The outcome of spinal decompression surgery 5 years on

N. K. Anjarwalla · L. C. Brown · A. H. McGregor

Received: 11 October 2006 / Revised: 12 April 2007 / Accepted: 22 April 2007 / Published online: 23 May 2007
© Springer-Verlag 2007

Abstract Decompression surgery is an increasingly common operation for the treatment of lumbar spinal stenosis. Although good relief from leg pain is expected after surgery, long term results of pain relief and function are more uncertain. This study prospectively followed a cohort of patients presenting with the signs and symptoms of spinal stenosis, who underwent decompression surgery to ascertain the long term outcome with respect to pain and function using visual analogue pain scores, the Oswestry Disability Index, and the Short Form 36, a general health questionnaire. From an initial pool of 84 recruited patients, 7 withdrew from surgical intervention; of the remaining 77, 51 (66%) returned for follow up assessments at 5 years. In these responders, a significant improvement was observed in back and leg pain, which was sustained for at least 1 year ($P < 0.01$). A significant improvement was also seen in physical function ($P < 0.05$) as assessed by Oswestry and SF-36. Although an initial improvement was noted in social function, this was not observed at 5 years. This study has demonstrated that decompression surgery is successful in relieving symptoms of lumbar spinal stenosis. Physical function, back and leg pain are significantly improved after 5 years but initial significant improvements in social function diminish over time.

Keywords Lumbar spinal stenosis · Decompression surgery · Pain · Physical function · Social function

Introduction

Degenerative lumbar spinal stenosis, due to hypertrophy of the ligamentum flavum and facet joints, is a narrowing of the lateral root canal of the spine. It may result in nerve root ischemia and neurogenic claudication. Typical symptoms of unilateral or bilateral leg pain and neurogenic claudication may only be brought on by ambulation and spinal posture and neurological deficits may be absent on clinical examination. It is a leading cause of disability and discomfort [5].

Although many studies support the use of surgical intervention for spinal stenosis [13, 14, 27, 42], the long term natural history of the disease is unclear. It has been suggested that the majority of patients have stable symptoms, with only 15% of patients deteriorating significantly over 3 years [19] and less than 20% of patients treated non-operatively electing to undergo surgery due to refractory pain [37]. This questions the need for surgery. Further, in those having operative interventions there is still limited information on long term outcomes beyond 2–3 years [14].

In order to fully appreciate the effectiveness of surgical intervention, the long term outcome has to be determined. Many spinal interventions appear to have excellent early post-operative results [2, 3, 14, 40], but there is a temporal decline in benefit [21, 35, 41]. This would then indicate that conservative options may provide a viable option. Ciol et al. [8] has suggested that spinal stenosis was the fastest growing cause for surgery in patients over 65 years, this combined with the findings of Yamashita et al. [42] which suggests that age may impact outcome, indicates a need for further research. This is further supported by the Maine study [4, 5] which suggested that early improvements in symptoms as a result of surgery diminished with time. Within our own institution we have demonstrated good

N. K. Anjarwalla · L. C. Brown · A. H. McGregor (✉)
Biodynamics Laboratory, Biosurgery & Surgical Technology,
Division of Surgery, Oncology, Reproductive Biology &
Anaesthetics (SORA), Faculty of Medicine,
Imperial College London, Charing Cross Hospital,
Fulham Palace Road, London W6 8RF, UK
e-mail: a.mcgregor@imperial.ac.uk

early results in outcome following spinal decompression surgery [30, 31]; however, in view of these current findings, we decided it was appropriate to review the long term impact of their surgery on their pain and function.

Methods

Patients presenting to the Spinal Clinic at the Charing Cross Hospital with the signs, symptoms and MRI findings of spinal stenosis as a result of degenerative changes were eligible for inclusion in this study. Stenosis due to trauma, malignancy and infection were excluded. Written informed consent was obtained from all subjects. A total of 84 subjects (41 female and 43 male, with a mean age of 52.8 ± 14.0 years) out of 135 approached were recruited into this study between September 1997 and 1999, which gave a recruitment rate of 62%. Of the 51 subjects who did not take part in the study, 35 declined participation, and the remainder were excluded on account of their age (over 80 years), language problems, confused state of mind, and coexisting pathology. Base line measures were obtained on the 84 patients recruited into this study at 6 weeks prior to surgery at a pre-admission clinic.

