THE JOURNAL OF BONE & JOINT SURGERY (BI)

Neurolysis is not required for young patients with a spontaneous palsy of the anterior interosseous nerve

RETROSPECTIVE ANALYSIS OF CASES MANAGED NON-OPERATIVELY

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We studied 21 patients with a spontaneous palsy of the anterior interosseous nerve. There were 11 men and 10 women with a mean age at onset of 39 years (17 to 65).

Pain around the elbow or another region (forearm, shoulder, upper arm, systemic arthralgia) was present in 17 patients and typically lasted for two to three weeks. It had settled within six weeks in every case. In ten cases the palsy developed as the pain settled. A complete palsy of flexor pollicis longus and flexor digitorum profundus to the index finger was seen in 13 cases and an isolated palsy of flexor pollicis longus in five. All patients were treated without operation. The mean time to initial muscle contraction was nine months (2 to 18) in palsy of the flexor digitorum profundus to the index finger, and ten months (1 to 24) for a complete palsy of flexor pollicis longus. An improvement in muscle strength to British Medical Research Council grade 4 or better was seen in all 15 patients with a complete palsy of the flexor digitorum profundus and in 16 of 18 with a complete palsy of flexor pollicis longus.

There was no significant correlation between the duration of pain and either the time to initial muscle contraction or final muscle strength. Prolonged pain was not always associated with a poor outcome but the age of the patient when the palsy developed was strongly correlated. Recovery occurred within 12 months in patients under the age of 40 years who achieved a final British Medical Research Council grade of 4 or better. Surgical decompression does not appear to be indicated for young patients with this condition.

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doi:10.1302/0301-620X.88B12.17700 $2.00

J Bone Joint Surg [Br] 2006;88-B:1606-9.
Received 30 January 2006; Accepted after revision 8 August 2006

Spontaneous atraumatic palsy of the anterior interosseous nerve has been described in association with neuralgic amytrophy,[1,2] isolated neuritis,[3] entrapment neuropathy[4,5] and hourglass-like fascicular constriction.[6] The aetiology of the condition, however, remains uncertain. Neurolysis of the nerve has been recommended if conservative treatment has not been successful after 12 weeks.[7-9] Seror[10] concluded that surgery should not be considered for a year, as late spontaneous recovery can occur. There have also been reports that suggest no difference in outcome between surgical and conservative treatment.[11,12] Nagano[6] identified an hourglass-like fascicular constriction of the relevant portion of the median nerve above the elbow: neurolysis yielded good results in such cases. No consensus has been reached about the treatment of this palsy because its aetiology is uncertain. Neither the time to spontaneous recovery, nor the extent to which the nerve will recover if left untreated have been defined. The purpose of this study was to determine the time to spontaneous recovery and the factors which affect it.

Patients and Methods

We studied 21 patients (11 men and 10 women) with a spontaneous palsy of the anterior interosseous nerve who attended the Department of Orthopaedic Surgery of Osaka City University Hospital between May 1988 and October 1999. Their mean age at the time of onset of symptoms was 39 years (17 to 65). The palsy was on the right side in nine patients and on the left in 12. Each patient underwent extensive electromyographic examination of the affected upper limb, sampling the upper fibres of trapezius, infraspinatus, deltoid, biceps, triceps, pronator teres, flexor pollicis longus, pronator quadratus, abductor pollicis brevis, and abductor digiti minimi.

We informed the patients that their palsy was very likely to recover spontaneously and treated them conservatively with vitamin B_{12} and electrical stimulation therapy. Electromyography was performed every three to five weeks for those who presented with a complete palsy. The appearance of voluntary contraction potentials, usually of very low amplitude, was considered a sign of recovery. Electro-

Table I. Details of 21 cases of lesions of the anterior interosseous nerve

Case	Age	Gender	Side	Site of pain*	Duration of pain	Form of palsy†	Time to signs of recovery		Follow-up (mths)	Final muscle strength (Medical Research Council)	
							FDP1 (mths)	FPL (mths)		FDP1	FPL
1	31	F	L	LE~F	4 wks	FPL-C	N/A‡	5	43	N/A	5-
2	27	M	L	None	None	FPL-C	N/A	7	19	N/A	5-
3	41	M	R	None	None	FPL-C, FDP1-C	9	9	85	5	5
4	58	M	L	LE	1 day	FPL-C	N/A	11	78	N/A	5
5	47	M	R	SA	4 wks	FPL-C, FDP1-C	13	13	76	5	5
6	41	F	R	RS~E	3 wks	FPL-C, FDP1-C	8	10	67	5	5
7	65	F	R	BS~F	10 days	FPL-C, FDP1-C	18	22	65	5	5-
8	51	F	R	RE	4 wks	FPL-C, FDP1-C	9	16	63	5	3
9	30	M	L	LE	10 days	FPL-C, FDP1-C	4	4	60	5	5
10	54	F	L	LE	10 days	FPL-C	N/A	24	60	N/A	3
11	24	M	L	LE~F	3 wks	FPL-C, FDP1-C	5	6	25	5	5-
12	17	M	R	None	None	FPL-C, FDP1-C	7	7.5	30	5	5
13	45	F	R	RE~F	6 wks	FPL-C, FDP1-C	2	11	21	5	4
14	40	F	L	LE	2 wks	FPL-I, FDP1-C	8	N/A	23	5-	5
15	39	F	L	LS~U	2 wks	FPL-C, FDP1-C	16	11	41	5-	4
16	41	M	L	LS~U	1 day	FPL-C	N/A	6	20	N/A	5-
17	29	M	R	RE~F	2 wks	FPL-C, FDP1-C	11	1	19	4	5
18	39	M	R	RE	2 wks	FDP1-C	6	N/A	20	5-	N/A
19	48	F	L	LS~F	3 wks	FPL-C, FDP1-C	16	16	31	5-	5-
20	24	F	L	LS~F	2 wks	FPL-C, FDP1-C	4	5	21	5	5
21	32	M	L	None	None	FPL-I, FDP1-I	N/A	N/A	17	5	5

* LE, left elbow; F, forearm; SA, systemic arthralgia; RS, right shoulder; E, elbow; BS, bilateral shoulder; RE, right elbow; LS, left shoulder; U, upper arm

† FPL, flexor pollicis longus; C, complete palsy; FDP1, flexor digitorum profundus to the index; I, incomplete palsy

‡N/A, not available

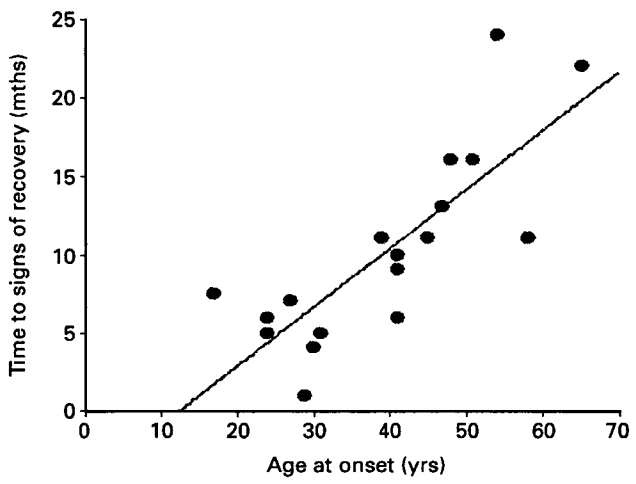

Fig. 1

Correlation between age at onset and time to signs of recovery of flexor pollicis longus.

myography was subsequently carried out at intervals of four to six weeks to monitor the improvement in muscular activity. The mean follow-up was for 42 months (17 to 85). Each patient was assessed for prodromal or associated symptoms, the site and duration of pain, the type of palsy, time to recovery, and the final muscular strength on British Medical Research Council (MRC) grading.[13]

Results

The details of each case are summarised in Table I. A past history of hepatitis B, surgery for hip replacement and nephrosis was noted in three cases. No patient had cold-like symptoms prior to the onset of palsy. A total of 17 patients complained of pain around the elbow or another region (forearm, shoulder, upper arm, systemic arthralgia) before the onset of paralysis. In three, the palsy developed simultaneously with the onset of pain, in four while the pain persisted, and in ten, simultaneously with the remission of pain. Denervation potentials from the pronator quadratus were observed in every case, except in one where they were also noted from the flexor pollicis longus. The other muscles tested also exhibited multiphasic potentials or giant spikes throughout their extent or in some part of the muscle, suggesting that the palsy was spontaneous and diffuse rather than the result of nerve entrapment.

