PACKING OF INTERVERTEBRAL SPACES WITH OXIDIZED REGENERATED CELLULOSE TO PREVENT THE RECURRENCE OF LUMBAR DISC HERNIATION

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OBJECTIVE: To investigate the impact of packing of intervertebral spaces with oxidized regenerated cellulose (ORC) on the incidence of recurrence of lumbar disc herniation (LDH).

METHODS: We retrospectively reviewed 158 consecutive patients who underwent surgery for a newly diagnosed LDH and had a minimum of 18 months of follow-up. Single-level (151 patients) and two-level (7 patients) procedures accounted for 165 microdiscectomies. After microsurgical removal of disc herniation and curettage, the interspaces were tightly packed with ORC.

RESULTS: The average hospital stay was 1.47 days, without any relevant and permanent complications. In particular, complications related to intervertebral ORC packing were never observed. At a median follow-up of 29 months (range, 18–51 mo), the pain decreased or disappeared in almost all patients and the patient satisfaction rate was very high. A recurrence of LDH was observed in two patients (1.34%), both of whom needed a second operation. Three patients (2.01%) experienced a disc herniation involving another intervertebral space.

CONCLUSION: Our preliminary results suggest that the packing of intervertebral spaces with ORC at the end of microdiscectomy is a safe technique that may reduce the incidence of recurrent LDHs, although the true impact of this technique on long-term follow-up is still unclear. At the moment, it seems reasonable to assume that this technique should be used only under the auspices of large clinical investigations with prospective and randomized protocols.

KEY WORDS: Low-back failure, Lumbar disc herniation, Microdiscectomy, Oxidized regenerated cellulose, Recurrence

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Lumbar disc herniation (LDH) is the most common (1) spinal disorder. A recurrence after microdiscectomy for LDH herniation is observed in approximately 4 to 11% of patients (6–9, 17, 19, 23). Recurrent LDH represents one of the most common causes of "failed-back syndrome," with legal consequences, Workers' Compensation claims, and psychological and social problems (7).

In an attempt to evaluate whether the packing of intervertebral spaces with oxidized regenerated cellulose (ORC) may reduce the incidence of recurrence, we retrospectively reviewed 158 consecutive patients who underwent surgery for an LDH and had a minimum follow-up of 18 months. All patients were treated with this technique after microsurgical removal of disc herniation and curettage of the interspace.

PATIENTS AND METHODS

Patient Population

From March 1998 to September 2000, 158 consecutive patients were operated on for a new LDH: 89 were men and 69 women, with an average age of 43 years (range, 22–84 yr). The most common presenting symptoms were lumbar pain and radiculopathy (91.1%; 144 patients), associated with motor and sensory deficits (22.2%; 35 patients). All patients had a positive straight-leg-raising test before operation. In all patients, the preoperative diagnosis was established by use of computed tomography and/or magnetic resonance imaging. The most frequently affected levels were L4–L5 (38.6%; 61 patients) and L5–S1 (50.6%; 80 patients). In seven patients (4.4%), two interspaces were involved. Surgical treatment was proposed in all patients presenting with extruded or bulky subligamentous LDH with or without mild neurological deficits after 20 days of unsuccessful conservative therapy (bed rest, myorelaxants, and corticosteroids or nonsteroid analgesics). Patients presenting with severe neurological motor deficits were operated on as soon as possible.

Surgical Procedure and Postoperative Course

All surgical procedures were performed via a standard midline microsurgical approach with dissection of the ligamentum flavum, minimal removal of laminae, and foraminotomy. Single-level (151 patients) and two-level (7 patients)

procedures accounted for 165 microdiscectomies. After microsurgical removal of disc herniation, curettage of the interspace, dura and nerve root(s) decompression, and accurate hemostasis, the intervertebral space was packed and filled with ORC (Tabotamp Fibrillar Absorbable Hemostat; Johnson & Johnson, Brussels, Belgium). The amount of ORC used varied in each procedure and was the amount necessary to fill the intervertebral space almost entirely. ORC was packed tightly within the interspace, without extending beyond the line joining the posterior surfaces of the vertebral bodies.

