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Posterior lumbar interbody fusion combined with instrumented postero-lateral fusion: 5-year results in 60 patients

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Abstract The technique of posterior lumbar interbody fusion allows decompression of the spinal canal and interbody fusion through one posterior incision. A number of techniques exist to achieve additional posterior stability. The literature reports wide variation in outcomes for these different techniques. We assessed retrospectively the clinical and radiological outcome of posterior lumbar interbody fusion (PLIF) supplemented with an instrumented postero-lateral fusion (IPLF) using a pedicle screw system. Between July 1987 and April 1997, 60 patients underwent PLIF + IPLF. Clinical outcome was measured with physical examination in the outpatient setting and a patient questionnaire (patient satisfaction, analgesic use, return to work, Oswestry Disability Index). Radiological outcome was assessed with serial radiographs. If doubt existed regarding fixation, flexion/extension radiographs and plain tomograms were performed. The mean age was 44 years (range 19–69 years). The average follow-up was 5.3 years (range 1–10 years). Eighty percent of patients returned sufficiently completed questionnaires; 83% of these patients rated their outcome as good or excellent. Fifty percent of patients were able to return to full-time employment. All patients showed radiographic evidence of stable fixation. Four patients sustained a neurological complication, three of which resolved completely. The combination of PLIF with IPLF demonstrates clinical success, a stable circumferential fixation and a low complication rate.

Key words Posterior lumbar interbody fusion · Instrumented postero-lateral fusion · Surgical technique · Clinical outcome · Radiological outcome

Introduction

Posterior lumbar interbody fusion (PLIF) allows decompression of the neural elements and fusion of the anterior column through one incision. The posterior approach to the anterior column avoids the morbidity traditionally associated with the anterior approach. In particular, damage to the great vessels and the pre-sacral plexus (important for ejaculation in men) can be avoided. Obesity may be a relative contraindication to anterior spinal surgery. The technique of PLIF was first described by Briggs and Milligan in 1944 [6]. Further descriptions followed, by Jaslow in 1946 [18] and Cloward in 1953 [10]. Numerous techniques have been reported subsequently, including the use of autologous iliac crest bone graft, allograft bone and bone chips [10, 11, 23, 25]. More recently, titanium [20, 24] and carbon fibre cages [4] have been used to prevent the complication of late graft collapse. Carbon cage implants packed with autologous bone have achieved quicker and more reliable fusions when compared to allograft bone alone in some series [3].

Common indications for PLIF include symptomatic spinal stenosis, low-grade spondylolisthesis, segmental in-

stablilty and discogenic pain [10, 11, 21]. Proponents of the procedure report high fusion rates and good clinical outcomes [2, 4, 9, 11, 15]. Those less enthusiastic cite its steep learning curve [14], technical difficulty and high complication rate, in particular graft migration and neural injury [26, 29, 30].

The PLIF procedure may be supplemented with posterior instrumentation: either standard pedicular fixation or translaminar screws. The addition of a posterolateral fusion to provide a truly circumferential fusion has been associated with superior outcomes in selected series [2, 27], but adds to operation time, cost and possible neurological complications. We evaluated the clinical and radiological outcome of PLIF combined with IPLF.

Surgical technique

The senior author (S.H.M.) has refined the technique of PLIF with experience, and would emphasise the key points as follows. The patient is placed prone on a Montreal mattress. The abdomen must be free from external pressure, to ensure minimal epidural bleeding. A routine midline approach is made, preserving the midline structures. This increases posterior stability and allows for anatomical closure of the lumbar fascia. The pedicles are then prepared for screws. The most cephalad entry point is made somewhat more lateral, to avoid damage to the adjacent facet joint, thereby preserving motion above the intended level of fusion. If screws are to be placed in S1, the anterior cortex of the sacrum is penetrated, often with a hand drill, to improve purchase. The screw position is checked radiographically with guide wires prior to insertion of pedicle screws. If tricortical bone blocks are to be used, these are harvested now. In addition, cancellous bone graft is taken for the postero-lateral fusion. For degenerative disc disease, access to the disc space is achieved by means of bilateral laminotomies and undercutting facetectomies, with complete removal of the ligamentum flavum. However, with severe spinal canal stenosis and spondylolytic spondylolisthesis it may be necessary to perform a laminectomy to ensure the neural elements are completely decompressed. A specialised nerve root retractor is used to protect and retract the dura and nerve roots. Exposure can be enhanced by inserting the nerve root retractor from the contralateral side, across the midline under the retained interspinous ligament. The nerve root and dural sac should never be retracted beyond the midline. Bleeding is controlled with bipolar diathermy coagulation to minimise post-operative epidural scarring. The exposed half of the disc is incised and removed with a rongeur and ring curette. A thin layer of endplate is removed with an osteotome (7–10 mm), to just expose bleeding bone. A specialised 10-mm spacer is inserted into the cleared disc space, providing gentle distraction to facilitate discectomy on the contralateral side. The disc space is measured by trial insertion of variously