Every patient eventually showed evidence of recovery. The mean time before the initial signs of muscle contraction appeared in the 15 cases of complete palsy of the flexor digitorum profundus (FDP1) to the index finger was nine months (2 to 18), whereas in the 18 cases of complete palsy of the flexor pollicis longus it was ten months (1 to 24). The final grade of FDP1 achieved on MRC grading in the 15 cases of complete palsy was 5 (normal) in ten cases, 5- in four and 4 in one. The final grade achieved by flexor pollicis longus in the 18 cases of complete palsy was also high (5 in eight cases, 5- in six, 4 in two, and 3 in two). The two

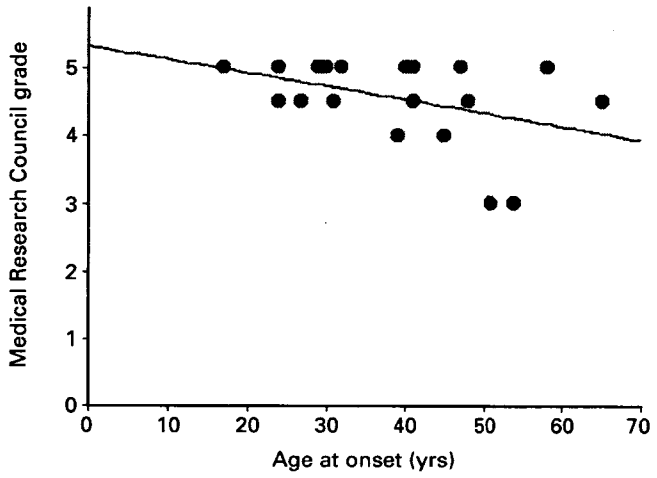

Fig. 2

Correlation between age at onset and final flexor pollicis longus strength.

patients with a final muscle strength of MRC grade 3 were women in their 50s. There was no significant correlation between the duration of pain and either the time to initial contraction of flexor pollicis longus or the final MRC grade. Prolonged pain was not associated with an inferior recovery. All of the patients who developed a palsy before the age of 40 years started to recover within 12 months (Fig. 1). The final muscle strength tended to be lower as the age at onset of the palsy increased, although this relationship was not significant. All of the patients who developed a palsy before the age of 50 recovered muscle strength to MRC grade 4 or better (Fig. 2).

Discussion

A palsy of the anterior interosseous nerve can result from entrapment neuropathy, neuralgic amyotrophy or an isolated neuritis.[1-5] Of these, nerve entrapment is the most common cause.[4] Shantz and Riegels-Nielsen[5] noted evidence of nerve compression in nine of 15 patients. On the other hand, Nagano[14] described 31 patients, ten of whom underwent surgical treatment. He found only one with apparent nerve compression, and concluded that although entrapment neuropathy is one cause of this palsy, its incidence is low. In our study, extensive electromyographic studies revealed diffuse neurogenic changes, including denervation potentials in markedly weakened muscle, and multiphasic potentials in muscles free of notable weakness. Consequently, it seems unlikely that nerve compression was the cause of the palsy. These findings, combined with the high percentage of patients with premonitory pain, suggests that neuralgic amyotrophy was responsible for the palsy in the patients studied.

The treatment of spontaneous palsy of the anterior interosseous nerve is controversial, principally because the condition is rare. Some investigators have recommended conservative treatment for up to one year,[10,15] but others advocate neurolysis if no recovery has taken place within three months.[7-9]

In this study we followed all patients with electromyographs at intervals of three to five weeks. As long as denervation potentials could be recorded[13] we were satisfied that no irreversible muscle fibrosis was taking place, and that conservative treatment could continue. When polyphasic potentials with low amplitude appeared we considered this to be evidence of nerve recovery and told our patients of this to relieve their natural anxiety.

Our findings suggest that a 'wait and see' policy can be adopted for spontaneous palsy of the anterior interosseous nerve even when paralysis is complete.

We found that the time to initial muscle contraction correlated significantly with the age of the patient. Recovery was noted within one year in all patients who developed the condition before the age of 40 years. The correlation between the age at onset and the final muscular strength was not significant. However, when paralysis occurred before the age of 50 years, muscular strength recovered to MRC grade 4 or better in every case.

In 2000, Tsukahara et al[16] found that when 12 hands in 11 patients were treated conservatively, the mean length of time required for recovery of muscular strength to MRC grade 2 or higher was three months for a teenager, 20 months for three patients over 30 years, 19.5 months for four patients over 40 years, 13 months for two patients over 50 years, and 25 months for two patients over 60 years. Seror[10] described 14 cases of palsy of the anterior interosseous nerve and noted that a 63-year-old man failed to recover in 21 months. Yamamoto et al[17] and Yamamoto, Tajiri and Yamamoto[18] noted two patients, a 69-year-old woman and a 73-year-old man, in whom recovery was not achieved with conservative therapy. We recommend non-operative treatment for patients under 40 years of age.

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.

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Lumbar juxta-facet cyst after trauma

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Received 10 May 2005; accepted 23 September 2005

Abstract

We report a post-traumatic lumbar facet cyst in which results of magnetic resonance imaging (MRI) performed at the time of injury were available. The patient was a 59-year-old man who presented with severe low back and right leg pain immediately after injury of his sacroiliac region in a traffic accident. MRI at the time of injury revealed high intensity signal change in the right facet joint at L4/5. Re-examination 5 months after the injury with MRI revealed a cyst, which was continuous with the facet joint. Surgical resection of the cyst yielded satisfactory results.

We describe detailed MRI findings for this case and review the literature on traumatic juxta-facet cyst in the lumbar spine.

Keywords: Juxta-facet cyst; Synovial cyst; Lumbar spine; Trauma

1. Introduction

Lumbar juxta-facet cyst is one of the causes of radiculopathy. There have been many reports published on this clinical entity in the literature.[1–8] Although the cause of juxta-facet cyst has not been elucidated, some reports have postulated a chronic degenerative process such as spondylolisthesis.[2,7] However, in the literature there have been few reports of trauma preceding cyst formation. In reported cases of trauma preceding cyst formation, findings of imaging at the time of injury and before cyst formation were not available.[4–8] We encountered a lumbar juxta-facet cyst associated with leg pain and numbness in a 59-year-old man. The patient had trauma prior to development of the leg pain. At the time of injury, MRI revealed no cystic lesion but did show high intensity signal change on T2-weighted MRI in the right facet joint. Several months later, MRI revealed cyst formation. This is the first reported case of juxta-facet joint cyst in the lumbar spine for which findings of MRI were available at the time of injury before cyst formation. The purpose of this paper is to report this case and review the literature on this clinical entity.

