Safety and Usefulness of Free Fat Grafts After Microdiscectomy Using an Access Cannula: A Prospective Pilot Study and Literature Review

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Abstract

Placing an interpositional fat graft over the dura has been practiced to prevent sciatica due to nerve tethering from scar. We assessed feasibility, outcomes, and complications of free fat grafts in patients undergoing lumbar microdiscectomy for herniated discs using an access cannula.

Retrospective review of prospectively collected data on 69 consecutive patients: those who received autologous fat graft (Group I) and those who did not (Group II). Clinical evaluation of leg pain and nerve tension sign was performed in the immediate postoperative period and at 1 month, 6 months, 12 months, and 24 months.

The combined visual analog scale (VAS) scores for leg pain improved from 8.3 preoperatively to 1.3 ($p<0.5$). The average VAS score for leg pain was 1.4 (0 to 3) in Group I and 1.3 (0 to 3) in Group II ($P>0.05$). Ninety-one percent had resolution of their leg pain immediately postop and 96% at final follow-up.

This study found no increased complications with the use of fat graft, but no clinical benefit, therefore the use of fat graft should be discouraged. The potential complication with the use of fat graft is the "mass effect" on the dura, and therefore, the width of the graft should be <1 cm.

There is an increasing trend toward use of less invasive surgery, and access cannulas are important tools in minimally invasive spine surgery (MISS) or less exposure spine surgery (LESS). With the aid of loop or microscopic magnification, there is better stereoscopic visualization with smaller incisions for surgeries, such as microdiscectomies for herniated lumbar disks. The smaller skin incisions allow for less exposure surgery (LES) with less tissue disruption, preservation of anatomy, a smaller laminotomy window, and thus the need for smaller fat grafts compared with open microdiscectomies.

Intuitively, fat graft is used to shield the nerve from epidural scar formation. Epidural scar formation has long been thought to be a complication associated with lumbar spine surgery. Scar formation, it is believed, can lead to nerve root adhesions, causing continued back pain or leg pain after surgery.[1-5] Various materials have been studied and used to prevent scar formation after lumbar discectomies. These materials include gel foam, bone wax, synthetic membranes, and free fat graft.[1,4,6-8]

Studies describing fat graft as an interpositional membrane have reported conflicting efficacy data.[1,8] Studies have also reported complications (eg, nerve root or spinal cord compression) from dislodged free fat grafts.[2,3,9] Dislodgement may manifest symptomatically as recurrent sciatica or cauda equina syndrome. Despite these reported complications, some surgeons still use free fat graft after discectomy, possibly because intuitively free fat graft provides a potential[2,4] barrier to adhesions and is easy and convenient to harvest.

The risk for recurrent sciatica with use of an access cannula is unknown. We conducted a pilot study to assess the feasibility, usefulness, and potential complications of free fat grafts in patients undergoing microdiscectomy.

Materials and Methods

We obtained institutional review board approval for this study, which was conducted in the Spine Surgery Service of the Department of Orthopaedics at the University of Pennsylvania. Included in the study were 69 consecutive patients (35 men, 34 women) who underwent microdiscectomy with a Minimally Invasive Retractor System prototype (Synthes Spine, Westchester, Pennsylvania) (**Figures 1A, 1B**). Mean age was 36.8 years (range, 20 to 68 years). All procedures were performed by Dr. Chin, a spine surgeon.

Inclusion criteria were a diagnosis of herniated nucleus pulposus on magnetic resonance imaging (MRI), sciatica, and positive nerve tension sign on clinical examination that did not improve with nonoperative intervention over a minimum

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Figure 1. (A) Synthes prototype access cannula. (B) Open against tissue pressure.

Figure 2. Harvested fat graft.

of 6 weeks. Nonoperative therapy included nonsteroidal anti-inflammatory drugs, muscle relaxants, opiates, methylprednisolone taper, epidural steroid injections, physical therapy, and activity modifications.