Approximately 6 to 8 hours after completion of surgery, patients were encouraged to stand up and walk with the aid of a nurse. Patients were discharged when they could stand and walk comfortably and unassisted.

Outcome Measures

Patients were evaluated 2 to 3 hours after surgery, at discharge, at 1 week, and after 1 month at a clinic visit. Patients were also evaluated 6, 12, 18, 24, and 36 months after operation at a clinic office visit or by phone assessment of their satisfaction rate. The patient treatment satisfaction rate was evaluated by use of a four-grade scale: poor (not improved), fair (improved), good (markedly improved), and excellent (asymptomatic). In particular, patients were asked to answer the following questions: 1) how would you define the result of surgery? and 2) would you undergo the operation again in the same preoperative situation (yes/no)? At the last clinic follow-up, the outcome was also evaluated by the Prolo Functional Outcome Rating Scale (14) (*Table 1*).

Reappraisal of symptoms in relation to recurrence of disc herniation or occurrence of a new LDH at a different level was confirmed by lumbar computed tomographic scan or magnetic resonance imaging with intravenous contrast medium when indicated by a clinic visit and neurological examination.

RESULTS

The mean operative time was 47 minutes for one-level procedures and 59 minutes for two-level procedures. There were no relevant and permanent postoperative complications. In particular, complications related to intervertebral ORC packing were never observed. Three postoperative complications (1.9%) consisted of two cerebrospinal fluid leaks, which were treated successfully without surgery, and one wound infection, which was cured with surgical cleansing and antibiotics. Eighty-three patients (52.5%) were ambulatory within 6 to 8 hours of the completion of the procedure, and all remaining patients were ambulatory 24 hours after surgery. Patients felt fit and comfortable to leave the hospital at a mean postoperative discharge time of 1.47 ± 0.08 days; 112 patients (70.9%) were discharged within 24 hours after surgery.

TABLE 1. Prolo Functional Outcome Rating Scale

1	Total incapacity (worsened)
2	Mild/moderate low back pain and/or leg pain (unchanged)
3	Low level of pain: able to perform all activities except sports (slightly improved)
4	Episodic recurrences of low back pain and/or leg pain (improved)
5	No pain; able to perform all previous activities (cured)

At the first evaluation, 3 to 4 hours after surgery, both back and leg pain had improved in the majority of patients; in particular, leg pain decreased markedly in 145 patients (91.8%). One patient who experienced preoperative cauda equina syndrome recovered completely from all symptoms within 12 hours after surgery. At discharge, 111 patients (70.3%) defined the results as excellent, 39 (24.6%) as good, and 8 (5.1%) as fair.

Nine patients (5.7%) were lost to follow-up 3 months after surgery. Twelve-month and 18-month follow-ups were obtained in 149 patients, 24-month follow-up in 121 patients, and 36-month follow-up in 22 patients. The first six patients of the series were contacted by telephone, and their satisfaction rates were evaluated 45 to 51 months after surgery.

June 30, 2002, was the follow-up closing date, with a median follow-up of 29 months (average, 28.2 mo; range, 18–51 mo). At this evaluation time, the pain had decreased or disappeared in almost all patients, with a high patient satisfaction rate: excellent, 122 patients (81.9%); good, 22 (14.8%); and fair, 5 (3.3%). The Prolo Functional Outcome Rating Scale score was 5 in 114 patients (76.5%), 4 in 29 patients (19.5%), 3 in 4 patients (2.7%), and 2 in 2 patients (1.3%). Approximately 95% of patients (141 patients) answered "yes" to the question "would you undergo the operation again in the same preoperative situation?"

