Micro-decompression for lumbar spinal stenosis

THE EARLY OUTCOME USING A MODIFIED SURGICAL TECHNIQUE

We describe a modified technique of micro-decompression of the lumbar spine involving the use of an operating microscope, a malleable retractor and a high-speed burr, which allows decompression to be performed on both sides of the spine through a unilateral, hemi-laminectomy approach. The first 100 patients to be treated with this technique have been evaluated prospectively using a visual analogue score for sciatica and back pain, the MacNab criteria for patient satisfaction, and functional assessment with the Oswestry Disability Index.

After a period of follow-up from 12 months to six years and four months, sciatica had improved in 90 patients and back pain in 84 patients. Their result was graded as good or excellent by 82 patients according to the MacNab criteria, and 75 patients had subjective improvement in their walking distance. Late instability developed in four patients.

Lumbar micro-decompression has proved to be safe, with few complications. Post-operative instability requiring fusion was uncommon, and less than using traditional approaches in published series.

Decompression of the lumbar spine for spinal stenosis is the most common operation performed on the spine in patients over 60 years of age. The aim is to relieve compression of the spinal nerves while retaining the integrity of the structural elements of the spinal column and its function as a supporting structure. Turner et al,1 in a meta-analysis, showed an average success rate of only 64% for improvement in pain and mobility following traditional spinal decompression, and Katz et al2 reported deterioration in the results over time. One explanation for late deterioration is that destruction of the stabilising structures by traditional approaches to the spinal canal could result in instability and recurrence of symptoms.

The traditional posterior approach to the lumbar spine down both sides of the spinous processes can defunction multifidus and alter the proprioceptive function of the ligaments. The importance of this anatomical disturbance is uncertain. Micro-decompression aims to address this problem by approaching and entering the canal from only one side. After decompressing the ipsilateral open side, the dissection crosses the midline beneath the overhanging spinous processes and contralateral laminae, allowing trimming of the facet joints and other compressive structures on the contralateral side from within the canal. All the bony and soft-tissue structures outside the canal on the contralateral side are preserved, with no increase in dissection required (Fig. 1). This concept is not new, and over the last 20 years a number of authors have shared their experience in dealing with the problem of preservation of the anatomy during decompression. An early report by Poletti3 described how the ligamentum flavum could be excised from one side. Later reports include thorough anatomical descriptions by Spetzger et al,4,5 and an elegant description by McCulloch6 of how he used a technique modified from that of Young, Veerapen and O’Laoire7 to provide excellent decompression for spinal stenosis. Kleeman, Hiscoe and Berg8 described success with an approach from both sides of the spinous process aiming at preserving as much of the anatomy as possible. They also found this approach useful in patients with mild degenerative spondylolisthesis.

Mayer et al9 reported success in 275 patients at a mean of two years following decompression via a unilateral approach. The main outcome measures were standing time and walking distance. There was an improvement in back pain in 48% of the patients and of leg pain in 51%. A dural leak occurred in 5%, and evacuation of a haematoma was required in 3.8%. Some of their patients required spinal fusion,
and the authors considered a grade 1 spondylolisthesis as an indication for instrumented fusion.\textsuperscript{10}

We have treated patients with spinal stenosis by micro-decompression since 2003, and describe the outcomes of our first 100 patients over a period of six years. We have evaluated the safety and feasibility of a modified technique of bilateral decompression through a unilateral approach, extended to include multiple levels when indicated. We have also assessed the effect on the stability of the lumbar spine in the longer term by recording which patients developed symptomatic instability which required stabilisation. The results have been analysed prospectively over a mean of 42 months (12 to 76), with recognised outcome measures and pain scores to differentiate between back and leg pain.

**Patients and Methods**

Between 2003 and 2007 micro-decompression was undertaken in 100 consecutive patients by a single surgeon (RM). Those with central or lateral recess stenosis and either unilateral or bilateral symptoms were considered eligible for this procedure. There were 58 women and 42 men, with a mean age of 68 years (48 to 87) at the time of surgery. The mean follow-up was 3.5 years (12 months to six years four months).

Patients with unilateral stenosis alone were not treated by this technique, as the opposite side would not benefit from prophylactic decompression. Those with previous lumbar surgery, significant spondylolisthesis (grade II and above), scoliosis or deformity were also excluded. Approximately 40\% (250) of all patients requiring surgical decompression were suitable for micro-decompression.

