf Liljenqvist

Results after anterior–posterior lumbar spinal fusion: 2–5 years follow-up

Received: 16 April 2004 / Accepted: 25 May 2004 / Published online: 27 July 2004
© Springer-Verlag 2004

Abstract Between 1991 and 1998, we treated 72 patients with fusion of the lumbar spine using posterior pedicle screw fixation followed by anterior retroperitoneal insertion of a titanium cage filled with autogenous bone graft. All patients had chronic low back pain after failed conservative treatment. We were able to review 54 patients with a mean follow-up of 51 (24–97) months. The mean Oswestry low back pain disability score improved from 56.8 preoperative to postoperative 29.8 and 31.2 at follow-up ($p<0.05$). The mean visual analog pain intensity scale improved from 8.3 to 4.0 postoperative and 4.8 at follow-up ($p<0.05$). The results demonstrate that circumferential lumbar fusion can be an option for the treatment of chronic low back pain.

Résumé Entre 1991 et 1998 nous avons traité 72 malades par fusion du rachis lombaire en utilisant une fixation postérieure par vissage pédiculaire suivie d’une insertion antérieure rétropéritonéale d’une cage en titane remplie d’os autogène. Tous les malades avaient une lombalgie chronique après échec d’un traitement conservateur. Nous avons revu 54 malades avec une moyenne de suivi de 51 mois (24–97). Le score moyen d’Oswestry a été amélioré de 56,8 en préopératoire à 29,8 en postopératoire et 31,2 au dernier recul ($p<0,05$). La moyenne de la valeur

analogique visuelle de la douleur a été amélioré de 8,3 à 4,0 en postopératoire et à 4,8 au suivi ($p<0,05$). Les résultats démontrent que la fusion circonférentielle lombaire peut être une option pour le traitement des lombalgies chroniques.

Introduction

Interbody fusion of the lumbar spine using pedicle screws and anterior titanium cages in order to achieve a 360° spondylodesis [1, 2, 4, 7–9, 13, 16] is used to treat degenerative lumbar spinal disorders with disabling chronic low back pain. Despite the fact that many authors have shown that clinical outcome and successful fusion do not correlate with the functional outcome [1–3, 8, 10, 13], pedicle screws and cages have gained widespread popularity in interbody fusion of degenerative disc disease. The aim of our study was to report the clinical and functional outcome of this technique.

Material and methods

We reviewed the charts of 72 patients who underwent spinal lumbar fusion between 1991 and 1998. Fifty-four patients returned for a clinical and radiological follow-up after a mean of 51 (24–97) months. The follow-up included a clinical examination and standard standing lumbar spinal radiographs as well as completion of the Oswestry low back pain disability score (ODS) and the visual analog pain intensity scale (VAS). An ODS and VAS had also been completed preoperatively and postoperatively. The average age at surgery was 47 years. There were 24 women and 30 men. In 18 cases the records or scores were incomplete and therefore not included.

Indication for surgery Indication for fusion was intractable chronic low back pain that had failed all conservative measures of treatment for at least 6 months and up to 2 years. The low back pain had to be the leading symptom,

T. Niemeyer (✉) · A. S. Bövingloh
Spine Service, Department of Orthopaedic Surgery, University
Hospital Tübingen,
72076 Tübingen, Germany
e-mail: thomas.niemeyer@med.uni-tuebingen.de
Tel.: +49-7071-2986685
Fax: +49-7071-294632

H. Halm
Centre for Spinal Surgery and Scoliosis Centre, Klinikum
Neustadt,
Am Kiebitzberg 10,
23370 Neustadt, Germany

U. Liljenqvist
Spine Service, Department of Orthopaedic Surgery, University
Hospital Münster,
48129 Münster, Germany

Fig. 1 Frontal and lateral radiograph of single-level fusion L5/S1

and a corresponding pathology of the lumbar spine had to be diagnosed. There were 25 patients with degenerative spondylolisthesis grade I/II; their mean age was 46.5 years (Group I). Eight patients with mean age 53.7 years were diagnosed with degenerative disc disease (Group II), and 21 patients had postnucleotomy syndrome; mean age 40.8 years.

Surgical technique All patients were operated by the senior authors (HH, UL) and with a uniform technique. Pedicle screws and instrumentation were used posteriorly, and fusion was achieved by laminar decortication and arthrodesis of the facet joints. Autogenous bone graft from the iliac crest was used. Anterior fusion was always performed through a paramedian retroperitoneal approach. After removal of disc and scraping the endplates, leaving subchondral bleeding, titanium cages filled with autogenous bone graft were implanted. In cases with multilevel fusions, cages were always inserted in the lowest fusion level. Sixty-eight patients underwent single-stage operations, and four patients had staged surgery. The majority of patients were operated with the Micomed Posterior Dual-rod System (MPDS) and titanium cages (Micomed Ortho, Germany) (Fig. 1).

