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ORIGINAL ARTICLE

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Lumbosacral fusion using the Boucher technique in combination with a posterolateral bone graft

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Abstract This study evaluates the clinical and radiological results of using the facet screw fixation technique described by Boucher in combination with a posterolateral fusion rather than a posterior fusion for symptomatic degenerative disease of the lumbosacral junction. It is a retrospective review of 38 consecutive patients with an average follow-up of 28 months. Radiologically, all patients had a solid fusion. Clinically, 23 patients (60%) had excellent results, 11 patients (29%) good results, 3 patients (8%) fair results and 1 patient (3%) had a poor result. There were no neurological complications. The findings support the view that the Boucher technique of facet joint fixation in combination with a posterolateral fusion is a safe and effective method of dealing with chronic symptoms relating to degenerative changes at the lumbosacral junction. The authors stress the importance of patient selection and attention to operative technique if the clinical results are to correlate with the results of fusion.

Keywords Facet joint fixation · Boucher technique · Posterolateral fusion · Low back pain

Introduction

A spinal fusion is an accepted method of treatment in patients with severe disabling low back pain arising from a failed motion segment [5, 8, 16, 17, 18, 20, 22, 23].

Various bone-grafting techniques have been described, and a review of the literature indicates that posterolateral fusion results in the lowest incidence of pseudoarthrosis [3, 16, 22]. The incidence of fusion is increased by instrumentation, which restricts motion across the segment being fused [7, 21, 25]. Again, various techniques with different points of attachment have been used.

In a comparative biomechanical study of fixation devices, Vanden Berghe et al. concluded that pedicular screws and facet joint screws provided the greatest overall stability [24]. Whilst pedicular fixation is now the most commonly used system of instrumentation in lumbar spine fusion, its role at the lumbosacral junction is questionable. The greater diameter of the sacral pedicles means that pedicular fixation works less well at this level than it does at the lumbar levels. To achieve a better purchase, longer screws that penetrate the anterior cortex of the sacrum have been proposed [1], but these screws carry the risk of potential neurovascular problems. Furthermore, pedicular fixation at the L5 level also carries the risk of damage to the L4/5 facet joint. Facet joint fixation obviates these problems.

Instrumentation of the lumbar facets was initially described by King [11], who placed short screws across the facet joints. In 1959 Boucher [2] altered this technique using longer screws directed obliquely across the facet joints towards the pedicle of the vertebra below, to achieve a better purchase. In 1984 Magerl [14] described another technique of facet joint fixation, with the screws being inserted from the contralateral side through the ipsilateral lamina. The placement of these translaminar screws is technically demanding, as the screw must be accurately directed through the relatively thin lamina.

In his original description, Boucher used a posterior bone graft. Such fusions, however, have the potential problem of bone hypertrophy, leading to stenosis [4, 13], and are difficult to assess on post-operative radiographs.

Both these difficulties are avoided by using a grafting technique that places the bone between the transverse processes or, in the case of a lumbosacral fusion, within the alar transverse space. The additional dissection required for the posterolateral graft also identifies the anatomical landmarks for placement of the facet joint screws under direct vision, thereby avoiding neurological problems. The position of the screws in this technique also leaves adequate space for a root decompression or discectomy, when this is indicated.

Degenerative disc disease giving rise to back and/or leg pain recalcitrant to medical measures is not uncommon. Magnetic resonance imaging (MRI) in these cases often reveals disc degeneration at multiple levels. In some cases, however, the changes responsible for the symptoms are located entirely at the L5/S1 junction. In such cases we would proceed to a posterolateral (alar transverse) fusion and combine it with fixation using the Boucher technique. Although this level has a greater inherent stability because of the ilio-lumbar ligaments, there is nonetheless a greater chance of a pseudoarthrosis if bone grafting is not supplemented with fixation [21].

The purpose of this study was to evaluate the clinical and radiological outcome of using this operative method in patients with symptoms secondary to isolated degenerative changes at the lumbosacral junction.