Excluding the patients lost to follow-up, recurrence of LDH was observed in two patients (1.34% of 149 patients and 1.28% of 156 microdiscectomies): a 61-year-old man with recurrence at 21 months after surgery and a 62-year-old man previously operated on for L4–L5 disc herniation with recurrence at 41 months after surgery. In both patients, a second operation was determined to be necessary on the basis of clinical and computed tomographic scan findings. An extruded disc fragment was removed from each of these patients. The consistency of the disc material was the same as that of a typical new LDH. A fibrous membrane, markedly damaged on one side (left side in the first patient and right side in the second), was found to cover both interspaces. In addition, a small amount of fibrous tissue was found inside the affected interspaces. Marked improvement of pain and radicular deficits was observed at 5 and 9 months after reoperation, respectively.

An LDH involving a level different from the one previously operated on was observed in three patients (2.01%) at 7, 11, and 15 months after surgery. In all of these patients, LDH was diagnosed with magnetic resonance imaging and was treated successfully with a second operation.

The results of the present series were compared with those of 147 patients operated on by the same microsurgical technique during the 2 years preceding the adoption of intervertebral ORC packing. In that group of patients, the rate of recurrent LDHs at 18 months after surgery was 3.4% (five patients). This difference was statistically significant by the χ^2 test ($P = 0.03$).

DISCUSSION

Standard microsurgical lumbar discectomy consists of removal of herniated nucleus pulposus, decompression of neural structures, and curettage of the intervertebral space (4, 11). Recurrent herniation after a discectomy is defined as an LDH at the same level as the one previously operated on, with a pain-free interval of at least 6 months after surgery (19). Although the aim of interspace curettage is to reduce the incidence of recurrences, approximately 4 to 11% of patients experience recurrences (6–9, 17, 19, 23). In fact, the complete removal of all disc material is usually not feasible, mainly because of the lack of a clear cleavage between anulus fibrosus and nucleus pulposus and because of the limited accessibility into the space (9, 12).

In a series of 984 surgically treated LDHs with long-term follow-up, Davis (7) observed a recurrence rate of 6%, approximately one-third of which occurred during the first year. In a morphological study, Laus et al. (10) observed that early recurrences (i.e., those appearing within approximately 1 yr of operation) are formed by disc tissue, as in primary herniation, whereas late recurrences are caused by mechanical collapse of reparative fibrocartilaginous tissue that has developed after discectomy.

To prevent the necessity of a second operation for recurrence of LDH, Hirabayashi et al. (9) suggested performance of a careful and complete removal of the intervertebral disc, especially deep to the posterior longitudinal ligament, and an extensive foraminotomy. Adopting this technique in a series of 214 patients, these authors reported an incidence of recurrence of 4.2% (nine patients) at a mean follow-up of 53 months. Yorimitsu et al. (23) observed that patients with preserved disc height on lumbar x-rays are at high risk for recurrent LDH, although their 10-year results are favorable. Taking these observations into account and considering that the curettage of vertebral endplates increases the risk of postoperative spondylodiscitis (15), our surgical strategy, for the past several years, has been the removal of the herniation and curettage of the intervertebral space to remove the advanced degenerated discal tissue (6), leaving in situ discs with normal consistency that are adherent to the vertebral endplates. Obviously, the small amount of disc remaining in the space exposes the patient to the possibility of LDH recurrence.

As is well known, ORC is an effective hemostatic agent often used in surgical procedures, with bactericidal protection capabilities. It is fully resorbed within 3 months and leaves in its place a fibrous scar (3, 13, 18, 21). ORC is a polyanion whose functional unit is polyanhydroglucuronic acid (13). Data derived from sequential uronic acid assays, histochemistry with Alcian Blue stain, and transmission electron microscopy of implanted ORC revealed that this hemostatic agent consists of two active components: 1) soluble uronic acid, which disappears after 6 hours, and 2) a fibrous component, resembling the ORC on electron microscopic analysis, which remains (13). In an attempt to reduce the incidence of recurrent disc herniations, we tried to fill the residual interspace with ORC at the end of microdiscectomy and curettage, with the aim of achieving interspace fibrosis and thus a barrier against the possible extrusion of the intervertebral residual disc. Although the median follow-up period (29 mo) is too short for any conclusions to be drawn, the incidence of recurrence is 1.34% (1.28% of 156 microdiscectomies). In comparison, a retrospective analysis of results in 147 patients operated on with the same microsurgical technique during the 2 years preceding the adoption of intervertebral ORC packing found that the rate of recurrences 18 months after surgery in this "historical" control group was 3.4% ($P = 0.03$).