2. Case report

A 59-year-old man riding a bicycle struck a stopped car and fell from his bicycle landing on his sacroiliac region. He visited our clinic with a chief complaint of leg and low back pain on the same day. Routine MRI was performed. T2-weighted axial images revealed canal stenosis at L4–5 and high intensity change indicating effusion in the right L4/5 facet joint (Fig. 1A). Sagittal T2-weighted MRI revealed no cysts in the spinal canal (Fig. 1B). Epidural injection and root block injection for the right L5 nerve root alleviated his symptoms. Myelography and computed tomographic myelography performed 7 weeks after the accident revealed no mass formation in the spinal canal (Fig. 2). He was able to return to his daily life activities, although his low back pain persisted.

Five months after the accident, our patient's symptoms rapidly worsened. The straight-leg raising test was restricted to 30° in his right leg. Muscle weakness was observed on extension of his right foot, and sensory disturbance was also observed in the dorsal area of his right foot. These neurological findings were not observed on his initial visit. Re-examination with MRI revealed cyst formation in the spinal canal with effusion in the right L4–5 facet joint (Fig. 3A). T2-weighted sagittal image demonstrated a cyst having high intensity signal content and causing significant spinal canal stenosis (Fig. 3B). Due to these neurological findings, surgical treatment was performed. The cyst existed between the superficial layer and deep layer of the ligamentum flavum and was adherent to the deep layer of the ligamentum flavum. The L5 nerve root was severely compressed by the cyst, which communicated with the right facet joint at L4/5.

With careful observation using an operating microscope, the cyst was completely removed. It contained serous material. Histological examination revealed no synovial lining within the cyst. The patient's symptoms disappeared immediately after surgery, and he had no signs of recurrence at follow-up 1 year after surgery.

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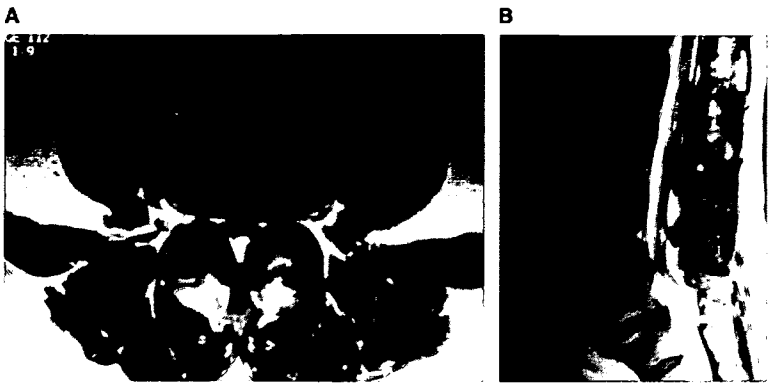

Fig. 1. (A) Axial scan of T2-weighted image on MRI at the time of injury reveals high signal intensity effusion in the right L4/5 facet joint. (B) T2-weighted sagittal scan reveals no cysts in the spinal canal.

Fig. 2. Computed tomographic myelogram 7 weeks after trauma reveals arthritic change of the right L4–5facet, but no mass in the spinal canal.

Table 1
Review of the literature reporting juxta facet cysts with a history of preceding trauma

Authors	Sex/age	Type of trauma	Interval (trauma to cyst detected)
Sypert G et al[5]	Male, 58	Fall	16 years
Bhushan C et al[4]	Female, 58	Automobile accident	3 months
Frank J et al[6]	Female, 62	Fall	7 months
Awwad E et al[8]	Male, 39	Leg injury	19 months
Prescod K et al[7]	Male, 63	Fall	4 months

3. Discussion

The mechanism of juxta-facet cyst formation remains controversial. Trauma is reported to be one cause of this type of cyst.[2–8] Our review of the literature disclosed five reports of this type of cyst having a history of preceding trauma and demonstrating the interval between trauma and cyst detection. (Table 1) However, the imaging characteristics at the time of injury were not available in these cases. The present case is thus the first in which MRI findings were available at the time of injury. The lack of evidence of the cyst on computed tomographic myelography 7 weeks after trauma also indicated that the cyst did not develop immediately after trauma, but gradually increased its size. The cyst took around 5 months to become large enough to cause the symptoms.

In our case, T2-weighted MRI findings at the time of injury were limited to high intensity signal change in the right L4/5 facet joint that appear to be an effusion. This change might have been due to rotation of the facet joint incurred at the time of the traffic accident. Frank et al. reported that an initial fall caused partial distraction of the facet joint, inducing gradual storage of synovial fluid.[6] The findings

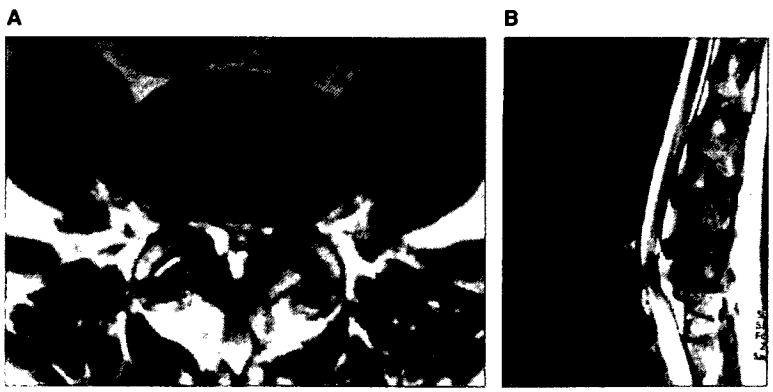

Fig. 3. MRI 5 months after trauma. (A) T2-weighted axial scan at L4–5 demonstrates cyst formation with high-intensity content adjacent to the right facet joint. (B) T2-weighted sagittal scan demonstrates a cyst causing significant spinal canal stenosis.

described above suggest that fluid accumulation of the facet joint could be the first step in cyst formation.

In the present case, due to the apparent neurological deficits, surgical treatment was performed. Under an operating microscope, resection of the cyst could be safely performed.

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doi:10.1016/j.jocn.2005.09.013

Eur Spine J (2006) 15: 577–582
DOI 10.1007/s00586-005-0912-8

ORIGINAL ARTICLE

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Objective assessment of reduced invasiveness in MED

Compared with conventional one-level laminotomy

Received: 1 May 2004
Revised: 1 December 2005
Accepted: 24 February 2005
Published online: 31 May 2005

