Survival analysis is a better estimate of recurrent disc herniation

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Studies on recurrent disc herniation quote rates of recurrence without regard to the times of recurrence and the influence of longer follow-up. Our objective was to assess the use of survival analysis to measure the rate of revision after lumbar microdiscectomy. We undertook a retrospective analysis of the hospital records of 993 patients who underwent lumbar microdiscectomy over a period of ten years. After calculating the overall rate of revision for the mean length of follow-up, we carried out a survival analysis using the life-table method. During the study period 49 patients had a revision microdiscectomy. This gave an overall rate of revision of 4.9% at a mean follow-up of 5.25 years. Using survival analysis, the rate of revision was 7.9% at a follow-up of ten years when the number at risk was 84. Survival analysis gives a more accurate estimation of the true rate of recurrence for patients undergoing lumbar microdiscectomy. The method allows better comparison between different interventions for disc herniation.

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Lumbar microdiscectomy is a well-established technique.¹⁻⁵ The rate of revision (or reoperation) after microdiscectomy is a recognised objective measure of the failure of primary surgery and is included in many studies of outcome.³⁻⁸ It is used by most authors as the measure of the rate of recurrence of herniation after surgery. Reports of recurrent disc prolapse requiring repeat operation, however, quote percentages with no regard to the effect of the length of follow-up. For example, Caspar et al⁵ reported a rate of recurrence of 3.30% at a mean of 2.8 years. We believe that as the length

of follow-up increases the rate of revision will also increase. Survival analysis is a statistical technique which rationalises the figures according to the length of follow-up.^{9,10} It is now the recognised standard in the assessment of failure in total hip replacement.^{9,10} In a survival analysis, the basic assumption is that all patients are operated upon on the same day, and then have different lengths of follow-up. There are two methods, the 'life-table method' and the 'product-limit' method. Our aim was to assess the use of survival analysis to measure the rate of revision after lumbar microdiscectomy.

Patients and Methods

We retrospectively reviewed the hospital records of all patients who had undergone primary excision of a lumbar disc between October 1990 and May 2001. All the patients were placed in a lateral decubitus ('fetal') position with the side to be operated on uppermost. The operator, who was sitting, used a loupe (3.5 x magnification) and light both attached to the same headband. A skin incision 2.5 cm long was made and after release of the lumbar fascia and paraspinal muscles, a curved retractor was placed over the facet joint to create a triangular working field. A fenestration laminotomy allowed access to the spinal canal, retraction of the nerve root and excision of prolapsed and loose disc material. The early results of this technique have previously been reported.¹¹

During a ten-year period, 993 patients underwent primary discectomy using this technique. There were 417 women (42%) and 576 men (58%) with a mean age of 40 years. All the patients had had intractable unilateral sciatica for more than six weeks with disc prolapse proven by MRI or, in a few, by CT or myelography. Most of the operations (60%) were at the L5/S1 level with 37% at the L4/5 level and only 27 at the L3/4 and L2/3 levels. We recorded any revision surgery on a lumbar disc. All operations at the same level as the primary microdiscectomy, for recurrent disc prolapse on the contralateral side as well as on the ipsilateral side, were recorded as a revision procedure. This ensured that our estimation of revision was as high as possible. Using this convention we calculated the mean rate of revision. We used Student's *t*-test and the chi-squared test to assess statistical differences in gender, age at primary opera-

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Table I. Life table for the survival analysis

Years since operation	Number at start	Number of withdrawals	Number at risk	Number revised	Annual revision rate (%)	Annual survival rate (%)	Cumulative survival rate (%)	95% CI
1	993	0	993	11	1.11	98.89	98.9	98.0 to 99.4
2	886	11	875	10	1.14	98.86	97.8	96.5 to 98.6
3	764	17	747	8	1.07	98.93	96.7	95.2 to 97.8
4	674	24	650	8	1.23	98.77	95.5	93.6 to 96.9
5	562	27	535	3	0.56	99.44	95.0	92.8 to 96.6
6	464	24	440	2	0.45	99.55	94.6	92.0 to 96.3
7	356	24	332	3	0.90	99.10	93.7	90.5 to 95.9
8	258	22	236	4	1.69	98.31	92.1	87.9 to 95.0
9	169	13	156	0	0.00	100.00	92.1	86.7 to 95.5
10	91	7	84	0	0.00	100.00	92.1	84.2 to 96.6

Fig. 1

Survival curve after lumbar microdiscectomy.

tion and the distribution of levels between the primary and revision groups.