Materials and methods

This is a retrospective study of 38 consecutive patients who underwent lumbosacral fusion using the Boucher technique combined with a posterolateral graft. All patients originally presented with chronic low back pain, and 30 patients also had leg pain, which had failed to respond to conservative measures (Table 1). Patients with a spondylolysis of L5 were excluded. There were 22 men and 16 women, with a mean age of 42.5 years (range 21–60 years). No patient had undergone previous back surgery. All patients were asked about being in receipt of financial benefits for reported invalidity, and any ongoing medico-legal claims (Table 1). They all underwent a full clinical examination and straight X-rays of the lumbar spine. In addition, 30 patients had an MRI scan, 6 a computed tomographic (CT) myelogram and 2 a myelogram. All patients underwent posterolateral fusion augmented with trans-facet screws using the Boucher technique. The outcome in each case was assessed by an independent observer (Spinal Fellow) from a review of the hospital records and the radiological findings. The clinical outcome in each case was assessed using the clinical rating system reported by Hirabayashi et al. [9] (Table 2). A solid fusion was considered to be present when there was a uniform bone mass in the posterolateral space and no evidence of movement or breakage of the screws. The mean follow-up was 28 months (range 8–79 months).

Table 1 Pre-operative data (*lt*. left, *rt*. right, *bilat*. bilateral)

Patient no.	Age	Sex	Presenting symptoms	Comments
1	42	F	Back & lt. leg pain	
2	37	F	Back & lt. leg pain	
3	54	M	Back & lt. leg pain	
4	41	M	Back & lt. leg pain	
5	41	M	Back & lt. leg pain	
6	36	F	Back & rt. leg pain	
7	49	M	Back pain	Financial benefits
8	52	F	Back & rt. leg pain	
9	31	M	Back & lt. leg pain	
10	46	F	Back & lt. leg pain	Work-related injury
11	45	M	Back & rt. leg pain	
12	39	M	Back pain	
13	33	M	Back & lt. leg pain	
14	40	M	Back & lt. leg pain	
15	50	F	Back pain	Not working
16	41	M	Back & lt. leg pain	
17	40	M	Back & lt. leg pain	
18	49	F	Back & rt. leg pain	
19	42	F	Back & lt. leg pain	
20	32	F	Back & lt. leg pain	
21	33	M	Back & lt. leg pain	
22	52	M	Back pain	
23	60	M	Back & rt. leg pain	Not working
24	54	F	Back & bilat. leg pain	
25	41	M	Back & lt. leg pain	
26	46	F	Back & rt. leg pain	Medico-legal claim
27	40	M	Back & rt. leg pain	Work-related injury
28	43	M	Back & rt. leg pain	
29	21	M	Back & lt. leg pain	
30	37	F	Back & rt. leg pain	
31	38	F	Back & bilat. leg pain	
32	44	M	Back & rt. leg pain	Financial benefits
33	23	F	Back pain	
34	45	F	Back pain	Combined hip & back problem
35	57	M	Back pain	
36	45	F	Back pain	Financial benefits
37	44	M	Back & bilat. leg pain	
38	56	M	Back & lt. leg pain	

Surgical technique

Under general anaesthesia and with the patient in the prone position, a mid-line lower lumbar incision is made and deepened down to the lumbar fascia. This is divided with cutting diathermy on both sides at its attachment to the spinous processes to permit lateral reflection of the muscles en bloc out to the capsules of the facet joints at the L4/5 and L5/S1 levels. The muscle attachment lateral to the capsules are divided to permit exposure of the transverse processes of L5 and the alae. The capsules of the level to be fused (L5/S1) are removed and those at the L4/5 level are left intact. The space between the facet joints and the transverse processes of L5 and the alae (the lateral gutters) are packed temporarily with a gauze swab prior to grafting.