Twenty of the 84 subjects had had previous surgery; 15 had had previous decompression surgery and the remaining 9 had had a discectomy. Of the subjects recruited, 77 underwent surgery; the remaining 7 subjects opted not to go through with their surgery choosing a conservative management approach and were therefore not included in the subsequent analysis. 72 subjects (94% of original recruited surgical population) were re-assessed at 6 weeks, 68 (88%) were reviewed at 6 months, 65 subjects (84%) completed their 1 year review and 51 subjects (66%) their 5 year review. Where possible, reviews were performed during the patient's post-operative follow-up appointments at the clinic; where patients were unable to attend questionnaires were posted to the patient for completion. Review assessments were performed by an independent observer and the questionnaires were completed by the patient. Patient drop out from the study was primarily a result of either patients moving out of the area or returning to full time employment and having insufficient time to complete the study.

Surgical procedure

All of the subjects underwent posterior decompression surgery through a midline approach, 83% had a bilateral decompression performed whilst the remainder had a unilateral decompression. The decompression involved a partial laminectomy, removal of ligamentum flavum and undercutting facetectomy. Midline structures were preserved. Five

subjects also underwent a fusion with instrumentation due to the presence of a degenerative spondylolisthesis. Evidence has suggested that the outcome of surgery for spinal stenosis in these patients is improved by fusion [15]. 77% of subjects had two or more levels decompressed whilst the remainder had only one level decompressed. All patients returned from surgery to an orthopaedic ward. Post-operative mobilisation was supervised by a physiotherapist, however, other than this patients were not routinely required to attend the hospital for any post-operative rehabilitation. The five subjects who underwent fusion received a lumbar corset, which was worn when mobilising for 3 months. All patients were encouraged to mobilise as pain and other symptoms allowed. Patients were discharged to their own homes when safely mobile and followed up in a spinal clinic at regular intervals.

Clinical assessment of patients

This was done in accordance with the original study protocol [30], which included anamnestic information and pain diagrams. At the 5 year review, patients were asked to identify their pain sites on a pain drawing [32] and to rate their current resting pain levels, and their worst and usual pain levels over the past week on a 10 cm visual analogue scale (with back and leg pain considered separately) with the mean value of current, worse and usual pain used in the analysis. In addition patients, completed the Short Form SF-36 Health Survey Questionnaire—a validated general health questionnaire [7, 12], and the Oswestry Disability Index (version 2.1) [11]—a disease specific disability index.

Analysis

All statistical analyses were performed on the statistical package STATA version 8.0 (Stata corp., TX, USA) on a personal computer. All analyses were performed according to a statistical analysis plan that was agreed before any data were seen. In order to investigate whether missing follow-up data were informative, Student's *t* tests and χ^2 tests were used to compare subjects who had attended follow-up with those who had not. Comparisons were made in terms of baseline leg pain, age, gender, smoking status and previous surgery. The primary outcome measure was leg pain with secondary outcomes including average back pain, Oswestry disability index (ODI) and the SF-36 sub-categories of physical and social functioning, relative to baseline pre-operative values using paired Student's *t* tests. Normality plots were used to check the distribution of all differences in the outcome variables. Linear regression models were used to assess whether improvement in outcome had been confounded by age, sex, smoking status and previous surgery at

baseline. The threshold for statistical significance was set at $P < 0.01$ to account for the multiple testing performed on the data.

Results

Missing data

There was little evidence to suggest that either leg pain or age were related to missing follow-up data status. However, there was some evidence to suggest that men were more likely to fail to complete their follow-up reviews compared with females but this was only statistically significant for the 6 week appointment when 23% of men did not attend compared with 5% of women ($P = 0.016$). Similarly there was weak evidence to suggest that smokers were consistently better at completing their follow-up reviews; however this was only strongly significant at the 5 year review ($P = 0.007$) where 19% of smokers failed to attend compared with 49% of non-smokers. There was no strong evidence to suggest that previous surgery related to missing data, although the data did indicate that people who had received previous surgery were more likely to complete their follow-up reviews.

Pain

Figure 1 illustrates the changes in back and leg pain over the 5 year period. A statistically significant improvement in leg pain was observed from baseline at all three review

Fig. 1 Changes in back and leg pain over 5 years, mean and standard error presented with Student's t test P values for difference from baseline, $n = 72$ at baseline, 68 at 6 weeks, 65 at 1 year and 51 at 5 years

stages ($P < 0.01$). Similarly, back pain appeared to reduce significantly ($P < 0.01$). However, as can be observed from Fig. 1 there was some deterioration in pain level at 5 years but the level of pain was still significantly improved from baseline, although the clinical impact of this reduction is questionable. Regression modeling indicated that these improvements in leg and back pain could not be explained by differences in age, sex, smoking status or previous surgery with all regression P values falling markedly above the threshold for significance of 0.01.