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Abstract Microendoscopic discectomy (MED) has been accepted as a minimally invasive procedure for lumbar discectomy because of the small skin incision and short hospital stay required for this surgery. However, there are few objective laboratory data to confirm the reduced systemic responses in the early phase after this procedure. In order to substantiate the reduced invasiveness of MED compared to microdiscectomy (MD) or procedures involved in one-level unilateral laminotomy, the invasiveness of each surgical procedure was evaluated by measuring serum levels of biochemical parameters reflective of a post-operative inflammatory reaction and damage to the paravertebral muscles. Thirty-three patients who underwent lumbar discectomy or one-level unilateral laminotomy (MED in 15 cases, MD in 11 cases and one-level unilateral laminotomy in 7 cases with lumbar spinal canal stenosis) were included in this study. The serum levels of C-reactive protein (CRP) and creatine phosphokinase (CPK) were measured at 24 h after operation. Interleukin-6 (IL-6) and Interleukin-10 (IL-10) were measured at 2, 4, 8 and −24 h following the surgery to monitor the inflammatory response to the respective surgery. The post-operative serum CRP levels from both the MD and MED groups were significantly lower than those from the open laminotomy group. However, there was no significant difference in these serum levels between the MED and MD groups. The levels of IL-6 and IL-10 in the MED group during0 the first post-operative day were also significantly lower than those in the laminotomy group. When the MED and MD groups were compared, the IL-6 levels in the MED group were lower than in MD group at 2, 4 and 8 h after surgery, but the differences were not statistically significant. However, the level was significantly lower in the MED group at 24 h after surgery. In terms of IL-10, no significant difference was noted between the MED and MD groups over the study period. The changes in serum levels of post-operative inflammatory: markers (CRP, IL-6 and IL-10) in the early phase indicated reduced inflammatory reactions in MED as well as in MD when compared with classical open unilateral laminotomy. These data draw a direct link between the lower level of the inflammatory response and reduced invasiveness of MED. However, an indicator for muscle damage (CPK) appeared not to be affected by the type of surgical procedure used to correct disc herniation.

Keywords Microendoscopic discectomy · Microdiscectomy · Lumbar disc herniation · Minimally invasive surgery

Introduction

Lumbar disc herniation is a common spinal disorder and surgical treatment is often indicated in patients who experience severe prolonged pain or significant neurological deficits. Discectomy through a posterior approach is widely performed and is associated with significant surgical insults. This procedure requires a median longitudinal skin incision, detachment of the paravertebral muscles from the spine and partial laminectomy. Advances in microdiscectomy [5] procedures have led to improved methods which are now widely used for the surgical treatment of lumbar disc herniation [1, 6, 20]. The MED system was introduced by Foley in 1997 [11] and has been used for resection of prolapsed and laterally herniated discs. Although this surgical approach requires considerable expertise, the techniques and the tools have been improved and refined to standardize the procedure [4, 8, 9, 10, 12, 14, 17]. Consequently, MED is now the procedure of choice in the field of spinal surgery—the skin incision can be minimized, and extensive detachment of the paravertebral muscle from the spine and laminotomy is not required. The absence of these surgical insults leads to attenuated postoperative inflammatory reactions, including pain and a shortened hospital stay. The reduction in the inflammatory response probably reflects the less invasive nature of this surgical procedure. To test this hypothesis, we measured inflammatory markers in the serum of patients who had been treated surgically for herniated discs using MED, microscopic discectomy (MD) or open unilateral laminotomy. Early recovery from endoscopic surgery has been attributed to reduced local production of pro-inflammatory cytokines such as Interleukin-1 (IL-1), Interleukin-6 (IL-6) or tumor necrosis factor-alpha (TNF-α) [2, 7, 15, 18]. In the present study, we collected laboratory data from patients who were treated surgically with MED for disc herniation. Data from MED patients were compared with similar parameters obtained from herniated disc patients who received open single-level unilateral laminotomy, or another less invasive procedure, microscopic discectomy.

Serum levels of C-reactive protein (CRP), which is produced in the liver and is released into the circulation in response to IL-1 produced at an inflammatory locus, were measured in all patients at 24 h after surgery. In addition, the amplitude of changes in serum levels of the pro-inflammatory cytokine IL-6 and anti-inflammatory cytokine IL-10 were assayed sequentially at 2, 4, 8 and 24 h post-operatively in patients who underwent MED. Measurements from MED patients were compared with data from patients treated with MD or single-level unilateral laminotomy.

In posterior lumbar spinal surgery, the degree of damage to the paravertebral muscles is a possible marker for surgical invasiveness. Therefore, the post-operative undulation in serum levels of CPK released from damaged muscles was adopted as a potential marker to evaluate the surgical invasiveness of MED, MD or open unilateral laminotomy in this study.

Patients

Thirty-three patients (19 men and 14 women) with a mean age of 42.4 years (range 20–72 years) were included in this study. Of these cases, 15 underwent MED and 11 underwent MD. The remaining seven cases had LSCS and received single-level unilateral laminotomy for radicular decompression. These patients were used as surrogates for classical open discectomy associated with partial laminectomy for the purpose of this study.

For this prospective study, MED or MD were randomly assigned to patients requiring surgical treatment for lumbar disc herniation. Gender, age and affected levels in each group are summarized in Table 1. None of these patients received any peri-operative anti-inflammatory or corticosteroid medication.

Methods

Operation time and blood loss were collected from clinical records. Clinical outcomes were assessed according to a scoring system proposed by the Japanese Orthopaedic Association (JOA score) (Table 2). The incidence of persistent low back pain or lumbar discomfort in the MED and MD groups was assessed 1 year after the operation. CRP and CPK levels were measured in blood collected at 24 h after surgery.

In order to measure cytokine levels, 2 ml of arterial blood was aspirated from the radial artery at 2, 4, 8 and 24 h after the operation through a catheter placed for monitoring blood pressure and respiratory function prior to surgery.

Table 1 Patients' data in this study

Group	MED	Microdiscectomy	Open laminotomy
Number of cases	15	11	7
Gender			
Male	6	8	5
Female	9	3	2
Age (Mean)	36.5	37.7	59.6
Age (Range)	25–60	20–58	49–72
Affected levels			
L3/4		1	
L4/5	8	7	6
L5/S	7	3	1

Table 2 Scoring system of the japanese orthopaedic association for low back pain (JOA score)

1. Subjective symptoms (9 points)			
A. Low back pain			
None (3)	Occasional mild pain (2)	Frequent mild or occational severe pain (1)	Frequent or continuous severe pain (0)
B. Leg pain and/or tingling			
None (3)	Occasional slight symptom (2)	Frequent slight or occational severe symptom (1)	Frequent or continuous severe symptom (0)
C. Gait			
Normal (3)			
Able to walk farther than 500 M although it results in pain, tingling, and/or muscle weakness (2)			
Unable to walk farther than 500 M owing to leg pain, tingling, and/or muscle weakness (1)			
Unable to walk farther than 100 M owing to leg pain, tingling, and/or muscle weakness (0)			
2. Clinical signs (6 points)			
A. Straight leg-raising tests (SLR) (including tight hamstrings)			
Normal (2)	30–70° (1)	Less than 30° (0)	
B. Sensory disturbance			
None (2)	Slight disturbance (not subjective) (1)	Marked disturbance (0)	
C. Motor disturbance (MMT)			
Normal (2)	Slight weakness (grade 4) (1)	Marked weakness (Grade 3-0) (0)	
3. Restriction of ADL (14 points)			
Turn over while lying			
Standing			
Washing	No restriction (2)		
Leaning forwards	Moderate restriction (1)		
Sitting (about 1 h)	Severe restriction (0)		
Lifting or holding heavy objects			
Walking			
4. Urinary Bladder Function (−6 points)			
Normal (0)	Mild dysuria (−3)	Severe dysuria (−6)	

Recovey rate: (B−A/29−A)×100 (%)
A JOA score at pre-op
B JOA score at the final follow-up

The blood samples were centrifuged to separate serum for the assay of IL-6 and IL-10 using assay kits (BIOTRAK High Sensitivity ELISA system®) with the minimum limit of detection for the assay at 0.1 pg/ml.

Statistical differences between parameters recorded for each group were tested using one-way analysis of variance (ANOVA) and *post hoc* testing was accomplished using the Bonferroni method. *P* values less than 0.05 were considered to be significant.