The involved lumbar disk levels were L5–S1 (43), L4–L5 (23), L3–L4 (2), and L2–L3 (1). Four patients had extraforaminal herniated disks, and 4 had 2-level disk involvement. The surgeon selected patients on day of surgery (before any incisions) by taking a mental count and trying to alternate patients to receive or not receive fat graft. Fat-graft patients had to have a body habitus that allowed for a fat graft with appropriate dimensions (1.5 cm in length and width, 1 to 1.5 cm in thickness) (**Figure 2**) to be harvested from the incision site, or they would be converted to the no-fat-graft group. All fat graft harvested adequately covered the hemilaminotomy defect. In no case did the surgeon change his decision after the microdiscectomy was performed or when the graft was too small to cover the hemilaminotomy defect.

Dr. Bassora independently reviewed the patients' clinical data from routine postsurgical follow-up and divided the patients into a fat-graft group (32 patients) and a no-fat-graft group (37 patients).

Fat Graft Harvest Protocol

In each case, the surgeon obtained the fat graft through the same incision used for the access cannula, but with the cannula removed at time of harvesting. Time needed for harvesting was less than the maximum of 3 minutes. Total surgical time was monitored. Time to prepare the graft was not monitored. A surgical knife was used to harvest the fat graft from the subcutaneous tissues and was trimmed to consistent dimensions: 1.5 cm in length and width, and 1 cm to 1.5 cm in thickness (**Figure 2**). The surgeon chose these dimensions because he was experienced in using small incisions, on the order of 1.5 cm to 3 cm, and calculating the hemilaminotomy defect to be less than 1.5 cm in any direction. A pair of scissors was used to trim the graft, and a sterile paper ruler was used to determine its dimensions. The graft, harvested only after the microdiscectomy was completed, was placed over the laminotomy defect under direct visualization (**Figure 3**).

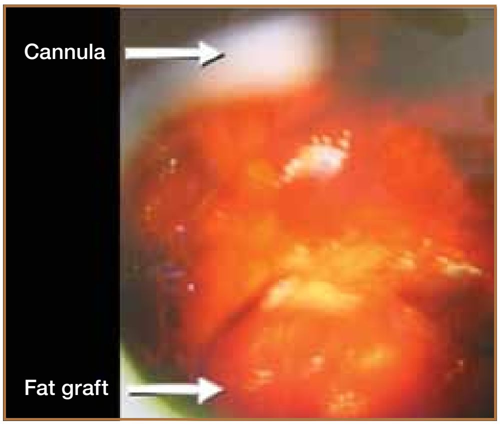

Figure 3. Fat graft in cannula over laminotomy defect.

All patients were clinically followed for more than 24 months, and data were gathered starting at 2 weeks, 3 months, 6 months, 12 months, and 24 months after surgery. Each patient was clinically examined for nerve tension signs, motor weakness, and sensory loss, and the findings were compared with the preoperative findings as a sign of mechanical compression on the nerve root that could be possibly attributed to fat graft dislodgement. Patients with a positive tension sign underwent MRI with gadolinium to assess for possible causes of mechanical compression or nerve root tethering or irritation, such as postoperative scarring, dislodged fat graft, recurrent or residual herniated disk, hematoma/seroma, and injury to the nerve root during surgery.

A visual analog scale (VAS) for leg pain was used at each postoperative visit to grade pain. Body mass index and incision lengths were compared between groups. Data were analyzed using Microsoft Excel 2002 (Microsoft, Redmond, Washington). Statistical comparisons were made using the Student t test with statistical significance defined as $P<.05$.

Surgical Technique

Each patient received general anesthesia and was positioned prone on an Andrews table (Orthopaedic Systems, Union City, California). The lumbar spine was prepared and draped in sterile fashion. Fluoroscopy was used to localize the affected disk space level.