Oswestry Disability Index

Minimal changes were observed in ODI score between baseline and 6 weeks; however, at 1 year statistically significant improvements were observed ($P = 0.002$) which were maintained at 5 years ($P = 0.015$) (see Fig. 2). The clinical relevance of these changes is less clear. Again, improvements did not appear to relate to age, sex, smoking status or previous surgery ($P > 0.05$).

SF-36 General Health Questionnaire

Table 1 gives the results for the physical and social functioning scores from the SF-36 assessment. For physical functioning, strongly significant improvement was observed at 1 year ($P = 0.004$) with some borderline evidence to suggest significant benefit at 5 years ($P = 0.028$). For social functioning, significant improvement only emerged at 1 year ($P < 0.001$) and appeared to diminish beyond this. Regression analysis did not indicate that

Fig. 2 Changes in Oswestry Disability Index score over 5 years, mean and standard error presented with Student's t test P values for difference from baseline. $N = 72$ at baseline, 68 at 6 weeks, 65 at 1 year and 51 at 5 years

Table 1 SF-36 physical and social functioning scores over 5 years

	Physical function	Social function
Baseline	28.8 ± 24.4	40.8 ± 26.9
6 weeks post-op	32.2 ± 22.4	36.2 ± 31.3
1 year post-op	39.4 ± 30.8	59.0 ± 32.5
5 years post-op	33.9 ± 26.2	43.9 ± 33.2

All values given as mean ± standard deviation

SF-36 score improvements were associated with age, sex, smoking status or previous surgery.

Discussion

This study reviewed the long term outcome in an established cohort of patients from whom prospective outcome data had been collected prior to and following a decompression procedure. Unfortunately only a 61% return rate was achieved, limiting the interpretation of these findings but there was little evidence to suggest that subjects who did not complete their follow-up were different from those who did. In agreement with previously published data, this study confirms that surgery achieved an initial improvement in pain and function at 1 year, and also demonstrated significant, although diminished improvement in symptoms at the 5 year review [6, 17, 42]. A limitation of this study was that it only looked at surgical management; however, a recent randomised controlled study from Finland highlighted a greater reduction in disability and pain in those receiving the surgical intervention as opposed to conservative intervention for spinal stenosis, but also that this improvement diminished at the 2 year follow up [26]. A further limitation of the current study was the inclusion of different decompressive procedures performed by different surgeons, ideally the analysis could account for this but this would require a larger study population or a more procedure-specific study. Similarly, all patients requiring decompressive surgery were included, regardless of whether this was a result of a degenerative spondylolisthesis or just severe degeneration. A small number had had previous surgery; however, this was noted to have limited impact on the outcome findings.

The objective of decompression surgery is to relieve leg pain and it is not surprising that improvement in leg pain was observed, a finding that is not unique to this study [6, 9, 17]. A significant improvement in back pain was also seen, similarly this is not new. Routinely patients are told that the surgery aims to relieve leg pain/symptoms only, thus patients are encouraged not to expect such an improvement. It is of interest that improvements in both pain sites deteriorate with time. Some may advocate

inadequate decompression at the time of surgery (but this is not consistent with the initial improvements observed), progression of the underlying spondylosis condition and inactivity combined with ageing [34, 36] as the cause for this deterioration. Work by Atlas et al [6] comparing the long term outcome of spinal stenosis suggests that it may be an inevitable part of the disease process but suggested that this effect was less marked in those who had surgical intervention. The answer to this dilemma is beyond the scope of this study and requires further research in the form of randomised controlled studies, ideally with a control population that permits the natural course of the disease to be assessed. Recent reviews of post-operative practice have noted clear inconsistencies within and between surgeons with regard to post-operative management and advice [[29]]. This can make patients uncertain and reluctant to return to normal activities. Combined with the deconditioned state many patients present with [1, 16, 23, 25, 33, 39] this may explain the low improvements in function observed. This lack of post-operative advice has now been addressed in the form of a patient education booklet [28], the value of which is currently being explored in a randomised controlled study.

Whilst many of our outcome measures demonstrate significant improvement, the clinical relevance of these changes is less clear. Of interest here is the finding that social function, unlike physical function, did not demonstrate significant improvement at the 5 year review, returning to pre-operative levels. This may be due to other co-morbidities, but may reflect more a lack of confidence in their spine and a lack of education as noted above. Patient's perception of general health status is known to predict outcome in decompression surgery [22], and this in turn is influenced by other psychosocial factors including depression [18, 24, 38]. Sex and smoking status were not related to outcome, which is of interest considering the relationship between smoking and back pain [10, 20].