Results

Surgical procedures and clinical outcome

The mean operation times for the MED, MD and laminotomy groups were 119 min (77–207 min), 123 min (59–270 min) and 109 min (60–212 min), respectively. The mean blood loss in the same groups was 26.6 g (10–180 g), 55 g (10–50 g) and 120 g (50–180 g), respectively. The blood loss values in the MED and MD groups were not significantly different, but they were significantly less than that in the laminotomy group.

The percentage improvement of the JOA score at final follow-up was 88.6% in the microdiscectomy group and 84.7% in the MED group. This difference was not statistically significant. Residual low back pain or lumbar discomfort was experienced by 66.7% of the MD group and by 36.7% of the MED group. This difference was significant. CRP values at 24 h after surgery in the MED, MD and laminotomy groups were 0.91 ± 0.18 mg/dl, 1.76 ± 0.36 mg/dl and 5.44 ± 0.94 mg/dl, respectively. Although no significant difference was noted between CRP values in the MED and in the MD groups, the CRP level in the laminotomy group was significantly higher than in the other two groups (Fig. 1).

Serum CPK levels at 24 h after surgery tended to be higher in the MED group than in the other groups, but these differences were not statistically significant (Fig. 2).

Figure 3 shows sequential changes of serum IL-6 level over the 24 h period after the operation. In the laminotomy group, the level was consistently higher over the 24 h period than in the MED or MD groups. Serum IL-6 levels in the MED and MD groups up to 8 h were not significantly different (6.06 ± 1.06 pg/ml and

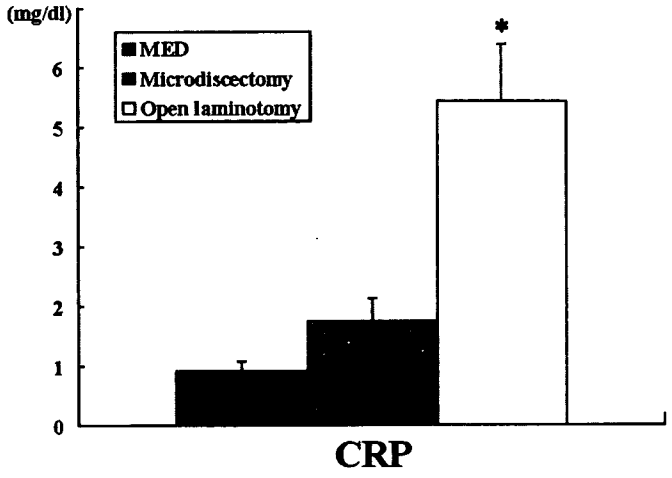

Fig. 1 CRP values 1 day post-operatively. The mean CRP level in the MED group was 0.91 ± 0.18 mg/dl, 1.76 ± 0.36 mg/dl in the MD group, and 5.44 ± 0.94 mg/dl the open laminotomy group. The MED and MD groups showed statistically lower values compared with the open laminotomy group. No significant differences were observed between the MED and MD groups. *Significantly different from MED group ($P < 0.05$)

10.02 ± 2.43 pg /ml, respectively). However, at 24 h, the IL-6 level in the MD group (19.34 ± 5.75 pg/ml) was significantly higher than in the MED group (4.96 ± 0.54 pg/ml).

Serum levels of IL-10 over 24 h were also significantly higher in the laminectomy group than in the MED or MD groups. In the MED and MD groups, IL-10 levels remained low with no significant difference observed between these two groups (Fig. 4).

The clinical parameters in each group have been summarized in Table 3.

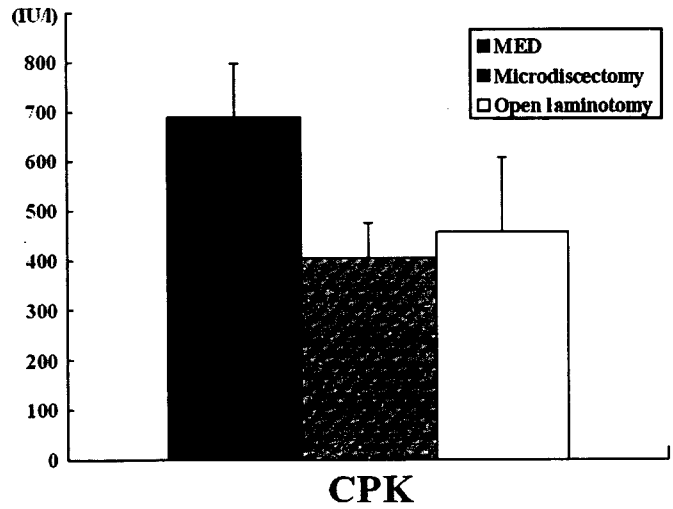

Fig. 2 CPK values 1 day postoperatively. CPK in the MED group was 689 IU/l on average. Values for the MD and open laminotomy groups were 406 IU/l, 458 IU/l. There were no significant differences between these three groups

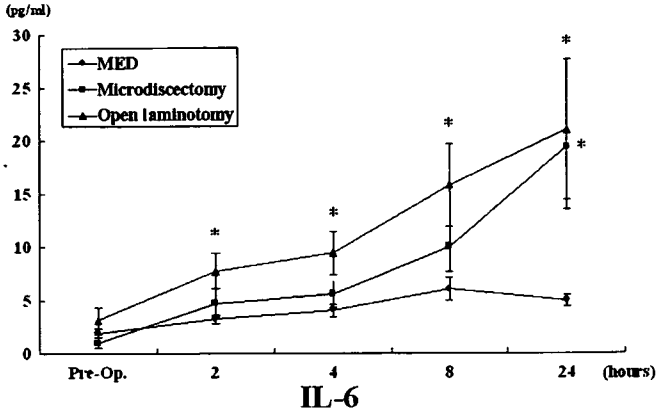

Fig. 3 The change in IL-6 values post-operatively. The values for the open laminotomy group were consistently higher and statistically different from those in the MED group. At 24 h after the operation, the IL-6 level following microdiscectomy was statistically higher than that following MED. *Significantly different from MED group ($P < 0.05$)

Discussion

The results from this clinical study indicated significantly lower levels of the inflammatory markers, CRP [3, 13, 21], IL-6 and IL-10 in the MED and MD groups than in the group treated with open unilateral laminotomy. These data confirm that the MED and MD procedures cause less tissue damage during surgery. Ideally, the appropriate control group for this study should have been patients who received the classical open discectomy associated with partial laminectomy. However, it was not possible to do this because we stopped using this procedure prior to the start of the present study. As an alternative, patients

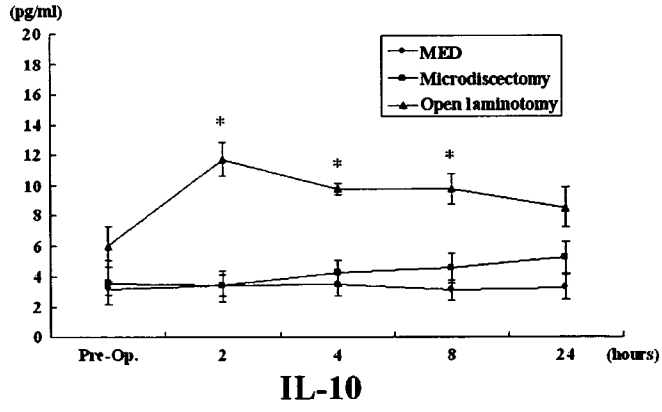

Fig. 4 The changes in IL-10 levels post-operatively. At each time point, the open laminotomy group showed statistically higher IL-6 values than both the MED and MD groups. Between the MED and MD groups, however, there was no difference detected. *Significantly different from MED group ($P < 0.05$)