Skin and soft-tissues were infiltrated with 20 c^3 of 1% lidocaine and 1:200,000 epinephrine. Next, an incision about the width of the surgeon's index finger was made about 1 cm lateral to the midline of the spine on the side toward the herniated disk at the appropriate level. A Cobb elevator was used to elevate the subcutaneous layers off the lumbodorsal fascia, obviating the need for sequential dilation for access. Then an incision, 0.5 mm lateral to the spinous process and in line with the skin incision, was made through the lumbodorsal fascia. The speculum retractor system was then placed in the wound down to the spine. Once it was docked against the facet and the lamina, standard microdiscectomy and foraminotomy were performed with the assistance of a microscope. Extraforaminal disks were excised from outside the spine without resecting bone. The canal space beneath the nerve root and dura was explored for loose disk fragments, and the foramen was probed to ensure adequate space for the nerve root.

Irrigation was forced into the disk space through the annular defect to remove any missed loose disk fragments. The lumbodorsal fascia was closed in layers to achieve watertight closure. Once wound closure was complete, a sterile ruler was used to measure incision length in millimeters. In this series, surgical time ran from time of incision to time of dressing application. In the first 3 patients, drains placed after surgery were removed before discharge on the morning of the first postoperative day. This practice was not used in the other patients, as they were going home within 2 hours after surgery. Each patient was scheduled for admission after surgery but was given the option to leave on the day of surgery without any involvement in the decision by the surgical team. The patients were allowed to walk immediately after surgery. Light activity with no heavy lifting was recommended for the first 2 weeks after surgery, until follow-up in the clinic, at which time unrestricted activity was permitted.

Results

With the groups combined, VAS scores for leg pain improved significantly, from 8.3 before surgery to 1.3 after surgery ($P<.5$). There was no significant difference in postoperative leg pain between the groups at any follow-up point. Mean postoperative VAS score for leg pain was 1.4 (range, 0 to 3) in the fat-graft group and 1.3 (range, 0 to 3) in the no-fat-graft group ($P>.05$). For 91% of patients, leg pain resolved immediately after surgery; for 96% of patients, leg pain resolved by latest follow-up.

There was no difference in blood loss (mean, <50 c^3) between the fat-graft and no-fat-graft groups, and there were no significant differences in surgical time (mean, 108 minutes; range, 51 to 188 minutes) or incision length (mean, 21 mm; range, 13 to 30 mm) between the groups.

Complications were a small dural tear in a fat-graft patient (did not require suture closure) and 3 seromas—2 in no-fat-graft patients (decompressed with a second operation, 3 days and 4 weeks after the primary procedure) and 1 in a fat-graft patient (successfully aspirated in the office). No case had to be converted to an open procedure.

Discussion

The practice of placing an interpositional fat graft between the dura and surrounding tissues has never been validated or shown to be better than no fat graft, but continues despite documented cases of complications attributed to fat graft dislodgement causing cauda or nerve root compression.

Epidural scar formation after lumbar laminectomy and discectomy was first described by Key and Ford[10] in 1948. They believed scar formation has its genesis in disruption of the annulus fibrosis, resulting in inflammation and fibrosis. Nachemson[5] later hypothesized that scar formation is caused by protein leakage from the intervertebral disk. In addition to anterior structures causing fibrosis, posterior structures have been implicated in postoperative formation of perineural scar. LaRocca and Macnab[4] described this process occurring secondary to migration of fibroblasts from the posterior spinal muscles into the spinal canal. The consensus is that scar may cause back and leg pain in the postoperative patient.[9,11,12]

Many types of interpositional materials have been used to try to reduce scar formation. Jacobs and colleagues[13] conducted a clinical trial comparing gel foam and free fat graft and suggested that the free fat graft group had a better clinical outcome with less perineural fibroses. Abitbol and colleagues[1] found that hyaluronic acid decreased the biomechanical strength of adhesion, reducing the tension on the involved nerve root. Hiraizumi and colleagues[6] conducted a cat study and concluded that a polyvinyl alcohol hydrogen membrane decreased adhesion to nerve roots, when compared with free fat graft or no interpositional membrane. MacKay and colleagues[8] found no statistical difference in clinical or radiographic outcome when gel foam was compared with free fat graft or when no interpositional membrane was used. Their study also suggested that the amount of radiographic scarring did not correlate with clinical outcome.