Radiographical evaluation The authors and a radiologist assessed the radiographs independently. Union was defined as bony trabecular continuity posteriorly and/or anteriorly. Nonunion was defined as subsidence of cage and breakage of screw or rod in combination with lytic zones. Absence of bony bridging in front of the cage but without subsidence and without metal breakage was defined as probable union.

Statistical methods Statistical analysis was carried out with Microsoft Excel 97: (Richmond, WA, USA) and (SPSS 10) applying the Wilcoxon test and Mann–Whitney *U* test with a level of significance of 5% ($p < 0.05$).

Results

Disability and pain scores

The mean ODS was 56.8 preoperative, 29.8 postoperative, and 31.2 at follow-up. The mean VAS was 8.4 preoperative, 4.1 postoperative, and 4.8 at follow-up. Both ODS and VAS showed a significant ($p < 0.05$) improvement (Tables 1, 2).

Group I: spondylolisthesis

The mean ODS was 55.7 preoperative, 30.7 postoperative, and 31.2 at follow-up and showed a significant ($p < 0.05$) improvement. The mean results of VAS also showed a significant improvement ($p < 0.05$) from preoperative 8.2 to postoperative 4.4 and to 4.6 at the time of follow-up.

Group II: degenerative disc disease

The mean ODS was 56.9 preoperative, 24.0 postoperative, and 23.7 at follow-up and showed a significant ($p < 0.05$) improvement. The mean results of VAS also showed a significant improvement from preoperative 8.3 to postop-

Table 1 Results of Oswestry disability score $n=54$

Time	Mean	Median	Minimum	Maximum	Standard deviation
Preoperative	56.78	56	16	94	16.52
Postoperative	29.83	28	0	80	21.75
Follow-up	31.225	24.4	0	82.5	23.002

Table 2 Results of visual analog scale $n=54$

Time	Mean	Median	Minimum	Maximum	Standard deviation
Preoperative	8.37	9	5	10	1.26
Postoperative	4.06	4	0	10	2.9
Follow-up	4.82	5	0	10	2.87

erative 3 ($p<0.05$) and 4.1 at the time of follow-up ($p<0.05$) [(Fig. 2)].

Group III: post-nucleotomy syndrome

The mean ODS was 58.1 preoperative, 30.7 postoperative, and 34.2 at follow-up and showed a significant ($p<0.05$) improvement. The mean results of VAS also showed a significant improvement ($p<0.05$) from preoperative 8.5 to postoperative 3.1 and at time of follow-up 3.1 ($p<0.05$) (Fig. 2).

Fusion length

There were 26 patients with single-level fusion (average age 38.3 years), 20 with two-level fusion (average age 39.7 years), and eight with multilevel fusion (average age 51.9 years). Patients with single-level fusion showed preoperatively a mean score of 54.5, postoperatively 24.7, and at follow-up 27.8. The improvement was significant ($p<0.05$) (Fig. 3). In the groups with two-level and multilevel fusions, there was no significant improvement.

Surgical results and complications

The average time for surgery was 297 (110–655) min, and the mean blood loss was 900 ml for all patients (500–2,300 ml). There were a number of complications. In five patients, the common iliac vein or the ascending lumbar

vein was injured and had to be ligated. Four patients had delayed wound healing. Five patients required a surgical revision due to pedicle screw malpositioning in combination with pain or neurological deficit (motor and sensory loss) ($n=4$) or deep wound infection ($n=1$). All neurological deficits had recovered at the time of follow-up. Four male patients reported retrograde ejaculation that persisted in two patients at follow-up. Four patients reported an anterior abdominal wall hernia.

Radiographic results

Three patients ($n=2$ multilevel fusion; $n=1$ two-level fusion) had rod breakage on one side but no other sign of nonunion. No further signs of pseudoarthrosis or implant failure were found in patients who returned for follow-up. Thus, no long-term complications regarding instrumentation or fusion were found that required revision surgery, and the authors considered the fusion within the 54 patients as solid.

Professional status

Forty-two patients were employed prior to surgery, five were housewives, and seven pensioners. After surgery, only 23 of 42 patients returned to a professional activity, and of those only 14 returned to their former job position. Only one patient returned to work immediately (within 3 months) after surgery. Twelve patients returned to work within the first 6 months; three of them failed to remain in their initial profession and applied for social benefits. Six patients resumed work within 6–12 months after surgery. Eight patients started work 12 months after surgery, and two of them failed to remain in their job. Therefore, 11 became pensioners after surgery and five failed to return to their former jobs and became social benefit pensioners. The average age at surgery for these patients was 43.6 (31–57) years. Thus, altogether 23 patients were pensioners at follow-up.

