Differences in post-operative functional disability and patient satisfaction between patients with long (three levels or more) and short (less than three) lumbar fusions

We examined the differences in post-operative functional disability and patient satisfaction between 56 patients who underwent a lumbar fusion at three or more levels for degenerative disease (group I) and 69 patients, matched by age and gender, who had undergone a one or two level fusion (group II). Their mean age was 66 years (49 to 84) and the mean follow-up was 43 months (24 to 65).

The mean pre-operative Oswestry Disability Index (ODI) and visual analogue scale (VAS) for back and leg pain, and the mean post-operative VAS were similar in both groups (p > 0.05), but post-operatively the improvement in ODI was significantly less in group I (40.6%) than in group II (49.5%) (p < 0.001). Of the ten ODI items, patients in group I showed significant problems with lifting, sitting, standing, and travelling (p < 0.05). The most significant differences in the post-operative ODI were observed between patients who had undergone fusion at four or more levels and those who had undergone fusion at less than four levels (p = 0.005). The proportion of patients who were satisfied with their operations was similar in groups I and II (72.7% and 77.0%, respectively) (p = 0.668). The mean number of fused levels was associated with the post-operative ODI (r = 0.266, p = 0.003), but not with the post-operative VAS or satisfaction grade (p > 0.05). Post-operative functional disability was more severe in those with a long-level lumbar fusion, particularly at four or more levels, but patient satisfaction remained similar for those with both long- and short-level fusions.

Fusion of three or more levels of the spine for symptomatic degenerative disease that has failed to respond to conservative treatment presents a number of problems for the surgeon, including longer operating times, greater blood loss, nonunion, adjacent segment disease and post-operative dysfunction.1-4 Several studies have described the radiological outcomes of long-level fusion and factors such as sagittal balance, nonunion and instrument failure associated with surgical outcomes,5-8 but there are few reports regarding the clinical outcomes after long-level lumbar fusion.9,10 The evaluation of functional disability is complicated by confounding factors, such as symptomatic pseudoarthrosis and adjacent segment disease,11 and the fact that there are no established methods of properly assessing functional disabilities after long-level lumbar fusion surgery.12

In general terms, long-level fusion surgery is thought to affect post-operative function and patient satisfaction adversely, but there is little evidence to support this view. The purpose of this study is to examine the differences in post-operative functional disabilities and patient satisfaction in those with long (≥ 3) and short (< 3) level lumbar fusions and to test the hypothesis that long-level lumbar fusion has a worse outcome.

Patients and Methods
We retrospectively reviewed 94 consecutive patients who underwent long-level (three or more motion segments) spinal fusion between February 2005 and March 2008. Our inclusion criteria were as follows: lumbar fusion for degenerative disease, severe restriction of the activities of daily living, failure to respond to conservative treatment for at least six months, and a minimum follow-up of two years with a completed questionnaire after visiting the outpatient clinic or answering a detailed telephone enquiry. The exclusion criteria were: previous surgery on the lumbar spine in 17 patients, symptomatic pseudoarthrosis in four, combined cervical or thoracic myelopathy in three, adjacent segment disease in four, failure of instrumentation in three, and inability to respond to the questionnaire or to perform activities of daily living due to comorbidity (cerebrovascular accident, parkinsonism,
psychotic disorders or other degenerative disease) in seven cases. This left 56 patients (19 men and 37 women) with a mean age of 66 years (49 to 84) in the study (group I). We compared them with 69 patients (group II) who were matched by age and gender and who had undergone a one- or two-level lumbar fusion during the same period, met the same inclusion and exclusion criteria, and had a minimum follow-up of two years (Table I).

Group I patients had combined pathologies including spinal stenosis, spondylolisthesis and degenerative flat back (n = 34) and multilevel disc degeneration and stenosis (n = 22). Group II patients had similar pathology including spinal stenosis, spondylolisthesis, segmental instability and degenerative disc disease (n = 44) and spinal stenosis (n = 25).

All operations were performed by the senior author (CSL) and involved posterior decompression and interbody fusion using a titanium cage and posterior instrumentation. Additional fixation with an iliac screw was undertaken in most cases when more than four levels were fused. Autogenous local bone harvested during surgery was used, but autogenous fixation with an iliac screw was undertaken in most cases. This left 56 patients (19 men and 37 women) with a mean age of 66 years (49 to 84) in the study (group I). We compared them with 69 patients (group II) who were matched by age and gender and who had undergone a one- or two-level lumbar fusion during the same period, met the same inclusion and exclusion criteria, and had a minimum follow-up of two years (Table I).

Group I patients had combined pathologies including spinal stenosis, spondylolisthesis and degenerative flat back (n = 34) and multilevel disc degeneration and stenosis (n = 22). Group II patients had similar pathology including spinal stenosis, spondylolisthesis, segmental instability and degenerative disc disease (n = 44) and spinal stenosis (n = 25).