Some surgeons continue to use free fat graft.[2,3,9] It is intuitive that, using MISS and LES techniques, the risk for dislodgement may decrease as incision size decreases and there is more undisrupted tissue overlying the hemilaminotomy defect to stabilize the graft to prevent dislodgement as may. That is what we observed and concluded in the present study.

Other studies have found that free fat graft size decreases over time. Kanamori and colleagues[7] conducted a 2-part study in which they analyzed the size and quality of free fat grafts in 22 patients up to 1 year after surgery. Using MRI, they found that fat graft size decreased to 57% at 6 weeks and to 33% after 1 year. They also found graft shape changed along the shape of the dura. In the second part of the study, they analyzed the histology of the free fat graft from surgical specimens taken at repeated lumbar surgery in 18 patients who had previously undergone posterior lumbar decompression. In all cases, the fat graft remained viable, though the size of the fat globules had decreased when compared with normal fat tissue.

Kanamori and colleagues[7] did not report any complications of dislodged free fat graft, but other studies have.[2,3] Cobanoğlu and colleagues[2] reported on a patient with recurrent symptoms 6 years after a left-side L5–S1 disk herniation operation. During a second operation, it was evident that the free fat graft used in the first operation was compressing the S1 nerve, causing pain. The fat graft was smaller than before.

Being mindful of changes in fat graft size over time, we adequately covered each hemilaminotomy defect with a 1.5 × 1.5 cm graft, but the dimensions may vary between surgeons and patients and incision size.

Use of access cannulas for MISS, or LESS, including microdiscectomy, has the potential to reduce recovery time and produce less postoperative pain,[14-16] partly because of the smaller incision and the clear access to the involved nerve root under loop or microscopic magnification. Our results suggested that use of free fat graft and an access cannula is not associated with increased risk for postoperative complications. However, we were unable to detect an increased clinical benefit over not using fat graft, so we ended the study at 69 patients.

This study had its limitations. First, postoperative imaging was not used to confirm that free fat grafts had not dislodged. As other studies had radiographically demonstrated the fate of fat grafts after lumbar surgery, we decided to focus on whether there were changes in clinical symptoms. MRI was reserved for patients with postoperative symptomatic nerve root signs.

Second, it is not established how long patients should be followed after surgery to adequately assess fat grafts. We followed our patients closely for more than 24 months. However, it is not known at what point the risk for graft dislodgement is highest. Other studies have reported complications up to 6 years after surgery.[2,3] We believed that a minimum of 6 months would be necessary to show a significant difference and that only rare and isolated cases of graft dislodgement would be expected afterward. Prior studies have found that the largest reduction in graft size occurred up to 6 months after surgery and that graft size is relatively stable thereafter.[2,3]

Third, the small incision size and surgical tract may have added stability to the graft—stability that may be better than that obtained with an open approach. Therefore, it is possible that, though fat grafts may be smaller during MISS techniques, the smaller surgical tract may confer more stability to the graft. Other possibilities are that the underlying laminotomy defect may be smaller than in open surgeries and that the smaller tract may have increased the risk for symptoms from muscle edema and hematoma causing compression on the fat graft and traversing nerve root. We cannot rule out this effect as a risk but did not identify this occurrence.

Fourth, we stopped the study after 69 patients but followed these patients for more than 24 months. We consider this a successful pilot study that gave us enough information to make a clinical decision. However, the study does not have the power to show a statistically significant difference and raises the ethical question of whether we should have continued the study to achieve statistical significance.

Despite these limitations, to our knowledge this is the first study to assess use of free fat graft in minimally invasive lumbar microdiscectomies using an access cannula. Our data suggested that the use of free fat grafts was not associated with an increased incidence of recurrent sciatica or cauda equina syndrome and that it appeared to be safe. However, we could not show a clinical benefit over no fat graft.

We therefore conclude that, as there is no clinical benefit, use of fat graft should be discouraged. As the potential complication with fat graft is the "mass effect" on the dura, graft width should be less than 1 cm. The primary reason for using fat graft is to decrease scar between the dura and adjacent tissue, and this study did not resolve the controversy regarding fat graft.

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