Table 3 Mean values of clinical parameters

Group	MED (mean ± SE)	Microdiscectomy (mean ± SE)	Open laminotomy (mean ± SE)
Operation time (min)	129 ± 11.8	123 ± 17.0	109 ± 21.5
Blood loss (g)	26.7 ± 11.3	55.0 ± 12.8	120 ± 24.3*
WBC	7600 ± 390	8200 ± 450	7100 ± 460
CRP (mg/dl)	0.91 ± 0.18	1.76 ± 0.36	5.44 ± 0.94*
CPK (IU/l)	689 ± 108	406 ± 71	458 ± 149
IL-6 pre-operation (pg/ml)	1.93 ± 0.40	1.01 ± 0.47	3.09 ± 1.25
IL-6 2 h (pg/ml)	3.23 ± 0.44	4.76 ± 1.36	7.77 ± 1.65*
IL-6 4 h (pg/ml)	4.07 ± 0.59	5.59 ± 1.32	9.41 ± 2.03*
IL-6 8 h (pg/ml)	6.06 ± 1.06	10.02 ± 2.43	15.8 ± 3.91*
IL-6 24 h (pg/ml)	4.96 ± 0.54	19.34 ± 5.75*	21.0 ± 6.58*
IL-10 pre-operation (pg/ml)	3.19 ± 0.44	3.57 ± 1.45	5.95 ± 1.31
IL-10 2 h (pg/ml)	3.37 ± 0.67	3.38 ± 1.01	11.71 ± 1.11*
IL-10 4 h (pg/ml)	3.46 ± 0.78	4.19 ± 0.86	9.74 ± 0.36*
IL-10 8 h (pg/ml)	3.06 ± 0.64	4.51 ± 1.00	9.70 ± 0.99*
IL-10 24 h (pg/ml)	3.28 ± 0.79	5.18 ± 1.06	8.47 ± 1.33

*$P < 0.05$ versus MED group

with lumbar spinal canal stenosis requiring unilateral laminotomy without discectomy were enrolled. Therefore, surgical invasiveness in the control group may have differed from patients treated by discectomy with partial laminectomy. We believe that the degree of invasiveness in the control group was similar to the level seen in classical discectomy with partial laminectomy.

The elevation of CRP level in serum has been widely recognized in the post-operative phase, typically peaks between 24 h to 72 h, and is an indicator for the intensity of post-operative inflammatory reactions. Therefore, the low levels of CRP, in the MED and MD groups at 24 h after surgery, are evidences of the lower surgical invasiveness of these surgical procedures when compared with the open laminotomy group. These data are further supported by the lower levels of inflammatory cytokines, IL-6 and IL-10 found in the MED and MD groups when compared with the open laminotomy group.

The IL-6 level at 24 h after surgery in the MD group was significantly higher than in the MED group. Although the reason for this was uncertain, it could mean that MED was less invasive than MD.

IL-10 is an anti-inflammatory agent which has been shown to regulate pro-inflammatory cytokines, including IL-6, at the transcriptional level [19]. The IL-10 level was also elevated in the early post-operative phase, probably as a result of the intense inflammatory reaction. The lower level of IL-10 in the MED and MD groups might also indicate a low level of inflammatory response in these patients.

Another problem encountered with posterior lumbar surgery has been the damage to soft tissues, especially the paravertebral muscles, which often causes persistent post-operative low back pain. In order to quantitate muscular damage, serum levels of CPK of muscle origin (CPK-MM) were measured [16]. Unexpectedly, the mean CPK level in the MED group was higher than in the other two groups, although this difference was not significant. This would indicate that damage to the paravertebral muscles was not minimized by the MED or MD techniques. The MED group showed a lower incidence of persistent post-operative low back pain than the MD group. Therefore, transient elevation of CPK in MED did not influence persistent low back pain.

In conclusion, the less invasive nature of the MED and MD procedures was substantiated by inflammatory markers in serum in the early post-operative phase. Although the post-operative inflammatory reactions were attenuated, the level of a marker for damage to the paravertebral muscles (CPK-MM) was not affected. This did not directly relate to persistent low back pain. However, there may be further opportunities to minimize muscle damage during MED.

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J Neurosurg Spine 5:461–467, 2006

Endoscopic vertebroplasty for the treatment of chronic vertebral compression fracture

Technical note

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✓The authors describe a new vertebroplasty technique for the treatment of chronic painful vertebral compression fractures (VCFs).

A urinary balloon catheter is introduced into the vertebral body (VB) via a bilateral transpedicular approach and inflated with contrast medium to obtain sufficient space for endoscopic observation. The granulation tissue occupying the VB is then removed using a punch or curette inserted through one pedicle, with the guidance of an endoscope introduced through the contralateral pedicle. After endoscopic resection of granulation tissue in the fractured VB, vertebroplasty is performed by injecting calcium phosphate cement (CPC) into the VB.

Fourteen patients in whom chronic painful VCFs were diagnosed underwent surgery involving the aforementioned technique. In all cases, intractable pain and ambulatory function improved after surgery, and there were no significant systemic complications. On radiological evaluation in eight cases in which the follow-up period exceeded 1 year, the mean height of the fractured VB improved from 38% of that of adjacent intact VBs to 85%. Although a slight loss of correction was routinely observed at 1 month postoperatively, an additional loss of VB height was not noted up to 1 year later. Bone formation was commonly seen along the anterior wall of the involved vertebrae in all cases.

Vertebroplasty involving the endoscopic removal of granulation tissue proved to be an efficacious procedure for the treatment of chronic painful VCFs. The osteoconductive capacity of CPC facilitated callus formation and ultimately restoration of vertebral bone structure.

KEY WORDS • **vertebral compression fracture** • **pseudarthrosis** • **vertebroplasty** • **endoscopy**

FRACTURE associated with osteoporosis is one of the most prevalent disorders in the elderly female population.[6] Because the number of people worldwide who are at risk of osteoporotic fracture is increasing, efficacious modalities for prevention and treatment of osteoporosis-associated fractures will be required to maintain the health of the aging population.[9] In the elderly, vertebral fractures occur most commonly with significant morbidity.

Vertebral fractures usually heal spontaneously within a few months, although this process is frequently associated with kyphotic deformity of the spine or loss of vertebral height. The pain experienced at the onset of fracture usually subsides as bone union progresses, but kyphotic deformities or losses in vertebral height are not corrected. Certain patients experience intractable back pain for prolonged periods, in the presence or absence of lower-extremity neurological deficits. In those cases, insufficient union or pseudarthrosis without consolidation of the vertebral fracture is often noted on radiography and/or MR imaging.[18,32] The incidence of pseudarthrosis following osteoporotic vertebral fracture is still not clearly known, but reports of such cases have increased recently.[4,20,36,39,42] Such patients have undergone various surgical procedures to promote spinal stability, relief from back pain, and resolution of concomitant neurological dysfunction.

In corrective surgery, resection of the fractured VB by placing bridging autograft material or replacing the structure with implants via an anterior approach has been used. Alternatively, a closed wedge osteotomy via a posterior approach has also been performed.[13,26,35,40] Given the age and overall compromised health of elderly patients, however, a less invasive and risky surgery would be desirable. To this end, transpedicular vertebroplasty has been reported to yield successful clinical results in patients with osteoporotic vertebral fractures.[1,12,22,33] In such cases,

Abbreviations used in this paper: CPC = calcium phosphate cement; HA = hydroxyapatite; MR = magnetic resonance; PMMA = polymethylmethacrylate; VAS = visual analog scale; VB = vertebral body; VCF = vertebral compression fracture.