All operations were performed by the senior author (CSL) and involved posterior decompression and interbody fusion using a titanium cage and posterior instrumentation. Additional fixation with an iliac screw was undertaken in most cases when more than four levels were fused. Autogenous local bone harvested during surgery was used, but autogenous iliac cancellous bone was added if this was insufficient. No bone morphogenetic protein, demineralised bone matrix, allograft, or bone substitute was used.

Pre- and post-operative disability and pain were assessed using the Oswestry Disability Index (ODI, range 0 to 100) and a visual analogue scale (VAS, range 0 to 10) for back and leg pain. For the ten items of the ODI, each mean score (range; 0, normal to 5, impossible) was recorded separately and compared. All patients were expected to complete the ODI and VAS before surgery and at each follow-up. The patients’ satisfaction grades, which were presented as very good (1), good (2), fair (3), bad (4), or very bad (5), were also evaluated by questionnaire. ‘Satisfied’ was defined as a response of very good or good in the questionnaire. If a patient was unable to attend for follow-up, a detailed telephone interview was conducted by an author (HIL) who was blinded to the results of the study.

The two groups were compared and the correlations between the number of fused levels and post-operative ODI, VAS and satisfaction grade were analysed.

The radiological factors that could affect function were also considered. The post-operative coronal and sagittal balance, as well as the lumbar lordosis angle, were measured and compared. The coronal balance was recorded using the distance from the C7 plumb line to the centre sacral vertical line (CSVL) and the sagittal balance was recorded using the distance from the C7 plumb line to the posterior corner of the sacrum. The lumbar lordosis angle was measured as the angle between the superior end plates of the vertebral bodies of L1 and S1 using Cobb’s method.14,15 The values of the coronal balance were changed to absolute values and compared.

Statistical analysis. Comparison and correlation analyses were performed by a statistician using SAS version 9.1 (SAS Institute Inc., Cary, North Carolina). The values were recorded as the mean with standard deviation. The two sample t-test, Mann-Whitney U test, Spearman rank correlation rho, cross-table analysis, and minimum p-value approach were used for statistical analysis. A p-value < 0.05 was considered significant.

Results

The mean number of fused levels in group I was 4.1 (3 to 8) and the mean follow-up 44.6 months (24 to 61). In this group, the mean ODI decreased from 54.7 (18.3) pre-operatively to 32.5 (4 to 60) at final follow-up and the mean VAS improved from 6.6 (2.0 to 10.0) and 6.8 (1.0 to 10.0) to 3.4 (0 to 8.5) and 3.8 (1.0 to 10.0) for the back and leg, respectively.

The mean number of fused levels in group II was 1.4 (1 to 2) and the mean follow-up 42.0 months (24 to 65). In this group, the mean ODI improved from 51.1 (13.3 to 86.7) pre-operatively to 25.8 (0 to 68.0) at final follow-up, and the mean VAS for the back and leg decreased from 5.7 (0 to 10.0) and 7.2 (0 to 10) to 3.5 (0 to 8) and 3.3 (1 to 9), respectively. The mean pre-operative ODI and pre- and post-operative VAS scores were similar in the two groups (p > 0.05), but the improvement in the mean post-operative ODI was significantly lower in group I (40.6%) than group II (49.5%) (p < 0.001) (Table II).

Although a significant difference between the groups was observed pre-operatively in only one item (standing) of the ODI (p = 0.025), the mean post-operative scores for four items (lifting, sitting, standing and travelling) were significantly higher in group I than group II (p = 0.016, 0.005, 0.004 and 0.003).
0.002 and 0.027, respectively) and there were no significant differences in the mean scores for the other ODI items post-operatively (p > 0.05). An analysis of the item of sex life was not performed due to the small number of replies. Pre-operatively, 21 patients in group I and 33 patients in group II replied to the sex life item and only 11 and 28 patients in groups I and II did so post-operatively (Fig. 1).

There was no significant difference in the mean post-operative coronal balance between groups I (14.0 mm (SD 16.1)) and II (10.2 mm (SD 7.1)) (p = 0.599). Although the patients in group I had a greater mean post-operative sagittal imbalance (40.9 mm (SD 27.5)) and a lower mean lumbar lordosis angle (38.1° (SD 11.9)) than group II (29.2 mm (SD 36.6) and 47.1° (SD 15.9), respectively), there was no significant difference in sagittal balance or lumbar lordosis (p = 0.161 and p = 0.059, respectively).

Post-operatively, 40 (72.7%) of 55 patients in group I (one answer not given) and 47 (77.0%) of 61 patients in group II (eight answers not given) were satisfied with their surgery: there was no significant difference in the proportion of satisfied patients (p = 0.668, Fig. 2).

The number of fused levels showed a significant association with the post-operative ODI (r = 0.266, p = 0.003), but no association with the post-operative VAS for back (p = 0.886) and leg (p = 0.074) pain and satisfaction grade (p = 0.552).