On each side an awl is used to begin a hole at the centre of the facet of L5 (Fig. 1a). This is deepened with a 3.2-mm-diameter AO

Table 2 Clinical rating system

Excellent	No post-operative pain
Good	Improved but with residual back or leg pain
Fair	No improvement
Poor	Worse than pre-operatively

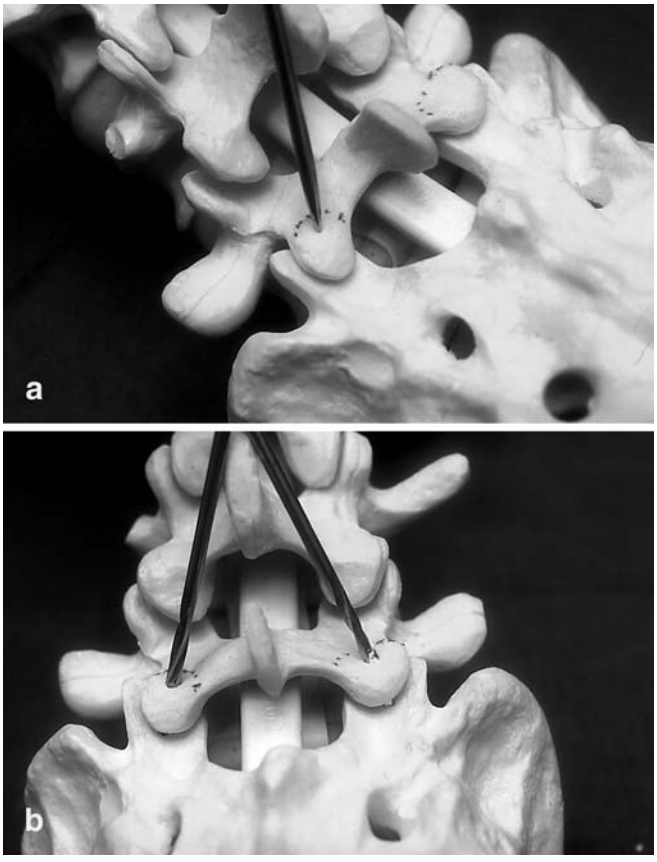

Fig. 1 **a** An awl defines the entry point for the drill. **b** Drill bits in the holes for screw placement

drill bit to a depth of 36 mm. The drill is directed laterally and caudally at an angle of about 30° in both planes (Fig. 1b). Bone graft is harvested from the outer surface of the posterior part of the ilium on the contralateral side to the operating surgeon (in our practice, it is always taken from the right side). The graft site is approached through the existing mid-line skin incision by developing the space between the subcutaneous fat and the lumbar fascia out to the iliac crest. The fascia covering the gluteal muscles is divided by cutting diathermy at its attachment to the outer lip of the iliac crest and the muscles are separated from the outer surface and held retracted. After graft recovery, the donor graft site is drained and the fascia is reattached to the crest with a continuous suture. The morselized bone graft is packed into the lateral decorticated gutters on both sides. A 4.5-mm AO cortical screw, 36 mm in length, is then inserted on each side. If, however, a unilateral decompression or discectomy is required, then this is performed prior to insertion of the ipsilateral screw. The decompression or discectomy begins with an oblique cut with an osteotome, which takes off the inferomedial aspect of the inferior facet of L5, leaving a bony margin surrounding the existing drill hole. Finally, the main wound is closed in layers over a subcutaneous drain.

Post-operative management

All patients had prophylactic antibiotic cover for 24 h. The drains were removed at 48 h, at which time the patients were mobilised in thoracolumbar sacral orthoses, which they used during the day. They were routinely discharged from hospital 1 week post-operatively, and reassessed in the clinic at 6 weeks with a new anteroposterior and lateral X-ray of the lower lumbar spine. If satisfactory at that time, they retained the orthosis for a further 2 weeks and then commenced physiotherapy. They were routinely reviewed again with further X-rays at 12 weeks post-operatively.