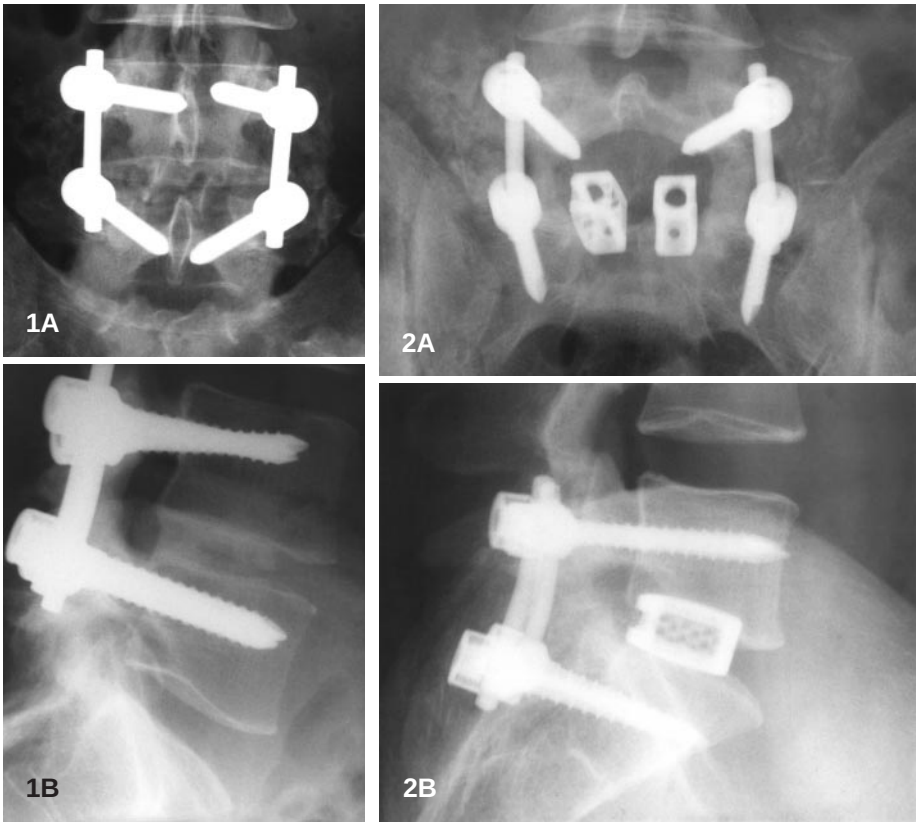

Fig. 1 A, B Posterior lumbar interbody fusion (PLIF) performed at L4/5 using tricortical autogenous bone graft. Anteroposterior (**A**) and lateral (**B**) radiographs, taken 18 months postoperatively, show good evidence of anterior interbody and posterolateral fusion

Fig. 2 A, B PLIF performed at L5/S1 using titanium cages filled with autogenous bone graft. Anteroposterior (**A**) and lateral (**B**) radiographs taken 24 months postoperatively show stable circumferential instrumentation

sized spacers (10–14 mm). Care should be taken not to overdistract the disc space, particularly with a two level PLIF (the L5 nerve root in particular seems vulnerable to this). The graft is prepared to the required dimensions and inserted. The author's preference is two tricortical autogenous bone blocks (Fig. 1), but bone chips, femoral head allograft or titanium interbody cages packed with autograft can be used (Fig. 2). The graft should be inserted both anteriorly enough to prevent posterior migration, and laterally enough to provide stability. The PLIF procedure can be performed via a unilateral approach. This may be necessary where exposure of one side is restricted (e.g. previous surgery with epidural scarring, or a conjoined nerve root). The postero-lateral fusion is then completed with decortication of the transverse processes and facet joints, addition of cancellous bone graft and instrumentation. If cages have been used, the disc space may be compressed with posterior instrumentation to reduce the risk of cage migration.

