

Preliminary Study on Effectiveness of Dexamethasone-Soaked Gelatin Sponges for Reducing Pain after Lumbar Microdiscectomy : A Randomized Controlled Trial

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Objective : A prospective, randomized, controlled clinical study is performed to verify the effectiveness of epidural dexamethasone-soaked gelatin sponges to reduce postoperative pain following lumbar microdiscectomy.

Methods : Twenty-three patients (10 men and 13 women) undergoing lumbar microdiscectomy were included. Five pieces of gelatin sponge measuring 1×1cm (Gelfoam; Pharmacia & Upjohn, Kalamazoo, MI, USA), soaked with either 5mg dexamethasone or an equal amount (2mL) of saline, were left on the decompressed nerve root after unilateral hemilaminectomy, flavectomy and discectomy.

Results : Subjective visual analog scale(VAS) scores of leg pain in the dexamethasone group on the first, third and fifth postoperative days (2.5, 2.5, 1.7, respectively) were significantly lower than in the control group (5.0, 4.8, 3.6) ($P < 0.05$). No side effects related to the dexamethasone-soaked gelatin sponges were observed.

Conclusion : The intraoperative application of dexamethasone-soaked gelatin sponges during lumbar microdiscectomy can provide effective postoperative analgesia without complications.

KEY WORDS : Dexamethasone · Gelatin sponges · Microdiscectomy · Randomized controlled trial.

Introduction

Corticosteroids, which have strong anti-inflammatory effects, have been administered to patients for many years to relieve sciatica from herniated discs. The common form of administration is oral, or by intravenous, intramuscular or percutaneous injection, such as transforaminal selective epidural, medial branch and caudal nerve blocks. Another common practice is the instillation of corticosteroids into the epidural space just before closure following discectomy. Many patients with microdiscectomy experience leg pain and numbness postoperatively, which leads to delayed hospital discharge and resumption of normal activity for some patients. The rationale of this treatment is to alleviate the postoperative pain and morbidity associated with nerve root inflammation. However, the results shown in the literature are equivocal^{4,7,10,11,13,18,22,27}.

In this prospective, randomized, controlled clinical study,

we assessed the effectiveness of dexamethasone-soaked gelatin sponges to reduce leg pain and numbness following microdiscectomy.

Materials and Methods

Patient selection

Twenty-three patients (10 men and 13 women) undergoing lumbar microdiscectomy at our institution between April 2004 and July 2004 were included. All participating patients had clinical presentations and neurological examinations consistent with an acute-onset single-level (L3/4, L4/5, or L5/S1) unilateral herniated nucleus pulposus without motor weakness, which was refractory to more than six weeks of conservative management. The diagnosis was verified by imaging study, such as computerized tomography and magnetic resonance imaging. Patients with spinal stenosis or previous disc surgery at such

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levels, and patients with any symptoms that persisted longer than six months were excluded. All patients were operated on within six months after the onset of symptoms.

Randomization

Towards the end of each operation, the scrub nurse prepared two types of gelatin sponge, which were soaked with either dexamethasone or saline. The operator, blinded to the presence or absence of dexamethasone in the sponge, selected one at random. The patient, also blinded to the treatment, was later evaluated by a nurse with training in pain management. The scrub nurse recorded the exact type of gelatin sponge inserted for each patient on a study sheet, sealed it, and sent it to the postoperative nurse, who evaluated the patient before unsealing the sheet and recording the actual treatment used.

Operative techniques

For all patients, standard surgical procedures consisting of hemipartial laminectomy and discectomy were performed according to Love's method¹⁵⁾. The operations were all performed in the same medical center, using the same surgical technique by the same neurosurgeon (SDA). All the patients were premedicated one hour before surgery with dormicum and glycopyrrolate. Anesthesia was induced with 2.5mg/kg of propofol and 2µg/kg of fentanyl; 0.1mg/kg of vecuronium was injected intravenously for muscle relaxation. Anesthesia was maintained with sevoflurane and 66% nitrogen oxide in oxygen. Before the surgical incision was made, skin and subcutaneous tissues were infiltrated with 5mL of 1% lidocaine containing 1:200,000 epinephrine to produce local vasoconstriction. A 2.5-cm-long midline skin incision was made. After the incision of the paramedian fascia, the paravertebral muscles were swept over the facet joint using a Taylor retractor. After identification of the level, hemipartial laminectomy, flavectomy, and discectomy were performed. Meticulous hemostasis was performed using a bipolar coagulator instead of inserting a hemovac, because the negative pressure produced by a hemovac can suck out medication as well as hematomas. After hemostasis, the fascia and subcutaneous tissue were closed with absorbable suture materials. The skin was sutured subcuticularly with absorbable sutures to avoid the need for later stitch removal. During the operations, nucleus pulposus protrusion was observed in all patients, confirming the preoperative diagnosis. No analgesics were injected into the paravertebral muscles and subcutaneous tissues.