To summarise, this prospective cohort study documenting the outcome of decompressive surgery showed that physical function assessed by ODI and back and leg pain were significantly improved after surgery but that these improvements had deteriorated slightly by 5 years. In particular, early improvements in social functioning observed at 1 year were not sustained. From this study we feel confident in being able to advise our patients before surgery that they can expect an improvement in the level of pain that they experience and in their physical abilities. This study provides new long-term data and suggests that patients should be informed that early benefits may diminish slightly with time, however, these findings do only represent a 66% return in the long term review data.

References

- Airaksinen O, Herno A, Kaukanen E, Saari T, Sihvonen T, Suomalainen O (1996) Density of lumbar muscles 4 years after decompressive spinal surgery. *Eur Spine J* 5:193–197
- Airaksinen O, Herno A, Saari T (1994) Surgical treatment of lumbar spinal stenosis: patients' postoperative disability and working capacity. *Eur Spine J* 3:261–264
- Airaksinen O, Herno A, Turunen V, Saari T, Suomalainen O (1997) Surgical outcome of 438 patients treated surgically for lumbar spinal stenosis. *Spine* 22:2278–2282
- Atlas SJ, Delitto A (2006) Spinal stenosis: surgical versus non-surgical treatment. *Clin Orthop Relat Res* 443:198–207
- Atlas SJ, Keller RB, Robson D, Deyo RA, Singer DE (2000) Surgical and nonsurgical management of lumbar spinal stenosis: four-year outcomes from the maine lumbar spine study. *Spine* 25:556–562
- Atlas SJ, Keller RB, Wu YA, Deyo RA, Singer DE (2005) Long-term outcomes of surgical and nonsurgical management of lumbar spinal stenosis: 8 to 10 year results from the maine lumbar spine study. *Spine* 30:936–943
- Brazier JE, Harper R, Jones NM, O'Cathain A, Thomas KJ, Usherwood T, Westlake L (1992) Validating the SF-36 health survey questionnaire: new outcome measure for primary care. *BMJ* 305:160–164
- Ciol MA, Deyo RA, Howell E, Kreif S (1996) An assessment of surgery for spinal stenosis: time trends, geographic variations, complications, and reoperations. *J Am Geriatr Soc* 44:285–290
- Corneffjord M, Byrod G, Brisby H, Rydevik B (2000) A long-term (4- to 12-year) follow-up study of surgical treatment of lumbar spinal stenosis. *Eur Spine J* 9:563–570
- Deyo RA, Bass JE (1989) Lifestyle and low-back pain. The influence of smoking and obesity. *Spine* 14:501–506
- Fairbank JC, Couper J, Davies JB, O'Brien JP (1980) The Oswestry low back pain disability questionnaire. *Physiotherapy* 66:271–273
- Garratt AM, Ruta DA, Abdalla MI, Buckingham JK, Russell IT (1993) The SF36 health survey questionnaire: an outcome measure suitable for routine use within the NHS? *BMJ* 306:1440–1444
- Gibson JN, Grant IC, Waddell G (1999) The Cochrane review of surgery for lumbar disc prolapse and degenerative lumbar spondylosis. *Spine* 24:1820–1832
- Gibson JN, Waddell G (2005) Surgery for degenerative lumbar spondylosis: updated Cochrane review. *Spine* 30:2312–2320
- Herkowitz HN, Kurz LT (1991) Degenerative lumbar spondylosis with spinal stenosis. A prospective study comparing decompression with decompression and intertransverse process arthrodesis. *J Bone Joint Surg Am* 73:802–808
- Hides JA, Stokes MJ, Saide M, Jull GA, Cooper DH (1994) Evidence of lumbar multifidus muscle wasting ipsilateral to symptoms in patients with acute/subacute low back pain. *Spine* 19:165–172
- Iguchi T, Kurihara A, Nakayama J, Sato K, Kurosaka M, Yamasaki K (2000) Minimum 10-year outcome of decompressive laminectomy for degenerative lumbar spinal stenosis. *Spine* 25:1754–1759
- Jarvik JG, Hollingworth W, Heagerty PJ, Haynor DR, Boyko EJ, Deyo RA (2005) Three-year incidence of low back pain in an initially asymptomatic cohort: clinical and imaging risk factors. *Spine* 30:1541–1548
- Johnsson KE, Rosen I, Uden A (1992) The natural course of lumbar spinal stenosis. *Clin Orthop Relat Res* 279:82–86