PMMA has usually been utilized as a filling material for this procedure. The use of PMMA, however, has been associated with tissue damage due to the heat generated by intracorporal polymerization and with the toxic effects due to exposure to the monomer before polymerization.[2,3,8,45,46] To avoid these risks, CPC, a new biocompatible bone cement, has been widely used in place of PMMA for various purposes including vertebroplasty, particularly in Japan. Calcium phosphate cement has been used despite its inferior mechanical strength compared with PMMA, especially when mixed with blood.[28,29,38]

To restore vertebral height and stability, it is essential that the defect in the fractured VB be filled with sufficient CPC to permit contact between the residual bone tissue and this material. To achieve this level of contact, it is important that all the granulation tissue in the VB be removed. We used a posterior transpedicular approach, endoscopic guidance, and a balloon catheter to ensure the safe and thorough removal of this tissue.

In this report, we introduce our new surgical technique and review the preliminary results of the procedures.

Clinical Material and Methods

Patient Population

Fourteen consecutive patients (11 women and three men) with 15 VCFs underwent transpedicular vertebroplasty between April 2003 and January 2005. The patients ranged in age from 65 to 87 years (mean 73.0 years) at the time of surgery. All patients presented with intractable back pain due to pseudarthrosis following osteoporotic VCF, which was diagnosed by dynamic radiography and MR imaging. The pain was especially pronounced when the individual changed position such as while rotating or attempting to stand after sitting. The fractures were at T-9 in one patient, T-12 in eight, L-1 in one, L-2 in three, L-4 in one, and L-5 in one. The preoperative duration of symptoms ranged from 3 to 13 months (mean 7.6 months). Primary osteoporosis had been diagnosed in all patients; to this end, we determined bone mineral density measurements in the lumbar spine or femoral neck and excluded other metabolic bone diseases or malignancies such as myeloma or metastatic cancer. The patients with vertebral fractures associated with lower-extremity neurological deficits caused by spinal cord or cauda equina compression were also excluded because extensive decompression and instrumentation-based fixation were necessary in addition to the vertebroplasty.

Study Parameters

We evaluated operation time, estimated blood loss, procedure-related complications, improvement of ambulatory function, and pain relief by using a pre- and postoperative VAS.

Patients for whom the follow-up duration exceeded 1 year were included in the radiographic evaluation. There were six patients for whom the follow-up period was less than 1 year. Eight patients were included in the radiographic evaluation. The percentage of VB height (percentage of VB height compared with adjacent normal VBs) was evaluated on lateral plain x-ray films preoperatively, intraoperatively, immediately after the operation, and 1 week, 1 month, 3 months, 6 months, and 1 year postoperatively.

Surgical Technique

The patient is placed on a four-poster frame in a prone position after induction of hypotensive general anesthesia. After marking the skin landmarks just above both pedicles of the fractured vertebra under vertical fluoroscopic control, two small longitudinal skin incisions about 2-cm long are made on both sides over the pedicle, and the bilateral paravertebral muscles are separated with dilators to reach the pedicles. Two plastic tubes are fabricated; 10-ml syringe tubes are cut and placed along the outside of the dilators to use as retractors. Both pedicles are tapped using a pedicle probe under image-intensified control anteroposterior and lateral monitoring (Fig. 1A).

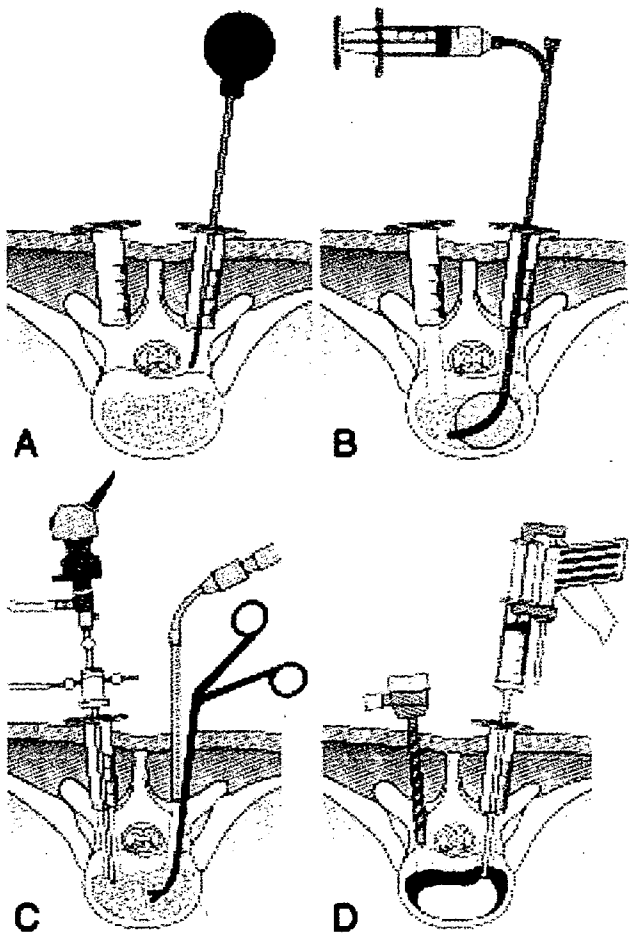

FIG. 1. Illustrations highlighting the procedural steps. A: Two syringe tubes are cut and placed in the small incisions and used as retractors. Both pedicles are probed with a pedicle probe under an image intensifier. B: A urinary balloon catheter is inserted into the VB via a pedicle and inflated with contrast medium. C: An arthroscope is inserted into the VB through one pedicle, fibrous tissue in the VB is resected with a rongeur and a curette is inserted through the other pedicle. D: The CPC is then injected into the fractured VB.