Patients with a longer fusion had a higher mean post-operative ODI. When the minimum p-value approach was performed to determine a cut-off value for the number of fused levels that showed the most significant difference in the post-operative ODI between fused levels, the most significant difference in post-operative ODI was between < 4 levels and ≥ 4 fused levels (p = 0.005). However, there was no significant difference in the mean pre-operative ODI and satisfaction grade according to the number of fused levels (p > 0.05, Table III).

Discussion
We found that functional disability was greater in the long-level fusion group, particularly in those with four or more fused levels. A better clinical outcome, in terms of ODI, was achieved in patients with a short-level fusion. On the other hand, there was no significant difference in satisfaction grade between the two groups. By contrast, Lettice et al\textsuperscript{9} reported that there was no significant difference in Short Form RAND 36-Item Health Survey (SF-36)\textsuperscript{16} between patients with a long- and short-level fusion, and, when using strict selection criteria, the number of levels fused might not have a significant impact on the overall clinical outcome. However, the number of the patients in this paper with three or more fused levels was small. In our results, patients with four or more fused levels had the most signif-
A significant difference in ODI score compared with those with less than a four-level fusion. We therefore believe that the numbers in the paper of Lettice et al. were insufficient to compare the difference between long- and short-level lumbar fusion.

A few studies with strict selection criteria describe good surgical outcomes after a long-level lumbar fusion. For example, Suratwala et al. showed significant post-operative functional improvement in the ODI, Roland Morris Scores, and SF-36 in patients with a circumferential fusion of three or more motion segments. Zouboulis et al. also reported clinical improvements in the ODI and VAS and higher satisfaction rates after surgical treatment for multi-level lumbar spinal stenosis. However, in these studies, there was no comparison between patients with a long- and short-level fusion nor was there any analysis of the functional disability and satisfaction rates in relation to the number of fused levels. We have shown that although there was greater post-operative functional disability in the long-level lumbar fusion group, the satisfaction rates were similar in both groups.

In this study, the ODI score was used to assess functional disability: this is the most commonly-recommended condition-specific outcome measure in spinal disorders. Each ODI item was also analysed and of all four items (lifting, sitting, standing and travelling) gave significantly higher mean scores post-operatively for group I than group II (p < 0.05). Accordingly, we believe that these items could play a more important role in evaluating post-operative function after a three or more level lumbar fusion and that patients, who are scheduled to undergo long-level lumbar fusion, should be informed of problems in these areas pre-operatively. The item of sex life was excluded from the analyses due to the small number of replies. In contrast to previous reports, the item of sex life was not considered to be valid for the evaluation of elderly patients with severe lumbar degenerative disease.

We considered the following reasons for more severe functional disability after a long-level lumbar fusion: 1) differences in the specific diagnosis and the extent of the pathological lesion between the two groups, 2) differences in the size and capacity for recovery of the damaged lumbar musculature, and 3) adverse effects of a long-level fusion on the restriction of lumbar movement. Glassman et al. reported that the improvement in health-related quality of life was not equal among the diagnostic subgroups. In our study, the differences in indications for fusion between the long- and short-level groups might affect the post-operative functional outcome. We have previously found, although not reported, that although the pre-operative strength of the lumbar musculature is similar, the post-operative strength was significantly lower in patients with a long fusion. These results could also help to explain the post-operative differences in the functional disability between the two groups.

The patients with a four or more level fusion showed the most functional disability. In a previous report, we showed that fusions of this length had an increased risk of nonunion at the lumbosacral junction and required additional fixation, thus we concluded these problems associated with long-level fusion should be considered when counselling patients pre-operatively. In order to clarify the post-operative functional disability of the patients, we compared 16 patients in group I who complained mostly of back pain and stooping and the other 40 patients who mostly had radiating pain and claudication in the lower...
legs. However, no significant differences were seen post-operatively in ODI or satisfaction grade ($p > 0.05$). In patients with a long-level lumbar fusion, the post-operative functional disability of patients who complained of back pain and stooping was no more severe than in those without. Meanwhile, the pre-operative ODI and VAS scores were similar in groups I and II (Table II). This suggested that the severity of the pathology in the short-level group was no less than that in the long-level group regardless of the number of degenerative levels; several authors have reported similar findings.19,27,28

There were some limitations to this study. First, it is retrospective and composed of a heterogeneous group of patients. However, to minimise this weakness, strict inclusion and exclusion criteria were applied and the data were standardised using an age- and gender-matched comparative group and universal evaluation forms. Secondly, only the ODI items were analysed without considering other measurements of function. Nevertheless, the ODI is the most universally used and condition-specific measurement tool to date and we added separate analyses for each item of the ODI and grade of post-operative satisfaction. Finally, other risk factors that can affect function post-operatively, such as fusion of lumbosacral junction or sacropelvic fixation, were not analysed.

In conclusion, post-operative functional disability was more severe in the group with a long-level lumbar fusion, particularly if this covered four or more levels, but patient satisfaction was similar in the long- and short-level fusion groups. Patients should be informed of these differences before undergoing fusion of the lumbar spine.

The authors give special thanks to S. Y. Woo for the statistical analysis. 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


