Surgical treatment of lumbar spinal stenosis

FIVE-YEAR FOLLOW-UP

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We carried out a retrospective review of 155 patients with lumbar spinal stenosis who had been treated surgically and followed up regularly: 77 were evaluated at a mean of 6.5 years (5 to 8) after surgery by two independent observers. The outcome was assessed using the scoring system of Roland and Morris, and the rating system of Prolo, Oklund and Butcher. Instability was determined according to the criteria described by White and Panjabi.

A significant decrease in low back pain and disability was seen. An excellent or good outcome was noted in 79% of patients; 9% showed secondary radiological instability.

Surgical decompression is a safe and efficient procedure. In the absence of preoperative radiological evidence of instability, fusion is not required.

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Stenosis is the commonest problem of the lumbar spine in people over the age of 65 years and surgery is required with increasing frequency.¹⁻⁴ Spinal stenosis has been defined as a narrowing of the vertebral canal and/or the foramen, to a degree that gives rise to compression of lumbosacral nerve roots or the cauda equina.⁵⁻⁷

The initial treatment should be conservative. The natural long-term outcome of conservative treatment, however, is often unsatisfactory. In a study of conservatively managed patients followed for four years, Johnsson, Rosen and Uden⁸ noted that 77% had persistent claudication, 85% were unchanged or had deteriorated, and 63% had con-

tinual low back pain. Surgery is required after the failure of conservative care.^{9,10} The procedure aims to decompress the spinal canal and the foramen while minimising the risk of secondary instability.

The literature presents a variable picture after the surgical treatment of spinal stenosis with good to excellent results in 26% to 100% of patients.⁴ The periods of follow-up have often been short and the outcome measures are usually not comparable because of the variability of the scoring systems used.

We have evaluated the long-term results of surgical treatment after five years or more applying established scoring systems in order to assess the quality of life, the incidence of low back pain and the functional and socioeconomic status^{11,12} of these patients.

We also determined the incidence of instability after surgery and its effect on the outcome.

Patients and Methods

We carried out a retrospective review of 155 consecutive patients who had decompression for lumbar spinal stenosis (LSS) at our centre between January 1990 and December 1992.

The patients assessed were undergoing primary lumbar spinal surgery, were in good general health without systemic pathology or vascular disease and had given informed consent. Patients who were participating in another simultaneous clinical study were excluded. Of the 155 patients, 22 were excluded; 15 had cardiopulmonary disorders, four had undergone previous surgery for LSS, one had rheumatoid arthritis, one had had an amputation of a lower limb, and one had bilateral osteoarthritis of the hip and was awaiting replacement surgery. Fifteen patients declined to participate, 25 died before appropriate follow-up, and 16 were lost to follow-up. Of the remaining 77 patients, four (5%) had congenital stenosis and 73 (95%) had acquired degenerative stenosis. The L4/5 level was stenotic in 86% of patients, L3/4 in 46%, L5/S1 in 35%, L2/3 in 5%, L1/2 in 3% and D12/L1 in 1%. Sixteen patients (21%) presented with concomitant degenerative spondylolisthesis, most commonly at L4/5 (12 cases). The mean age of the patients at the time of surgery was 61 years (25 to 85) and 58% were male.

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Table I. The anatomic-economic/functional (AEF) rating system of Paolo, Ohlund and Butcher¹¹

Economic status	
E1	Complete invalid
E2	No gainful occupation (including ability to do housework or continue retirement activities)
E3	Able to work but not at previous occupation
E4	Working at previous occupation on part-time or limited status
E5	Able to work at previous occupation with no restrictions of any kind
Functional status	
F1	Total incapacity (or worse than before operation)
F2	Mild to moderate level of low back pain and/or sciatica (or pain same as before operation but able to perform all daily tasks of living)
F3	Low level of pain and able to perform all activities except sports
F4	No pain, but patient has had one or more recurrences of low back pain or sciatica
F5	Complete recovery, no recurrent episodes of low back pain, able to perform all previous sports activities
Score: sum of the economic and functional status (2 to 10)	

Operative technique. Decompression was achieved by laminectomy, preserving the pars interarticularis.^{3,13} A high-speed burr was used to reduce the size of thickened laminae. The surfaces of the facets were maintained by undercutting using angled Kerison punches. A large fenestration was performed in patients with monosegmental lateral stenosis and discectomy in those with frank extrusion or sequestration of the disc (n = 38, 49%). Sixty-five patients (84%) were decompressed at one level, nine (12%) at two levels, and three (4%) at three levels. Twelve patients with preoperative degenerative spondylolisthesis were considered to be unstable according to the criteria of White and Panjabi¹⁴ and underwent an associated fusion.^{15,16}

Follow-up. The patients were reviewed neurologically initially at six weeks. They were also asked to comment on the early subjective outcome, with regard to low back and leg pain, and their walking ability. These data were collected by an independent observer and entered into the computer-adapted protocol of Strömqvist et al,¹⁷ using the disability questionnaire, the pain rating scale of Roland and Morris¹² and the anatomical economic functional rating system of Prolo et al¹¹ (Table I) in which a score of 2 to 4 was poor, 5 to 6 fair, 7 to 8 good and 9 to 10 excellent.