dexamethasone or the same amount (2mL) of saline at random. Saline or treatment was applied to five pieces of 1 × 1cm gelatin sponges that were then placed on an epidural space. Two pieces were placed on the decompressed nerve root, and single sponges were applied to the shoulder of the upper root, to the ventral dura, and to the dorsal dura.

Postoperative management

All the patients received the same postoperative pain management. Nimesulide (200mg; Choongwae, Seoul, Korea) was used postoperatively for daily analgesia. Postoperative patient-controlled analgesia and analgesic injections were prohibited, to avoid masking any analgesic effects of the steroid.

Postoperative evaluation

Postoperative evaluation was performed by the pain specialist nurse, while all concerned were blinded to which treatment a patient had received. The patients were asked to grade the pain intensity on the first, third, and fifth days after their operation. Assessment of pain was reported using a subjective visual analog scale(VAS) score from 0 to 10 (0=no pain; 10=the worst pain imaginable). Numbness in the leg was reported by the patient on a VAS score ranging from 0 to 4 (0=no numbness, 1=slight numbness, 2=moderate numbness, can be tolerated without medication, 3=severe numbness, cannot be tolerated without medication, 4=severe numbness, cannot be tolerated with medication).

Statistical analysis

Demographic characteristics, duration of surgery and VAS scores of back pain, and leg pain and numbness of the two groups were compared statistically using Student's t tests. The results are reported as mean scores and as the percentages in reduction in mean scores compared with preoperative data; *P*<0.05 was considered statistically significant.

Results

Demography

Twelve patients (six men and six women; mean age 50.2 years) received dexamethasone-soaked gelatin sponges. Eleven patients (four men and seven women; mean age 41.6 years) received control saline-soaked gelatin sponges. The mean duration of surgery was 47.5 minutes for the treated group and

Table 1. Demographics

	<i>n</i>	Men : women	Age (years)	HLD, L3/4	HLD, L4/5	HLD, L5/S1	Operation duration(min)
Dexamethasone group	12	6 : 6	62.2	2	8	2	47.5
Control group	11	4 : 7	41.6	0	7	4	44.2

HLD : herniated lumbar disc

Epidural steroid administration
Immediately after removal of the disc, patients received either 5mg

Table 2. VAS scores of back pain before and after surgery

	Mean preoperative score	Day 1	Day 3	Day 5
Dexamethasone-treated group	8.8	4.9(38%)	4.8(49%)	3.3(67%)
Control group	8.2	4.7(27%)	4.0(34%)	3.3(47%)
<i>P</i>	0.246	0.267	0.340	0.153

Figures in brackets show the percentage reduction from the mean preoperative score

Table 3. Visual analogue scale scores of leg pain

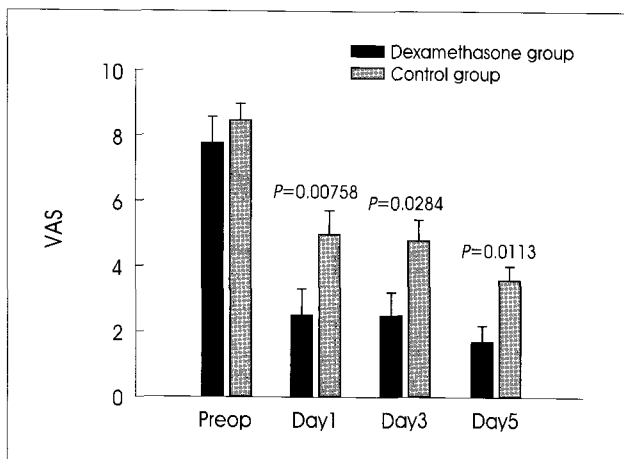
	Mean preoperative score	Day 1	Day 3	Day 5
Dexamethasone-treated group	7.8	2.5(69%)	2.5(71%)	1.7(81%)
Control group	8.5	5.0(40%)	4.8(41%)	3.6(55%)
<i>P</i>	0.275	0.00758	0.0284	0.0113