Fig. 2 Oswestry low back pain disability score preoperatively, postoperatively, and at follow-up in groups of different pathology ($n=54$). Group I: spondylolisthesis, Group II: degenerative disc disease, Group III: post-nucleotomy syndrome

Discussion

Fusion is a common procedure for the treatment of chronic low back pain. But as Hanley and David [13] stated, in only half the patients fusion leads to pain reduction and functional improvement. It appears that differences in outcome are related to the indication for surgery and to socioeconomic factors. The fusion techniques do not influence the outcome [1–4, 8, 9, 13]. These results have

Fig. 3 Oswestry low back pain disability score (ODI) preoperatively, postoperatively, and at follow-up in patients with a single level or two levels or more of fusion

been confirmed by recent studies. However, it has been reported [7] that lumbar fusion has a tendency for better results than conservative treatment. We did not compare conservative and operative treatment of chronic low back pain but only studied the outcome after circumferential fusion of the lumbar spine in a heterogeneous group of patients.

Our results showed a significant improvement of ODS and VAS compared to the preoperative scores. Patients with degenerated disc disease (Group II) but no spondylolisthesis showed the best improvement, followed by the group of patients with spondylolisthesis. Even the small subgroup of patients suffering from postnucleotomy syndrome showed an improvement; however, that improvement was minor. Fusion length did not influence the outcome significantly. Only a slight improvement could be reported in patients with single-level fusion compared to multilevel fusion patients (Fig. 3), which corresponds to current literature [8, 13, 15].

The technique described in our study seems to achieve the most stable fixation of a motion segment because it involves disc excision combined with an instrumented interbody fusion and thus eliminates the chemical and mechanical source of pain associated with internal disc disruption. However, the current literature confirms that functional outcome and fusion technique do not correlate [1–4]. As Bono and Lee [2] previously stated: the clinical benefit of instrumented interbody fusion remains unclear. Fritzell et al. [8] confirmed that fusion technique does not influence the functional outcome, but they concluded that a circumferential technique offers the highest chance of fusion. Our fusion results were somewhere in the middle of the spectrum of results reported in the literature [1, 2, 4, 8, 10, 13–15, 18], with a solid fusion in all 54 patients that led to a fusion rate of 75% considering the loss to follow-up patients ($n=18$). The described radiological criterias can only be used as an indirect evidence of a solid bony fusion. The authors are well aware that on plain

radiographs, an anterior, solid, bony fusion cannot be established with certainty [6, 13, 15, 16, 18]. However, we believe that the fusion rate was acceptable despite the difficulty of assessing fusion using cage technology because in the case of a nonunion, the instrumentation would have failed after a long follow-up of more than 2 years and up to 5 years.

In our study, we compared a heterogeneous group of patients with different clinical history, different degenerative diseases and conditions of the lumbar spine, and a different socioeconomic background without knowledge of the compensation status that is known to influence clinical outcome [1, 2, 10–14]. Especially, the analysis of the professional status after surgery in our group showed a rather disappointing situation: 38% of our patients had become pensioners and received social benefits 2 years after surgery. In view of the high number of patients receiving social benefits after surgery, the significant improvement of ODS/VAS in all groups becomes less remarkable. In the literature, it is obvious that small, selected groups with the same degenerative condition, e.g., lytic spondylolisthesis [2, 5, 10, 13] treated with the same fusion technique operated by the same surgeon leads to a higher percentage of patients returning to work. Evaluation of professional status was done retrospectively comparing different degenerative conditions and showed disappointing results, with more than one third of our patients living on disability benefits. As many authors [2, 13] pointed out, work status depends on several factors, such as motivation and socioeconomic conditions in the society, which affect the availability of work.

Our complication rate lies within the rates described in the current literature [9, 13, 17]. Our revision rate was altogether 12.3% including all early and late complications that required surgical intervention. Fritzell et al. [9] found with the increased demanding technique that the complication rate increases. In view of two male patients in our study with persistent retrograde ejaculation, we believe

that a posterior fusion technique should be preferred in those young male patients.

At the time the study was commenced, the Oswestry disability score and the VAS were the only scores available within the department that allowed a continuous process of evaluation in this difficult field. Our study lacks several important issues, but we still feel our results should be reported. For example, we were unable to demonstrate reduction of health care costs with the tools we used, which were available at the time of the study. We could not correlate the outcome of diagnostic injections and tests or results of the psychological assessment. Furthermore, the group was very heterogeneous regarding age; gender and lumbar spine changes and patients were not randomized.