The patients were assessed prospectively by clinical evaluation and a patient-completed questionnaire both before and after surgery. These included visual analogue scores (VAS) for back and leg pain, the MacNab grading for outcome,\textsuperscript{11} the Oswestry Disability Index (ODI)\textsuperscript{12} and subjective perception of walking before and after surgery. Although all patients were assessed with radiographs and MR scanning of the lumbar spine prior to surgery, those with symptoms suggesting instability had additional standing radiographs with flexion and extension views. Those who had symptoms after operation were assessed in a similar way, and imaging was repeated for comparison.

Surgical technique. The spine is approached through a midline incision with unilateral retraction of multifidus to allow entry to the canal through a partial laminectomy. This allows decompression of the lateral recess on the more symptomatic ipsilateral side first. A malleable copper retractor is then used to protect the neurological structures. A high-speed burr is used to scalp the inferior aspects of the adjacent spinous processes so that the midline can be crossed, affording good access to permit careful and precise undercutting of the facet joints on the opposite side of the canal, using a combination of the high-speed burr and Kerrison punches. Safety is ensured by the use of the operating microscope, saline irrigation, and fine suction to allow clear visualisation. The malleable copper retractor is placed carefully beneath the bony overhang to protect the dura and nerves during the decompression (Figs 1 and 2).

**Results**

A single level, most commonly L4-5 was decompressed in 49 patients. Two levels were treated in 45 patients, and three in six patients (Table I). The pre- and post-operative mean VASs for pain are shown in Table II. Improvement in leg pain was experienced in 90 patients with two describing deterioration at their final follow-up. One of these had sciatica in the opposite leg, which did not require treatment, and had improved in all other outcome criteria. The second patient was treated for post-operative discitis. In all, ten patients reported no improvement, but in eight of these the pre-operative VAS for leg pain was < 3. The VAS for back pain improved in 84 patients; three patients were experiencing worse back pain at their final follow-up. There was no improvement in 14 patients, including five who did not have back pain before or after surgery. Their mean ODI improved from 56\% pre-operatively to 24\% at the final follow-up.\textsuperscript{14} The outcome was graded as good or excellent in 82 patients according to MacNab’s assessment criteria.

Pre-operative sensory disturbance in the leg was noted in 12 patients, and this improved in seven. New symptoms were found in three patients. The power of dorsiflexion of the foot was reduced in ten patients pre-operatively, and improved in eight following surgery. Mild weakness in dorsiflexion (MRC grade 4/5)\textsuperscript{15} of the foot was noted on the opposite side to the open approach in one patient.

Subjective walking ability improved in 76 patients. In 61 patients, walking was considered normal after decompression, compared to only 17 pre-operatively. Deterioration in walking was experienced by four patients. Another two suffered a stroke more than a year after surgery and were confined to a wheelchair at follow-up.

Complications included a dural tear induced by the Kerrison punch while clearing the opposite side. This was repaired with a 6/0 nylon suture, and no post-operative problems were experienced. A surgical infection, in the form of a spondylodiscitis, occurred six weeks after operation in a 71-year-old man and required antibiotic therapy. The disc had not been entered at the time of surgery. After
an initial course of intravenous antibiotics for four weeks, oral antibiotics were continued until the inflammatory parameters had returned to normal after a further three weeks. At 40 months there was minor improvement in back and leg pain but walking was not limited. Radiographs suggested obliteration of the disc space and spontaneous fusion. Another patient had a superficial wound infection, which responded to a two-week course of oral antibiotics. Her symptoms improved and she graded her outcome as excellent.

Five patients had recurrent symptoms, four of which were attributable to spinal instability. Fusion was required in two for symptomatic instability after initial improvement. The other two declined revision and fusion, as they felt they could tolerate the symptoms. All had undergone a single-level decompression. The fifth patient, a 77-year-old woman, required a disectomy for recurrent symptoms due to herniation of a disc 11 months after the initial microdecompression.

A total of 11 patients died during the study period from causes unrelated to surgery, including malignancy, cerebrovascular incidents and cardiovascular disease. These occurred at between 12 months and four years eight months after surgery, and the data gathered from their last review have been included. Of these patients, four had not reached the two-year follow-up period, and they are the only patients who did not reach the two-year threshold.
Discussion

McCulloch\(^6\) gave a detailed description of a technique to decompress the spine from one side as a modification of that of Young et al.\(^7\) We have based our method on this description, and have found that by adding a malleable copper retractor, a high-speed burr and the use of an operating microscope, we were able to protect the theca and nerves while achieving full decompression of the contralateral side. This allows preservation of all structures external to the spinal canal on one side, with no additional dissection required on the side of the hemilaminectomy.