Figures in brackets show the percentage reduction from the mean preoperative score

Table 4. Leg numbness

	Mean preoperative score	Day 1	Day 3	Day 5
Dexamethasone-treated group	2.3	1.2(48%)	1.2(48%)	1.3(44%)
Control group	1.3	0.7(50%)	0.6(56%)	0.5(63%)
<i>P</i>	0.158	0.186	0.138	0.0778

Figures in brackets show the percentage reduction from the mean preoperative score. Leg numbness was assessed on an arbitrary scale: 0=no numbness; 1=slight numbness; 2=moderate numbness, can be tolerated without medication; 3=severe numbness, cannot be tolerated without medication, 4=severe numbness, cannot be tolerated with medication

**Fig. 1.** Comparison of VAS scores of leg pain between the dexamethasone-treated and control groups.

44.2 minutes for the controls (Table 1). There were no significant differences between groups in terms of age, sex ratio, or the duration of surgery.

Back pain

The mean back pain scores for the dexamethasone-treated group on the first, third and fifth days were 4.9, 4.8, and 3.3, respectively. For the control group, the equivalent scores were 4.7, 4.0, and 3.3. These differences were not statistically significant (Table 2).

Leg pain

The mean leg pain scores for the dexamethasone-treated group on the first, third and fifth days were 2.5, 2.5, and 1.7, respectively. For the controls, the equivalent scores were 5.8, 4.8, and 3.6. The VAS scores for postoperative leg pain were lower than the controls for the dexamethasone-treated group at all points ($P < 0.05$; Table 3, Fig. 1).

Leg numbness

Numbness intensity in the leg was recorded using a tentative 0-4 grading system. The mean numbness scores for the dexamethasone-treated group on the first, third and fifth days were 1.2, 1.2, and 1.3, respectively; for the controls, the equivalent scores were 0.7, 0.6, and 0.5. These differences were not statistically significant (Table 4).

Complications

No side effects possibly relevant to steroid use (such as wound infections, gastritis, or gastrointestinal hemorrhage) were observed.

Discussion

Early observations by Dandy³⁾ and by Mixter and Barr²⁰⁾ suggested that the symptoms and signs caused by herniated lumbar disc material were exclusively caused by mechanical distortion of the nerve root. However, a great deal of evidence supports the hypothesis that the mechanisms of pain in lumbar disc disease are more complicated than simple nerve root compression, and that inflammation is an important mediator of pain in these patients. Kelly⁹⁾ speculated that some unknown chemical factors might contribute to the production of clinical hyperalgesia during chronic lumbar nerve root compression.

Lindahl and Rexed¹⁴⁾ biopsied the posterior lumbar nerve roots during laminectomy for disc herniation and reported that a significant number appeared inflamed. Importantly, Saal et al. reported high levels of phospholipase A2 enzyme activity in the disc material from patients with nucleus pulposus herniations undergoing lumbar discectomy²⁴⁾. This plays a crucial role in inflammation because of its regulation of the arachidonic acid cascade. Thus, the use of steroids has been consistently suggested to reduce the symptoms provoked by lumbar disc herniation. Pain relief by steroids is thought to be accomplished by anti-inflammatory mechanisms, such as the inhibition of phospholipase A2 activity, reduction of C-fiber activity, stabilization of neuronal cell membrane, and reductions in ectopic neuronal discharges. Steroids have been administered via various routes to reduce postoperative pain after lumbar discectomy with variable results.

Many reports describe favorable outcomes after the use of steroids. For example, Chaddock et al.¹⁾ reported a statistically significant reduction in postoperative pain for patients who received a steroid-soaked piece of macerated autologous fat over the nerve root. Autologous fat has well known anti-adhesion properties, but it cannot maintain a depot of steroid for a long time because of its hydrophobic nature. Davis et al.⁴⁾ demonstrated that the intraoperative application of epidural methylprednisolone acetate during a unilateral low-lumbar discectomy led to shorter hospitalization because of less pain and spasm. Epidurally applied steroids without any storage medium may permeate into the wound and disappear quickly. King et al.¹⁰⁾ found that oral dexamethasone given in the postoperative period positively affects the patient's post-surgical course. Mirzai et al.¹⁹⁾ reported that the perioperative use of bupivacaine and corticosteroids during lumbar discectomy maintains effective postoperative analgesia. Oral or intravenous steroid use frequently leads to systemic complications, such as gastric ulcers and Cushing syndrome. Russegger et al.²³⁾ also reported that intrathecal triamcinolone administration is highly effective in relieving post-discectomy pain and may reduce the period of postoperative pain significantly. However, this procedure is thought to damage nerve roots, and intrathecal steroids will be delivered to the whole central nervous system via cerebrospinal fluid circulation, leading to unnecessary systemic complications.