Materials and methods

Between July 1987 and April 1997, 60 consecutive patients underwent the PLIF + IPLF procedure at our institution. Preoperative assessment included plain films, discography, myelography, computed tomography, and magnetic resonance imaging, dependent on the patient's complaints and available imaging at the time. Indications for surgery are shown in Table 1. All procedures were performed or closely supervised by the senior author (S.H.M.).

The graft material used was tricortical autogenous bone blocks in 70% of cases, titanium interbody cages in 15% and femoral head allograft bone blocks in 15%. Seventy percent of patients had a single-level fusion (40% at L5/S1 and 30% at L4/L5). Thirty percent had a two-level fusion, the majority from L4 to S1. An instrumented postero-lateral fusion supplemented with pedicle screws was carried out in all cases. Patients were mobilised in a lumbosacral orthosis for 3 months. The orthosis prevents extremes of motion, reducing the risk of graft migration and screw pull-out.

All 60 patients were subject to clinical review, including a full physical examination (at 6 weeks, 3, 6, 9 and 12 months and an annual review thereafter) and a radiological review (plain films). If doubt existed regarding the state of fixation, flexion/extension radiographs and plain tomograms were obtained for further assessment. Significant movement on flexion/extension radiographs was taken as greater than 3 mm of dynamic antero-postero translation. Tomograms were inspected for extent of fusion mass. Finally a questionnaire incorporating the Oswestry Disability Index, pain relief, return to work data and overall patient satisfaction was mailed to all 60 patients.

Table 1 Indications for surgery (n = 60)

Degenerative disc disease	28
Spinal stenosis	10
Post discectomy syndrome	8
Degenerative spondylolisthesis	8
Isthmic spondylolisthesis (grade I/II)	6

Results

The group contained 36 men and 24 women (mean age of 44 years, range 19–69 years). The mean duration of symptoms prior to surgery was 6.5 years (range 9 months to 12 years). Preoperatively, 60% of patients complained predominantly of low back pain, 20% predominantly of leg pain and 20% of equal back and leg pain. Mean duration of surgery was 2.4 h. The average intraoperative blood loss was 1.3 l (range 0.6–2.0 l). There were no intraoperative complications. Mean hospital stay was 6.5 days (range 4–12 days). The mean duration of follow-up was 5.3 years (range 12 months to 10 years).

All 60 patients were subject to clinical review, radiological review and a questionnaire. Repeated attempts to obtain questionnaires from all 60 patients were made. Unfortunately, only 48 out of 60 questionnaires (80%) were returned sufficiently complete for analysis (see Table 2). In those returned patient satisfaction was high, with 83% reporting good or excellent results; 83% (40/48) of patients reported more than 90% improvement in back and leg pain; 63% (30/48) of patients no longer required analgesia; 50% of patients had returned to work, with a further 21% working part-time; 79% (38/48) had a postoperative Oswestry Disability Index of less than 30%.

Radiographs showed implants to be satisfactorily positioned in all cases. There were no cases of graft dislodgement or cage migration. In five patients, concern regarding the state of anterior fusion prompted the clinician to perform flexion/extension radiographs and tomograms. No significant movement was detected on the dynamic films and all tomograms confirmed the presence of a bridging fu-

Table 2 Outcome parameters

Criteria	Number (n = 48)	Percentage
Patient satisfaction		
Excellent	26	54%
Good	14	29%
Fair	5	11%
Poor	3	6%
Pain relief		
> 90%	40	83%
50–90%	8	17%
< 50%	0	0%
Analgesic use		
None	30	63%
Occasional	16	33%
Regular	2	4%
Return to work		
Full-time	24	50%
Part-time	10	21%
Not working	14	29%

sion mass. All patients were shown to have, by definition, a stable circumferential fixation.

Four patients suffered neurological complications. Of these, one patient developed leg pain, which resolved with repositioning of a pedicle screw. Two patients experienced transient extensor hallucis longus weakness (both patients having undergone a two-level PLIF); both recovered within a period of 6 weeks. One patient suffered bilateral foot drop (the right side recovering by 6 weeks and the left side remaining weak, reported as a poor result by the patient). Thus a permanent neurological deficit occurred in 1.7% (1/60) of cases. Three patients (5%) suffered a deep venous thrombosis requiring anticoagulation, and one patient (1.7%) developed a superficial wound infection, which responded to antibiotic therapy.