For the survival analysis, we used the 'life-table' method, as described by Dobbs⁹ and later popularised by Murray et al¹⁰ for the follow-up of hip arthroplasty. The 'withdrawals' were those patients who were removed from the calculation because they had been revised at some point before each particular time interval. Our definition of failure was the occurrence of a revision. We used the Rothman exact method to calculate the 95% confidence intervals (CI).

Results

Within the period of the study, 49 patients had undergone revision microdiscectomy. The overall rate of revision was 4.9% at a mean follow-up of 5.25 years. There were 23 women (47%) and 26 men (53%), with a mean age at the primary operation of 42 years. In total, 31 (63%) of the operations were at the L5/S1 level, and 18 (37%) at the L4/5 level. There was no significant difference in these parameters for the group undergoing revision compared with the primary group.

The results for the survival analysis are presented in Table I. The number of withdrawals was subtracted from the number of patients at the start of the time period to give the number of patients 'at risk' of undergoing revision at each interval of follow-up after primary surgery. The number of revisions occurring allows the annual revision rate to be calculated. This figure is subtracted from 100% to give the annual survival rate and these are progressively multiplied to give the cumulative survival rate. The 95% confidence intervals are also shown. The results of the survival analysis are shown graphically in Figure 1.

Subtraction of the cumulative survival rate from 100% gives the revision rate as estimated by survival analysis. By this method the revision rate was 7.9% at ten years of follow-up when the number at risk was 84.

Discussion

The rate of revision (reoperation) after lumbar discectomy is a recognised outcome measure. A recent review article was dedicated to this topic.⁸ The problem with many of the previous reports, however, is the arbitrary way in which the revision rates are reported, usually calculated over a mean length of time. It may be tempting for authors to report their flattering early results of new treatments for lumbar disc herniation, but disorders of the disc are not static and longer follow-up is needed to allow a more accurate evaluation and a better comparison between different methods of treatment. Reports of longer-term follow-up show higher rates of recurrence than those reporting mean rates. Findlay et al⁶ reported a rate of revision of 5.1% on the same side at ten years. Since the rate of revision is used as an indication of the outcome of treatment we feel that it is important to report an accurate assessment of the true rate of revision. In our series the rate continued to rise steadily with each year of follow-up; it was only 1.1% in patients followed to one year, 5.0% at five years and 7.9% at eight years. No revisions have occurred after eight years from the primary operation. We have shown that survival analysis estimates a higher rate of revision at longer follow-up, and we believe that this is a more accurate figure than the mean rate.

Certain factors related to the patients may influence the recurrence of disc herniation. As part of our analysis we were able to assess the effect of age, gender and level of primary protrusion on the occurrence of a revision. We found that the distributions of these variables were almost identical in the revision and primary groups, with no increased risk of revision for any specific factor. There was no relationship between age and the length of time between primary discectomy and recurrent disc prolapse.

We recognise that there are potential criticisms of our study. The data were collected retrospectively from the hospital records. We believe that most patients with recurrent disc herniations return to the same hospital, but it is likely that some from the primary group have undergone revision elsewhere. The true rate of revision is thus likely to be even higher than that estimated using survival analysis. Our study clearly shows, however, the value of survival analysis as a better measure of revision rate in lumbar discectomy.

We recommend that this statistical technique should be used in future reports of the outcome of different methods of treatment of prolapse of a lumbar disc.

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