In this study, we decided to use gelatin sponges soaked with dexamethasone for anti-inflammatory effects. The gelatin sponge material used here has various effects. It has inherent hemostatic effects²¹⁾, and its absorbing nature offers storage for dexamethasone, enabling slow release. We found that the epidural application of dexamethasone-soaked gelatin sponges was effective in the relief of leg pain after surgery, without any complications. Although this study focused on immediate effects after the operation, we expect that reducing immediate postoperative pain by this mode of preemptive analgesia will enhance long-term outcomes. Preemptive analgesia is intended to inhibit the sensitizing of the central nervous system with a stimulus by applying analgesia before the pain stimulus starts²⁶⁾. Beyond our expectations the percentage reduction of leg numbness was higher in control group. But the difference was scanty, and statistically insignificant. Also we could not find any previous reports containing the fact that steroids can increase leg numbness. We presume that the result was due to small sample size. Complications of topical steroid use such as salt and water retention^{5,12)} and epidural abscesses are rarely reported^{12,6,12,17,25)}. One potential complication of general and local steroid is an increased risk of infection¹⁾. Steroids are believed to weaken the immune system against infection by inactivating macrophages. Lowell et al.¹⁶⁾ reported that the use of perio-

perative epidural methylprednisolone was associated with infections. However, no such complication was observed in our series. We believe that preoperative antibiotics, proper skin preparation using betadine, intraoperative sufficient saline irrigation, and avoiding the use of systemic steroids can prevent infection.

Finally, it should be noted that our sample size was small, and that the observation period was limited to hospitalization. We therefore plan to increase the sample size and observe patients for a longer period.

Conclusion

The epidural application of dexamethasone-soaked gelatin sponges diminished postoperative leg pain experienced in this series of 23 patients in the immediate postoperative period following microdiscectomy, with no complications.

References

1. Chaddock JB, Sneyd JR, Pobereskin LH : The role of bupivacaine in early postoperative pain control after lumbar decompression. *J Neurosurg (Suppl 1)* 90 : 67-72, 1999
2. Chan ST, Leung S : Spinal epidural abscess following steroid injection for sciatica. Case report. *Spine* 14 : 106-108, 1989
3. Dandy WE : Loose cartilage from intervertebral disk stimulating tumor of the spinal cord. *Arch Surg* 19 : 660-672, 1929
4. Davis R, Emmons SE : Benefits of epidural methylprednisolone in a unilateral lumbar discectomy : a matched controlled study. *J Spinal Disord* 3 : 299-307, 1990
5. Goebert HW Jr, Jallo SJ, Gardner WJ, Wasmuth CE : Painful radiculopathy treated with epidural injections of procaine and hydrocortisone acetate : results in 113 patients. *Anesth Analg* 40 : 130-134, 1961
6. Goucke CR, Graziotti P : Extradural abscess following local anaesthetic and steroid injection for chronic low back pain. *Br J Anaesth* 65 : 427-429, 1990
7. Jones KG, Barnett HC : The use of hydrocortisone in spinal surgery. *South Med J* 48 : 617-623, 1955
8. Katz J, Jackson M, Kavanagh BP, Sandler AN : Acute pain after thoracic surgery predicts long-term post-thoracotomy pain. *Clin J Pain* 12 : 50-55, 1996
9. Kelly M : Is pain due to pressure on nerves? Spinal tumors and the intervertebral disk. *Neurology* 6 : 32-36, 1956
10. King JS : Dexamethasone-a helpful adjunct in management after lumbar discectomy. *Neurosurgery* 14 : 697-700, 1984
11. Knight CL, Burnell JC : Systemic side-effects of extradural steroids. *Anaesthesia* 35 : 593-594, 1980
12. Kim TJ, Kim CH, Chang JH, Bak KH, Kim JM, Oh SJ : Fatal complications following to epidural steroid injections for lumbago and sciatica. A case report. *J Korean Neurosurg Soc* 29 : 420-425, 2000
13. Lavyne MH, Bilsky MH : Epidural steroids, postoperative morbidity, and recovery in patients undergoing microsurgical lumbar discectomy. *J Neurosurg* 77 : 90-95, 1992
14. Lindahl O, Rexed B : Histologic changes in spinal nerve roots of operated cases of sciatica. *Acta Orthop Scand* 20 : 215-225, 1951
15. Love JG, Walsh MN : Protruded intervertebral disks. *JAMA* 111 : 396-400, 1938
16. Lowell TD, Errico TJ, Eskenazi MS : Use of epidural steroids after discectomy may predispose to infection. *Spine* 25 : 516-519, 2000
17. Mamourian AC, Dickman CA, Drayer BP, Sonntag VK : Spinal epidural abscess : three cases following spinal epidural injection demonstrated with magnetic resonance imaging. *Anesthesiology* 78 : 204-207, 1993
18. McNeill TW, Andersson GB, Schell B, Sinkora G, Nelson J, Lavender SA : Epidural administration of methylprednisolone and morphine for