At a mean long-term follow-up of 6.5 years (5 to 8), the patients underwent a further independent neurological evaluation and radiological studies which included standard and flexion/extension radiographs of the lumbar spine. Detailed measurements from the static (pre- and postoperative) and dynamic (postoperative) radiographs were obtained to determine the rotation of the vertebral bodies in the sagittal plane and spondylolisthesis in order to assess the instability¹⁴ (Table II).

Results

Quality of life. The mean score of Roland and Morris before surgery was 14 points (24, severe disability, 0, no disability), which reflects a severely compromised quality of life.¹⁸ The mean short-term follow-up score was five points, indicating a significant decrease in the level of

disability. The mean reduction by eight points between the preoperative and long-term follow-up score confirms maintenance of this improvement (Student's *t*-test, *p* < 0.001) (Fig. 1).

Walking ability improved in 95% of patients. Before surgery, 85% could not walk more than 0.5 km. After six weeks, 38% could walk more than 5 km, and 98% more than 0.5 km. This improvement was maintained, with 66% walking more than 5 km and 24% between 1 and 5 km at the long-term follow-up (Fig. 2).

The patients' opinion regarding the outcome was such that at six weeks, 92% were satisfied and 8% remained

Table II. Radiological criteria of instability by White and Panjabi¹⁴

Flexion/extension radiographs	
Sagittal plane translation	>4.5 mm or 15%
Sagittal plane rotation	>15° at L1-2-3-4 >20° at L4-5 >25° at L5-S1
OR	
Resting radiographs	
Sagittal plane displacement	>4.5 mm or 15%
Relative sagittal plane angulation	>22°

Fig. 1

Graph showing evolution of the disability scores of Roland and Morris¹² before and after surgery. Above 14 points, the quality of life is considered to be severely compromised.

Fig. 2

Bar chart showing evolution of walking abilities before and after surgery.

Fig. 3

Bar chart showing evolution of the requirement for analgesics before and after surgery.

Fig. 4

Bar chart showing the interpretation of the score of Prolo et al.,¹¹ indicating evolution of the economic and functional status of the patients before and after surgery.

uncertain. At the long-term follow-up, 90% were still satisfied, 7% remained uncertain and 3% were dissatisfied.

Pain. The application of the Roland-Morris pain scale showed that relief of pain was maintained over time. A marked decrease in the intensity of low back pain was noted. Preoperatively, 84% of patients had had severe (score 5/6) or very severe (6/6) pain. At six weeks, no patient had severe pain, 35% had minor pain (2/6) and 45% no pain (1/6), with a mean decrease of 3.03 points (2.76 to 3.30). At five years, 4% had significant pain (4/6), 18% had minor pain and 64% had no pain, with a mean decrease of 3.13 points (2.82 to 3.44). For leg pain, 81% had no pain at six weeks and 82% had no pain at five years. The requirement for analgesia is summarised in Figure 3.

Functional status. The Prolo score was used to assess the socio-economic and functional status of the patients (Table I). At six weeks, 73% (56 patients) showed good or excellent scores (35% excellent, 38% good) and only 8% had unsatisfactory scores, with a mean decrease of 5.03 points (4.63 to 5.43). Five years after surgery, the results improved further with 51% having excellent and 28% good scores;

5% had an unsatisfactory score at five years with a mean decrease of 5.61 points (5.13 to 6.09) (Fig. 4).

Complications. There were complications in 11 patients (14%): six (8%) had an increased motor deficit, two (3%) an increased sensory deficit, one (1%) had a sphincter disturbance, one (1%) had a dural leak and one (1%) a superficial wound infection (*Staphylococcus aureus*).

The dural leak resolved after bed rest for two days, and the superficial wound infection settled unremarkably. The sphincter weakness resolved spontaneously after two years. Only two patients experienced long-term complications with persistent motor deficit.

Radiology. According to the criteria of White and Panjabi¹⁴ (Table II), 12 patients (16%) had preoperative lumbar instability. They underwent a posterior instrumented fusion at the time of the decompression and did not show persistent instability at long-term follow-up. Five years after surgery, only seven patients (9%) developed a secondary lumbar instability. Two of these had decompression at one level, two at two levels, and three at three levels. The L5/S1 level became unstable in three patients, who underwent a three-level decompression. The L4/5 level was the only other level at which there was postoperative instability. None of these patients had either instability or degenerative spondylolisthesis before operation.