We believe that circumferential lumbar fusion using posterior pedicle screws and anterior interbody fusion with cages can be a surgical alternative in the treatment of chronic low back pain. However, as Bono et al. [2] previously stated: a uniform system of outcomes that contains a core of critical demographic, perioperative, and postsurgical information is needed to support the idea of fusion for the treatment of chronic low back pain. We agree as Gehrchen et al. [10] concluded that since spinal fusion is an expensive treatment with potentially serious risks and leaves one-third of patients with an unsatisfactory result, more studies focusing on the indications for surgery, socioeconomic factors, and cost reduction should be performed.

References

1. Andersen T, Christensen FB, Hansen ES, Buenger CE (2003) Pain 5 years after instrumented and non instrumented posterolateral lumbar spinal fusion. *Eur Spine J* 12:393–399
2. Bono CM, Lee CK (2004) Critical analysis of trends in fusion for degenerative disc disease over the past 20 years. *Spine* 29:455–463
3. Christensen FB, Hansen ES, Larsen M, Thomsen K, Bunger CE (2002) Long-term functional outcome of pedicle screw instrumentation as a support for posterolateral spinal fusion: randomised clinical study with a 5-year follow-up. *Spine* 27:1269–1277
4. Christensen FB, Hansen ES, Eiskjaer SP (2002) Circumferential lumbar spinal fusion with Brantigan cage versus posterolateral fusion with titanium Cotrel–Dubousset instrumentation: a prospective, randomized clinical study of 146 patients. *Spine* 27:2674–2683
5. Deguchi M, Rapoff AJ, Zdeblick TA (1998) Posterolateral fusion for isthmic spondylolisthesis in adults: analysis of fusion rate and clinical results. *J Spinal Disord* 11:459–464
6. Eck KR, Lenke LG, Bridwell KH, Gilula LA, Lashgari CJ, Riew KD (2000) Radiographic assessment of anterior titanium mesh cages. *J Spinal Disord* 13:501–509
7. Fritzell P, Haegg O, Wessberg P, Nordwall A (2001) Lumbar fusion versus nonsurgical treatment for chronic low back pain: a multicentre randomised controlled trial from the Swedish lumbar spine study group. *Spine* 26:2521–2532
8. Fritzell P, Haegg O, Wessberg P, Nordwall A (2002) Chronic low back pain and fusion: a comparison of three surgical techniques. *Spine* 27:1131–1141
9. Fritzell P, Haegg O, Nordwall A (2003) Complications in lumbar fusion surgery for chronic low back pain: a comparison of three surgical techniques used in a prospective randomized study. *Eur Spine J* 12:178–189
10. Gehrchen PM, Dahl B, Katonis P, Blyme P, Tondervold E, Kiaer T (2002) No difference in clinical outcome after posterolateral lumbar fusion between patients with isthmic spondylolisthesis and those with degenerative disc disease using pedicle screw instrumentation: a comparative study of 112 patients with 4 years of follow-up. *Eur Spine J* 11:423–427
11. Glaser J, Stanley M, Sayre H, Woody J, Found E, Spratt K (2003) A 10-year follow-up evaluation of lumbar spine fusion with pedicle screw fixation. *Spine* 13:1390–1395
12. Greenough CG, Petersen MD, Hadlow S, Fraser RD (1998) Instrumented posterolateral fusion. *Spine* 23:1918–1925
13. Hanley EN, David SM (1999) Lumbar arthrodesis for the treatment of back pain. *J Bone Joint Surg Am* 81:716–730
14. Hanley EN, Levy JA (1989) Surgical treatment of isthmic spondylolisthesis. Analysis of variables influencing results. *Spine* 14:48–50
15. Madan SS, Boeree NR (2003) Comparison of instrumented anterior interbody fusion with instrumented circumferential lumbar fusion. *Eur Spine J* 12:567–575
16. McAfee C (1999) Interbody fusion cages in reconstructive operations on the spine. *J Bone Joint Surg Am* 81:859–880
17. Sasso RC, Burkus JK, LeHuec JC (2003) Retrograde ejaculation after anterior lumbar interbody fusion. *Spine* 28:1023–1026
18. Shah R, Mohammed S, Saifuddin A, Taylor B (2003) Comparison of plain radiographs with CT scan to evaluate interbody fusion following the use of titanium interbody cages and transpedicular instrumentation. *Eur Spine J* 12:385–387