- pain after a spinal operation. A randomized, prospective, comparative study. *J Bone Joint Surg* 77A : 1814-1818, 1995
19. Mirzai H, Tekin I, Alincak H : Perioperative use of corticosteroid and bupivacaine combination in lumbar disc surgery : a randomized controlled trial. *Spine* 27 : 343-346, 2002
 20. Mixer W, Barr J : Rupture of the intervertebral disc with involvement of the spinal canal. *N Engl J Med* 211 : 210-215, 1934
 21. Moak E : Hemostatic agents. Adjuncts to control bleeding. *Today's OR Nurse* 13 : 6-10, 1991
 22. Naylor A, Flowers MW, Bramley JE : The value of dexamethasone in the postoperative treatment of lumbar disc prolapse. *Orthop Clin North Am* : 3-8, 1977
 23. Russeger L, Schroder U, Langmayr JJ, Twerdy K : Intrathecal administration of triamcinolone in treatment of pain after discectomy. *Wien Klin Wochenschr* 109 : 808-811, 1997
 24. Saal JS, Franson RC, Dobrow R, Saal JA, White AH, Goldthwaite N : High levels of inflammatory phospholipase A2 activity in lumbar disc herniations. *Spine* 15 : 674-678, 1990
 25. Shealy CN : Dangers of spinal injections without proper diagnosis. *JAMA* 197 : 1104-1106, 1966
 26. Siddall PJ, Cousins MJ : Spinal pain mechanisms. *Spine* 22 : 98-104, 1997
 27. Watters WC 3rd, Temple AP, Granberry M : The use of dexamethasone in primary lumbar disc surgery. A prospective, randomized, double-blind study. *Spine* 14 : 440-442, 1989

Commentary

In this manuscript, authors have well described the usefulness dexamethasone-soaked gelatine sponges for reducing pain after lumbar microdiscectomy as a prospective, randomized, controlled clinical study involving 23 patients. Here, authors have concluded that intraoperative application of such materials can provide effective postoperative analgesia, mostly leg pain not back pain, without complications. We agree that steroid-soaked sponges applied on epidural space and

around the root, ventral root and dorsal dura is effective in decreasing postoperative leg pain or sciatica as evidenced by many recent reports including our experiences based on the fact that chronic sciatica is not only produced by mechanical compression but also produced by biochemical substances or neurotransmitters generating painful symptoms from neurogenic inflammatory cascades mostly exerting from anterior spinal space and from dorsal root ganglion after herniation or rupture of disc materials. This evidence is quite important in understanding the pathophysiologic mechanisms underlying sciatic pain unlike to other mechanisms involving chronic low back pain. Also, pain reduction with early functional restoration will provide beneficial effect on fast recovery following operation. However, immediate pain following operations can be caused by various factors that make pain evaluations difficult. Thus, effectiveness on pain perception on prolonged period of time as well as cost-effectiveness and influence on long-term management of pain and functional recovery will be dependent on many factors including early post-operative pain reduction evidenced by authors' results. In this respect, it is highly recommended to design and pursue further in-depth research on long term effect of on pain and functional recovery after their applications with larger population based study before justifying its true value and emphasizing clinical impact on its general use based on its usefulness.

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