Results

The average operative time was 105 min (range 60–180 min) and the mean blood loss was 250 ml (range 50–700 ml). There were no neurological problems and no wound infections. Three patients had minor complications: one patient had a dural tear at operation, which was repaired with no further problems; one patient had a temporary ileus, which resolved; and one patient had persisting discomfort from the donor graft site without any functional limitation. At the time of fusion, 18 patients also underwent a simultaneous discectomy, and 12 had a lateral recess decompression. Thirty-three patients were judged as having excellent results and 11 patients good clinical results; 3 patients had fair results and 1 patient had a poor result. All 38 patients were judged to have a solid fusion (Fig. 2).

Discussion

The results show clearly that the combination of transfacet screw fixation at the lumbosacral junction in combination with a posterolateral bone graft, rather than the posterior grafting technique used by Boucher, is an effective method of fusion. Radiologically, all patients in this study were judged to have a sound fusion. Clinically, the results were also comparable with the best results published in the literature. Thirty-four of the 38 patients (92%) had either good or excellent results. The only distinguishing characteristic of the remaining four patients, who reported themselves as having a less satisfactory outcome despite an apparent solid fusion, was that each had financial considerations that might have been prejudiced by symptomatic relief: three were in receipt of financial benefits for reported disability and the fourth had an on-going medico-legal claim for a back injury. Patient selection, therefore, would appear to be an important factor if the clinical result of any fusion procedure is to match the radiological outcome.

The same operative technique was used in all cases without difficulty and with no neurological complications, and in particular no nerve root problems. The exposure of the plane between the transverse processes of L5 and the ala on each side, which is not done when the original Boucher technique employing a posterior fusion is used, means that the placement of the facet joint screws is car-