Although we did not observe any complications related to the filling of the interspace with ORC, the excess of ORC at the end of spinal surgical procedures may produce epidural migration of swollen, blood-soaked ORC (the so-called "surgiceloma"), which sometimes leads to the development of cauda equina syndrome (2) or spinal cord compression (5, 16, 20, 22). To avoid these complications and possible deleterious inflammatory responses around nerve roots, we packed the ORC tightly inside the interspace without extending beyond the line joining the posterior surfaces of the vertebral bodies.

Our preliminary results are encouraging, but the widespread use of this still unproven technique is frankly not advisable at present, primarily because of the absence of published reports of pertinent experiences in the literature. Although the difference between the study group and historical controls is statistically significant ($P = 0.03$), the short-term follow-up and the retrospective design of the present study do not allow us to assess the efficacy of ORC intervertebral packing in reducing the incidence of recurrent LDH. To validate the safety and the preliminary favorable short-term results of this technique, a multicenter randomized clinical trial with adequate follow-up is encouraged.

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COMMENTS

Mastronardi and Puzzilli describe a unique approach to the management of lumbar disc herniation (LDH). They have packed the interspace, after disc interspace evacuation, with oxidized regenerated cellulose (ORC). This certainly introduces scarring, while at the same time maintaining disc interspace height. The newly developed scar will most likely not herniate dorsally once the scar is mature. Therefore, this technique may indeed function as a nuclear replacement technique but will be associated with a much lower cost (and, apparently, risk). Although this is an untested technique, future work regarding its efficacy and safety is clearly warranted.

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The authors conducted a retrospective study of 158 patients who underwent lumbar microdiscectomy for radiculopathy. After removing the disc, they packed the disc space with ORC, with the objective of decreasing the rate of recurrent herniation. The minimum follow-up was 18 months (median, 29 mo; mean, 28.2 mo; range, 18–51 mo). The rate of recurrent herniation at the same level of surgery was 1.3%. A recurrence at another level was observed in three patients (2.01%). These are excellent numbers. However, it is well known that rates of recurrence increase with longer follow-up. Consequently, I hope the authors will continue to follow up their patients to determine whether this low rate of recurrence will persist.

It is also of interest to note that the surgical intervention seems somewhat aggressive. Although all patients had a straight-leg-raising test, a period of only 20 days of unsuccessful conservative treatment was considered to be an indication for surgery. I hope the authors will continue their diligent follow-up to ensure that these good clinical outcomes and the low rate of recurrence are maintained.

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Mastronardi and Puzzilli report a retrospective analysis of 158 consecutive patients who underwent lumbar discectomy. Of these patients, 121 were available for examination 24 months after the operative procedure. A decompressive procedure was performed through a standard midline approach. The disc space was thoroughly explored, and all degenerated disc material was removed. Apparently, the cartilaginous endplates were not removed. A foraminotomy was performed. At this point, the authors packed the interspace tightly with ORC. The material was packed to the posterior edges of the vertebral bodies. The authors contend that this maneuver decreases the recurrence of LDH. If one simply examines the historical controls, I am not convinced that this is the case. As the authors note, Davis (1) observed a 6% recurrence rate, one-third of which occurred in the first year. This 2% is very close to the 1.34% the authors report. I am not certain that this represents a statistically significant difference. The authors examined their own practice before using ORC and found a significant difference in lumbar disc recurrence rates earlier in their experience. Because these two groups of patients were not treated concurrently and in a randomized fashion, this comparison is invalid. The authors' current low recurrence rate may simply be a result of their excellent, meticulous decompressive technique.