Herkowitz and Kurz\(^17\) found an 18% incidence of late instability after decompressive surgery, and others also report a high degree of iatrogenic instability.\(^18\text{-}22\) Our patients have not deteriorated to the same degree. As Herkowitz and Kurz\(^17\) had only four cases of late instability, this technique may offer an advantage over the traditional methods used in these other series. The explanation for this may be that degenerative spondylolisthesis is not necessarily a progressive condition, and that once a stable position of the slip has been achieved, further slip is prevented. This is particularly relevant in asymptomatic conditions, where the lack of pain implies that a stable state has been achieved. The micro-decompression technique may be less inclined to induce further instability than the more extensive dissection of wider, bilateral, decompressive procedures, and is particularly useful in this group of patients deemed to have a stable spondylolisthesis where instability is to be avoided.

Sengupta and Herkowitz\(^19\) point out that the mainstay of treatment for spondylolisthesis is decompression, but there is no overwhelming consensus about the indications for fusion in this condition. Decompression relieves radicular symptoms and claudication, whereas fusion aims at dealing with back pain and eliminating instability. We included patients with grade 1 spondylolisthesis as observed on standing radiographs in our study, and have found this to be acceptable in most cases. The four patients who developed late symptomatic instability all had evidence of pre-operative primary degenerative grade 1 spondylolisthesis. The symptoms of instability usually occurred two years after the primary procedure, following an initial period of symptomatic improvement. No patients developed post-operative or secondary degenerative spondylolisthesis in the absence of pre-operative spondylolisthesis. We acknowledge the issue raised by some authors of deterioration occurring after > 5 years when instrumentation is not performed after decompression in patients with spondylolisthesis.\(^17,18,22\text{-}24\) In these series the decompression was open on both sides, and the late instability may be due to the increased anatomical destruction associated with these techniques.

Weiner et al\(^25\) described their experience of McCulloch’s technique,\(^6\) using the Neurogenic Claudication Outcome Score in 30 patients undergoing a unilateral approach for spinal decompression, and found the outcomes to be satisfactory, with no intra-operative complications.

The complications we encountered were not considered unusual for this type of operation. The sensory and motor disturbances that did occur, albeit mild, were considered to be a complication related to the surgical technique, as all occurred on the contralateral side to the open laminectomy/hemilaminectomy. No specific injury was noted at the time of surgery. One explanation for this may be that the surgical instruments or malleable copper retractor may inadvertent compression of the already vulnerable nerves. However, the retractor does allow safe use of a high-speed burr within the canal, so we consider it a useful aid to the technique.

### Table I. The operated levels (in 100 patients)

<table>
<thead>
<tr>
<th>Level</th>
<th>Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>L4-5</td>
<td>46</td>
</tr>
<tr>
<td>L3-5</td>
<td>34</td>
</tr>
<tr>
<td>L4-S1</td>
<td>9</td>
</tr>
<tr>
<td>L3-S1</td>
<td>4</td>
</tr>
<tr>
<td>L3-4</td>
<td>3</td>
</tr>
<tr>
<td>L2-5</td>
<td>2</td>
</tr>
<tr>
<td>L2-4</td>
<td>1</td>
</tr>
<tr>
<td>L2-3 + L4-5</td>
<td>1</td>
</tr>
</tbody>
</table>

### Table II. Results of the assessments after operation

#### MacNab scores total/100

- Excellent: 38
- Good: 44
- Fair: 14
- Poor: 4

#### Pre-operative VAS* mean (95% CI†)

- Leg: 8 (7 to 9)
- Back: 7 (6 to 8)

#### Post-operative VAS mean (95% CI)

- Leg: 2 (1 to 3)
- Back: 2 (1 to 3)

#### ODI mean (95% CI) /100

- Pre-operative: 56 (46 to 66)
- Post-operative: 24 (18 to 28)

#### Post-operative walking

- Improved: 76
- Unchanged: 19
- Worse: 5

#### Post-operative recurrent symptoms (number of patients)

- Instability: 4
- Disc prolapse: 1

* VAS, visual analogue score  
† CI, confidence interval  
‡ ODI, Oswestry disability index
We realise that our study is limited in that it is not randomised with a control group, but the purpose was to evaluate the outcomes of our modified technique of microdecompression compared with the existing literature on traditional procedures. The technique has potential advantages in preservation of the supportive anatomy without compromising safety, but it will be important to continue with follow-up over five years. This justifies bilateral treatment when unilateral symptoms exist in the presence of bilateral stenosis, particularly as symptoms on the opposite side are likely to develop when left alone.24

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References