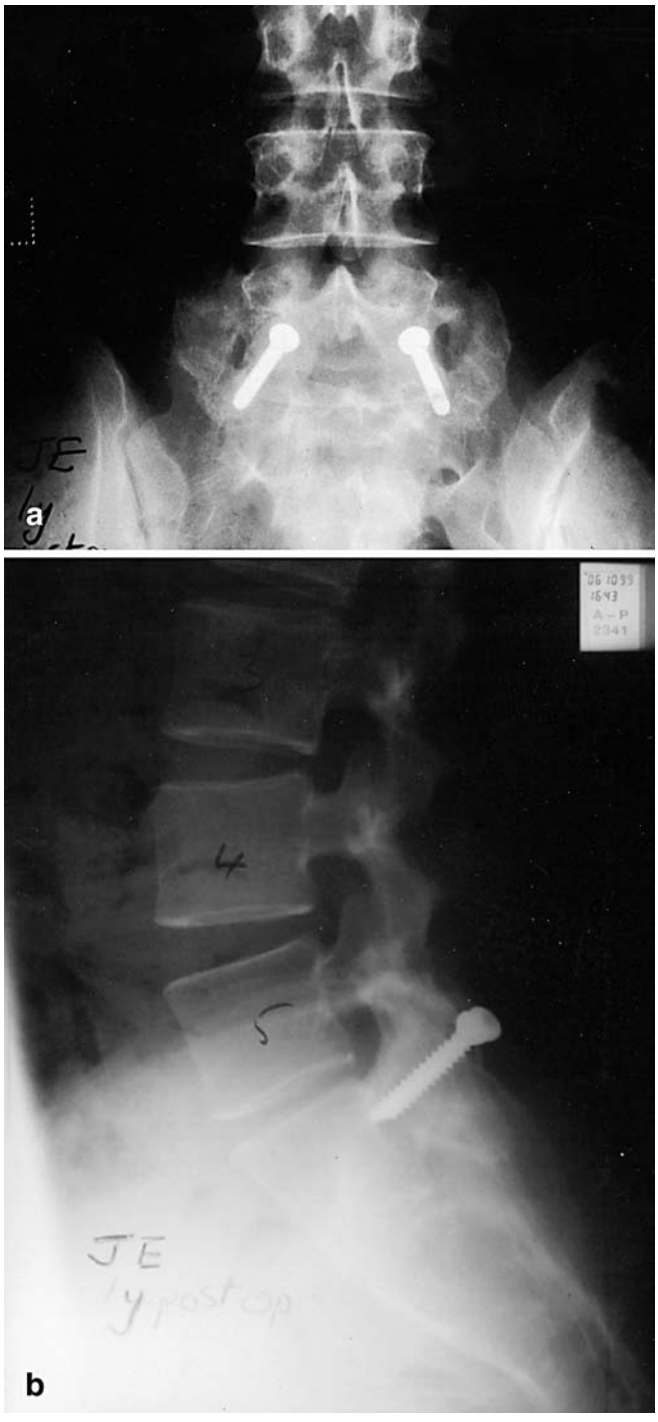

Fig. 2 **a** Anteroposterior radiograph of the lumbosacral junction, 1 year after operation, showing a solid fusion. **b L**ateral radiograph of the same patient, 1 year after operation

ried out under direct vision, thus reducing the possibility of nerve root injury. By comparison, the technically more demanding procedure of trans-laminar facet joint fixation described by Magerl [14] has been associated with neurological problems. Montesano et al. [15] reported an 11% incidence of transient neurological problems in a series of 36 patients, and Jacobs et al. [10] an incidence of 7% of transient neurological problems in 33 patients. Pedicular fixation also carries a risk of nerve root injury, which has been reported as between 1 and 2.4% [6, 12]. Thus, whilst all instrumentation of the lumbar spine carries a potential neurological risk, the combination of trans-facet screw fixation with a posterolateral graft provides a visibly safe technique with no neurological complications in this study.

With regard to the stability of facet joint fixation, there has been no direct biomechanical comparison between the trans-facet screw fixation described by Boucher and the translaminar fixation reported by Magerl. Separate studies into each technique do, however, exist. Jacobs et al. [10] reported that biomechanical tests had demonstrated that translaminar screws provide a stiffness nearly three times that of a normal spine and 20% more than that provided by Luque fixation with sublaminar wires. Vanden Berghe et al. [24], in a comparative biomechanical study of different methods of fixation, also found the Boucher screw fixation to be superior to other forms of fixation, including Luque rods and sublaminar wires, and second only to pedicular systems. Thus, although there is no direct clinical comparison of the two techniques of facet joint fixation, there is nonetheless biomechanical evidence, from separate studies, that both techniques confer significant stability. In practice we have found that the simple trans-facet technique described by Boucher, which is minimally invasive and was not associated with nerve root problems, provides an effective method of fixation with no loosening or breakage of the screws.

Jacobs et al. [10] reported a 91% fusion rate and clinical improvement in 93% of 43 patients who underwent posterolateral fusion augmented with translaminar facet screw fixation using the Magerl technique.

In a similar study by Reich et al. [19] using the same technique, the authors reported a 98.4% fusion rate and clinical improvement in 93.4% of 61 patients. Our results using the Boucher trans-facet screws augmented with posterolateral fusion compares favourably with these results.

The technique of fixation and fusion described in this paper also permits a simultaneous discectomy or root canal decompression to be carried out easily, where indicated. To date, achieving a good decompression of the S1 root with a satisfactory placement of the screw on the same side has never been a problem.

We have been at pains in this paper to outline all the particular stages in the operative procedure, as we strongly believe that attention to detail is imperative for the success of the operation.

Finally, in these times of financial stringency, it is worthy of note that the cost of instrumentation for a Boucher fusion is approximately one-tenth of that for the pedicular screw systems currently available.

Conclusions

We believe that posterolateral fusion augmented by transfacet screws using the Boucher technique is a very safe and effective method of achieving a fusion at the lumbosacral junction. Patient selection is, however, paramount if the clinical results are to equate with a solid radiological fusion.

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