The authors discuss several theories to explain why the placement of ORC would aid in the prevention of recurrent disc herniation. They also note the risks involved with this technique, including herniation of the ORC itself and inflammation. Despite my criticisms, I agree with their conclusion that these preliminary results appear to be encouraging. The safety and efficacy of this technique, however, will be defined only by a prospective, randomized clinical trial.

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1. Davis RA: A long-term outcome analysis of 984 surgically treated herniated lumbar discs. **J Neurosurg** 80:415–421, 1994.

This article describes the results in 158 patients with LDH managed by microdiscectomy followed by packing of the disc space with ORC. The results are good and are essentially comparable to most other surgical series on LDH. Perhaps

most importantly, no obvious deleterious effects were associated with the authors' disc space-packing maneuver. The low reported rate (1.34%) of disc recurrence is suggested by the authors as evidence that this technique may reduce the incidence of recurrent disc herniation.

Importantly, the authors point out the inherent limitations in their study design and methods. It is nearly impossible to accurately assess the effects directly attributable to their "ORC disc space-packing" maneuver in the absence of a truly comparable concurrent control group, matched in every way to the treatment group except for the disc packing. Although the authors use a historical control group, such comparisons are notoriously unreliable and nearly always favor the contemporary treatment. Refinements in surgeon selection criteria, operative skills, techniques, and judgment, for example, could easily account for different outcomes in the noncurrent treatment group. Comparisons with previously published series are even more problematic, because there is no way to control for differences in patient population, selection criteria, operative technique, and outcome measurement. Furthermore, differences in the definitions and determinations of disc recurrence, the completeness of follow-up, and study duration virtually preclude any meaningful comparisons between this study and other published series.

The impressively low reported rate of disc recurrence (1.34%) in this study must also be scrutinized further in the context of the authors' study design and methods, particularly with regard to how disc recurrence was defined and identified. Most surgeons would agree, for example, that gadolinium-enhanced magnetic resonance imaging represents the "gold standard" for recurrent disc herniation identification, yet presumably, only a tiny fraction of the patients in this study underwent postoperative magnetic resonance imaging. Thus, many asymptomatic, minimally or moderately symptomatic, or temporarily or episodically symptomatic disc recurrences may have remained undetected. One could legitimately wonder in how many of the 29 patients (19.5%), for example, with a Prolo Grade 4 at follow-up ("episodic recurrence of low back and/or leg pain"), a recurrent disc may have been responsible for these symptoms. In the absence of postoperative magnetic resonance imaging, we do not know. The same is true for the additional six patients with Prolo Grade 2 or 3 outcomes. Alternatively, one could raise the additional concern of whether and to what degree these persistent symptoms, reported in nearly 25% of patients, could be the result of excessive perineural scarring induced by the ORC. There is simply no way to assess this without a prospective study design using a comparable control group and routine postoperative magnetic resonance imaging follow-up.

Finally, the duration and completeness of follow-up may also have an effect on the reported rate of disc recurrence. If, for example, the nine patients lost to follow-up before the 3-month postoperative visit had a symptomatic disc recurrence, then the disc herniation recurrence rate would be 7%. It is also important to note that those patients with recurrent disc herniations in this study were diagnosed, on average, at 2.5 years (21 and 41 mo) after surgery. Yet, only 77% of patients were either available or had reached the 2-year follow-up, and 3-year follow-up is available for only 22 (14%) of the patients. The expected rate of 3-year follow-up in this study (using a commencement date of March 1998 and a conclusion date of June 2002 and assuming a constant rate of enrollment of patients, i.e., 4.6 patients/mo) should be 65 patients. Thus, there seems to be a high lost-to-follow-up rate beyond 2 years. This could result in a speciously low reported rate of long-term disc recurrences, particularly compared with previously published series with longer and more complete follow-up.

Thus, although the authors' hypothesis is intriguing and provocative, there is simply no way to validly assess whether packing of the intervertebral disc space with OCR after microdiscectomy has any beneficial effect on the incidence of recurrent disc herniation. Only a prospective study with a comparable control group can validly assess this question.

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