- Kaila-Kangas L, Leino-Arjas P, Riihimäki H, Luukkonen R, Kirjonen J (2003) Smoking and overweight as predictors of hospitalization for back disorders. *Spine* 28:1860–1868
- Katz JN (1995) Lumbar spinal fusion. Surgical rates, costs, and complications. *Spine* 20:78S–83S
- Katz JN, Stucki G, Lipson SJ, Fossel AH, Grobler LJ, Weinstein JN (1999) Predictors of surgical outcome in degenerative lumbar spinal stenosis. *Spine* 24:2229–2233
- Kawaguchi Y, Matsui H, Tsuji H (1994) Back muscle injury after posterior lumbar spine surgery. Part 2: histologic and histochemical analyses in humans. *Spine* 19:2598–2602
- Levy HI, Hanscom B, Boden SD (2002) Three-question depression screener used for lumbar disc herniations and spinal stenosis. *Spine* 27:1232–1237
- Luoto S, Taimela S, Hurri H, Aalto H, Pyykko I, Alaranta H (1996) Psychomotor speed and postural control in chronic low back pain patients. A controlled follow-up study. *Spine* 21:2621–2627
- Malmivaara A, Slati P, Heliovaara M, Sainio P, Kinnunen H, Kankare J, in-Hirvonen N, Seitsalo S, Herno A, Kortekangas P, Niinimäki T, Ronty H, Tallroth K, Turunen V, Knekt P, Harkanen T, Hurri H (2007) Surgical or nonoperative treatment for lumbar spinal stenosis? A randomized controlled trial. *Spine* 32:1–8
- Mariconda M, Fava R, Gatto A, Longo C, Milano C (2002) Unilateral laminectomy for bilateral decompression of lumbar spinal stenosis: a prospective comparative study with conservatively treated patients. *J Spinal Disord Tech* 15:39–46
- McGregor AH, Burton AK, Sell P, Waddell G (2006) The development of an evidence-based patient booklet for patients undergoing lumbar discectomy and un-instrumented decompression. *Eur Spine J* 16(3):339–346
- McGregor AH, Dicken B, Jamrozik K (2006) National audit of post-operative management in spinal surgery. *BMC Musculoskelet Disord* 7:47
- McGregor AH, Hughes SP (2002) The evaluation of the surgical management of nerve root compression in patients with low back pain: Part 1: the assessment of outcome. *Spine* 27:1465–1470
- McGregor AH, Hughes SP (2002) The evaluation of the surgical management of nerve root compression in patients with low back pain: Part 2: patient expectations and satisfaction. *Spine* 27:1471–1476
- Ohnmeiss DD (2000) Repeatability of pain drawings in a low back pain population. *Spine* 25:980–988
- Rantanen J, Hurme M, Falck B, Alaranta H, Nykvist F, Lehto M, Einola S, Kalimo H (1993) The lumbar multifidus muscle five years after surgery for a lumbar intervertebral disc herniation. *Spine* 18:568–574
- Roh JS, Teng AL, Yoo JU, Davis J, Furey C, Bohlman HH (2005) Degenerative disorders of the lumbar and cervical spine. *Orthop Clin North Am* 36:255–262
- Scholz M, Firsching R, Lanksch WR (1998) Long-term follow up in lumbar spinal stenosis. *Spinal Cord* 36:200–204
- Shao Z, Rompe G, Schiltenswolf M (2002) Radiographic changes in the lumbar intervertebral discs and lumbar vertebrae with age. *Spine* 27:263–268
- Simotas AC, Dorey FJ, Hansraj KK, Cammisa F Jr (2000) Nonoperative treatment for lumbar spinal stenosis. Clinical and outcome results and a 3-year survivorship analysis. *Spine* 25:197–203
- Sinikallio S, Aalto T, Airaksinen O, Herno A, Kroger H, Savolainen S, Turunen V, Viinamäki H (2006) Depression and associated factors in patients with lumbar spinal stenosis. *Disabil Rehabil* 28:415–422
- Taylor H, McGregor AH, Medhi-Zadeh S, Richards S, Kahn N, Zadeh JA, Hughes SP (2002) The impact of self-retaining retractors on the paraspinal muscles during posterior spinal surgery. *Spine* 27:2758–2762

40. Turner JA, Ersek M, Herron L, Deyo R (1992) Surgery for lumbar spinal stenosis. Attempted meta-analysis of the literature. *Spine* 17:1–8
41. Weber H (1983) Lumbar disc herniation. A controlled, prospective study with ten years of observation. *Spine* 8:131–140
42. Yamashita K, Ohzono K, Hiroshima K (2006) Five-year outcomes of surgical treatment for degenerative lumbar spinal stenosis: a prospective observational study of symptom severity at standard intervals after surgery. *Spine* 31:1484–1490