No patient with evidence of secondary instability was clinically symptomatic.

Congenital lumbar stenosis. Four patients (5%) presented with congenital stenosis, two women and two men with a mean age of 40 years (32 to 49). Three had good to excellent results at six weeks and the fourth a fair result according to the Prolo score. This outcome did not change at long-term follow-up.

Discussion

Our study has the deficiencies inherent in all retrospective reviews, but the variables used were selected because they are reliable and widely accepted. The quality of life, the

severity of low back pain and the functional and socioeconomic status were recorded according to established scoring systems.^{1,11,12}

In previous reports of the outcome after surgery in the treatment of spinal stenosis with a five-year follow-up, the incidence of good to excellent results has varied between 55% and 86%.^{3,19-22} Airaksinen et al²³ recently described poor functional results in 38%. Similarly, Jonsson et al^{24,25} found unsatisfactory results in 35% and Atlas et al¹ in 31%. Improved outcomes after decompression combined with fusion were obtained in selected patients, e.g., those with degenerative spondylolisthesis or scoliosis.²⁶⁻³¹ In the Maine Lumbar Spine Study, Atlas et al¹ enrolled 148 patients with LSS, of whom 81 were treated surgically and 67 conservatively. He noted an improvement of 8.4 points in the Roland-Morris score in the surgical group compared with 1.6 points in the conservatively managed group (Student's *t*-test, $p < 0.001$). Iguchi et al²² reported an excellent or good outcome in 56.7% of 37 patients followed up for a minimum of ten years. Our results are consistent with these studies. We observed good and excellent results in 73% at six weeks and 79% at a mean follow-up of 6.5 years (5 to 8). In terms of quality of life, we recorded a mean improvement of eight points in the disability questionnaire of Roland and Morris, which is statistically significant.

There were poor and fair outcomes in 21%, which is similar to other studies. These were subjective results which could not be explained on the basis of the neurological examination at follow-up, and these patients were dissatisfied because of persistent low back pain despite the resolution of sciatica and the neurogenic claudications, and the absence of secondary instability.

Our results differed in one significant aspect from previous studies in that there was no deterioration during follow-up. Of the patients with a good or excellent short-term outcome, seven had a fair and two a poor long-term outcome, but 15 with poor or fair results at the short-term follow-up had good or excellent results at five years.

The report of Herno, Airaksinen and Saari³² is the only study with better results at long-term than at medium-term follow-up, and the authors concluded that patients continued to improve during a period of 7 to 13 years after decompression. Our series shows good and excellent results of surgical treatment of LSS for 73% to 79%, with a mean long-term follow-up time of 6.5 years ($p < 0.001$). We believe that the facet joints should be preserved by using an undercutting technique in combination with the laminectomy, and that only in selected cases proven to be unstable radiologically should decompression be combined with a fusion.

In a meta-analysis study of the literature between 1975 and 1995, Niggemeyer, Strauss and Schultz³³ stated that the least invasive surgical procedure produced the best results. In a review of 88 cases, Katz et al³⁴ reported no significant differences in outcome between different treatment groups (laminectomy alone, laminectomy and fusion)

except in some cases of degenerative spondylolisthesis.

The improvement in back pain noted in our study is somewhat surprising. However, before surgery, patients often try to relieve their claudication by bending forwards which enlarges the spinal canal. This posture increases low back pain. After decompressive surgery, the patients can again extend their lumbar spine which decreases low back pain.

A major concern after decompression is the recurrence of low back pain because of secondary instability. There is considerable variation in the reported incidence of this complication. Pappas and Sonntag³⁵ had an incidence of 3% and Guigui et al³⁶ of 24%. Both pre- and postoperative instability are negative predictive factors for the long-term outcome.^{29-31,34} Postacchini, Cinotti and Gumina³⁷ found an incidence of secondary instability in 63% of patients who had preoperative evidence of instability after decompression. Guigui et al³⁶ and Katz et al²⁰ reported that secondary spondylolisthesis was twice as common among patients with unsatisfactory results after lumbar decompression.

Iguchi et al²² stated that multilevel decompression and a preoperative sagittal rotation angle of more than 10° are risk factors for poor results. Twelve patients in our study had some lumbar instability at presentation and underwent fusion at the time of decompression. None has developed instability, but there were seven patients (9%) who were considered to be radiologically stable preoperatively and who then became unstable. The radiological diagnosis did not correspond to the clinical symptoms, however, and only one patient had mild occasional low back pain. Our study has shown that decompression by laminectomy with undercutting of the facet joint is a safe procedure with a low rate of secondary instability. There is a high incidence of excellent or good long-term results.

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