Discussion

Advocates of posterior lumbar interbody fusion (PLIF) report superior results compared to other lumbar fusion techniques [2, 4, 9, 11, 15, 24, 27], while opponents cite its technical difficulty and high complication rate, particularly with regard to neural injury [14, 29, 30]. The technique requires generous bone resection, judicious nerve root retraction, and meticulous haemostasis. Over-vigorous nerve root retraction or disc space distraction may lead to neural injury. Excessive bleeding impairs visualisation, placing the dura and nerve roots at further risk, and may even predispose to epidural fibrosis. Some authors advocate a unilateral approach to the disc via the neuroforamen (transforaminal PLIF), suggesting this may reduce neural injury [16].

There have been many materials used for interspace graft including autograft, allograft [8, 10, 11, 23, 25], and more recently titanium and carbon fibre cages packed with autologous bone [5, 20]. The use of tricortical graft from the iliac crest allows easy radiographic follow-up of the fusion and is inexpensive. However some series report significant donor site pain in up to 25% of patients [28]. This has not been our experience. The use of allograft, whilst reducing donor site morbidity, has been associated with increased rates of pseudarthrosis, higher incidence of graft collapse [3], and an increased time to fusion [3, 9]. There remains also the theoretical risk of disease transmission. Interbody cages were introduced to try to tackle some of these problems. Their design provides structural support while cancellous graft incorporates and, in some series, they are said to reduce graft collapse [4]. Human cadaveric models of PLIF have shown adequate and equal mechanical strength when comparing tricortical bone graft and titanium fibre mesh implant [17]. Interbody cages obviate the need for tricortical iliac crest grafts and possibly reduce donor site morbidity. Carbon cages packed with autologous bone are claimed by some to achieve a quicker and more reliable fusion when compared to allograft alone [3]. Titanium cages may obscure the disc space on radiographs making the assessment of interbody fusion difficult. The cost of these implants should also be taken into account. In our series, all three techniques (autograft, allograft and interbody cages) were used and, although the numbers were small and the patients were not randomised, we observed no significant difference in clinical outcome or circumferential stability. We observed no significant correlation between surgical indication and outcome. Somewhat surprisingly, the cases with severe loss of disc height, although technically more demanding, were not associated with a worse outcome.

The addition of posterior pedicle fixation to PLIF is not universally accepted. It adds to cost, operating time and blood loss and potentially increases the risk of nerve root injury. Nevertheless posterior implants allow compression of the interspace, reducing graft/cage migration. Posterior pedicular constructs provide load sharing with the anterior column and enhancement of the posterior tension band, thereby more closely resembling physiological loading. The addition of such instrumentation has been shown to increase initial stiffness [7] and stabilisation of lumbar spine segments after PLIF with intersegmental cages [22]. Jost et al. suggest the mode of compression failure is always endplate fracture and play down the importance of cage design or posterior instrumentation for PLIF [19].

Outcome following PLIF is variously reported in the literature. Fusion rates vary enormously from 65% to 94% depending on the technique used [2, 13, 15, 21]. Gill and Blumenthal reported fusion rates of 62% for allograft and 85% for autograft PLIF in a series of 238 patients [15]. Brantigan similarly has noted a higher pseudarthrosis rate with allograft [3]. There is a paucity of literature assessing clinical outcome for PLIF combined with IPLF using pedicular fixation. Only two of 68 papers reviewed by Boos and Webb [2] discussed the outcome of such surgery. The results were excellent (fusion rate 94%, satisfactory clinical outcome 87%) when compared to other forms of fusion. We have reported a stable circumferential fixation in all of our patients, with a satisfactory clinical outcome in 83%.

Complications often cited in association with PLIF include neural injury, dural laceration, excessive bleeding, graft migration and graft collapse. These are predominantly associated with the exposure and retraction required for disc clearance and graft insertion. Gill and Blumenthal reported foot drop in one patient (0.4%), dural leak in one (0.4%), leg pain in six (2.5%) and graft retropulsion in two (0.8%) [15]. Collis reported a large series with relatively few complications: temporary leg weakness in six (0.8%), dural laceration in four (0.5%) and graft migration in seven (0.9%) [11]. Davne reported on 486 patients with a deep wound infection rate of 0.6% and a neural injury rate of 1.1% [12]. Our neural injury rate (6% temporary, 1.7% permanent) was comparable to the literature. We had no cases of deep infection or cage migration.

Conclusions

In this series, the combination of PLIF with IPLF demonstrates clinical success in 83%, a stable circumferential fixation in all cases, and a low complication rate (permanent neurological deficit 1.7%). The procedure is technically demanding and should only be performed by an experienced surgeon. The combination of titanium interbody cages packed with autologous graft and posterior pedicular fixation would appear to give at least a similar outcome to tricortical graft combined with pedicular fixation in this series.

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