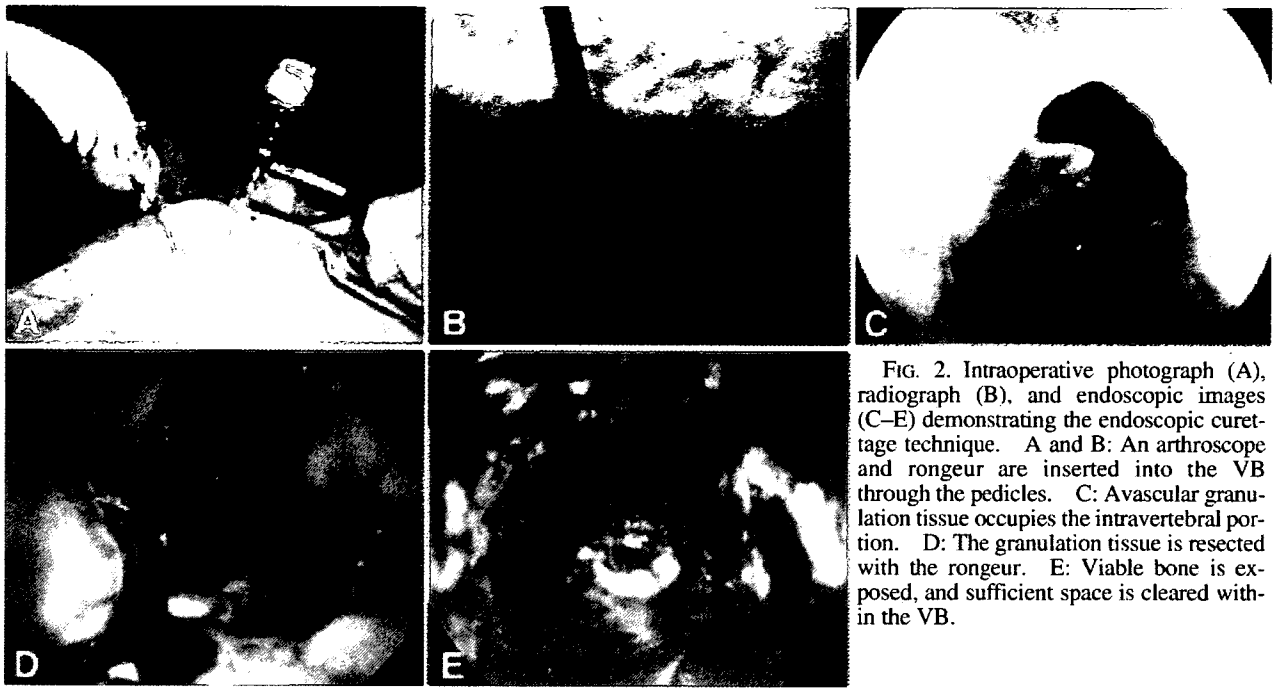

FIG. 2. Intraoperative photograph (A), radiograph (B), and endoscopic images (C–E) demonstrating the endoscopic curettage technique. A and B: An arthroscope and rongeur are inserted into the VB through the pedicles. C: Avascular granulation tissue occupies the intravertebral portion. D: The granulation tissue is resected with the rongeur. E: Viable bone is exposed, and sufficient space is cleared within the VB.

To confirm the continuity of the pedicle holes through the fractured VB, saline is injected into the VB from one pedicle hole and the flow out of the other pedicle hole is checked. A No. 8 French urinary balloon catheter is then inserted into the VB via a pedicle and inflated with iotrolan contrast medium (Isovist 240; Nihon Schering K.K., Osaka, Japan) (Fig. 1B). The shape of the inflated balloon or the space produced by the inflated balloon within the VB is visualized by fluoroscopy. As a result of inflating this balloon, the granulation tissues within the fractured vertebra are squeezed onto the vertebral sidewall or endplates to provide space for endoscopic observation.

A 30- or 70°-angled arthroscope is then inserted into the VB through one pedicle. The fibrous tissue on the vertebral wall is resected under endoscopic observation with a rongeur, and a curette is inserted through the other pedicle (Figs. 1C and 2) until viable cortex or cancellous bone can be seen.

Contrast medium is injected into the VB and the image intensifier is used to check for leakage into the surrounding veins and extravertebral space. Following these steps, the CPC paste is injected into the intravertebral space (Fig. 1D). The paste is made by mixing the CPC powder with liquid at a ratio of 4:1. The photographs in Fig. 3 show the devices used for these procedures.

Profile of the CPC

The CPC (Biopex-R; Mitsubishi Material Corp., Tokyo, Japan) was launched as a commercial product in 1993. The CPC kit is composed of dry powder and mixing liquid. The powder contains 75% tricalcium phosphate, 18% tetracalcium phosphate, 5% dicalcium phosphate, and 2% HA, whereas the liquid is a solution of 5% sodium chondroitin sulfate, 12% sodium succinate, and 83% water. The cement starts to harden within 10 to 15 minutes after mixing the powder and liquid, and it achieves a maximal mechanical strength in approximately 72 hours. The solid CPC transforms into HA, with a maximum compressive strength of 82 MPa, which exceeds that of cancellous bone (strength range 1.9–7.0 MPa).

Statistical Analysis

The percentage of vertebral height was expressed as the mean ± standard deviation and was compared using the Kruskal–Wallis test. Differences between times of examination were evaluated with the post hoc Tukey–Kramer test. The VAS scores were compared using a two-tailed paired t-test. Differences with a probability less than 0.05 were considered significant.

Results

Operative time ranged from 102 to 215 minutes (mean 168 minutes), and estimated blood loss ranged from 10 to 250 ml (mean 100 ml). No severe systemic complication occurred during the surgeries. In one case, the medial wall of a pedicle was pierced intraoperatively. This occurred because of a skin incision that was too small to permit clear visualization of the surgical site and severe osteoporotic bone. The cement leaked through this pierced hole. This leak was recognized on intraoperative fluoroscopy, and the liquid cement was subsequently evacuated by open surgery. In this patient a transient motor deficit developed, corresponding to the right L4–S1 segments in the right leg, because of cement leakage through the right L-4 pedicle.

Preoperatively, nine patients were bedridden due to intractable back pain experienced while sitting or standing; one patient was able to move in a wheelchair; and four could ambulate with a walker. Postoperatively, six became

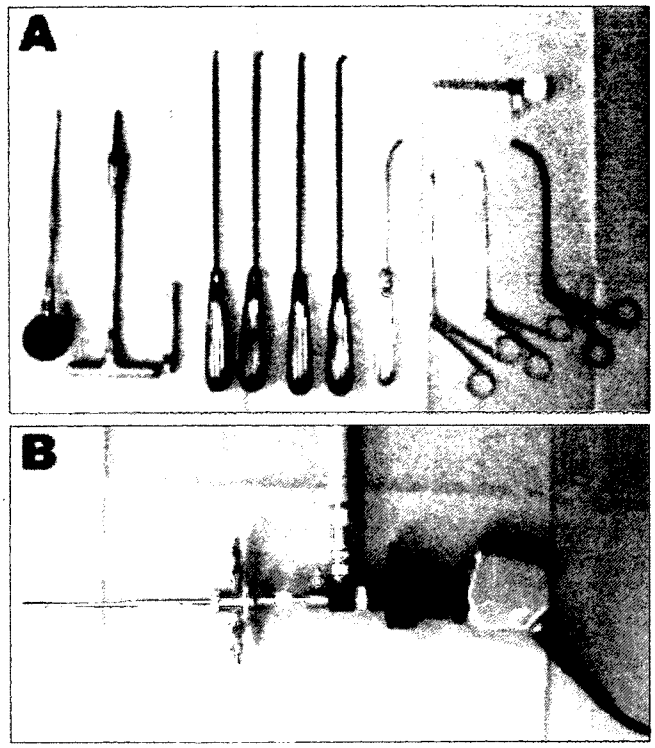

FIG. 3. Photographs showing the surgical instruments. A: Pedicle probe and tap, feeler, curette, rongeur, and universal cannula. B: A 30- or 70°-angled arthroscope of 4 mm diameter is used in the procedure.

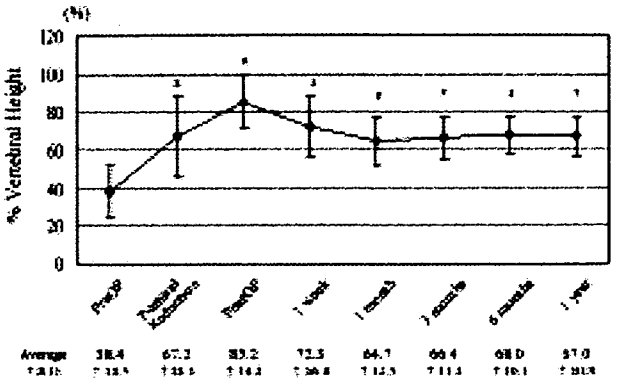

FIG. 4. Line graph demonstrating changes in the percentage of vertebral height compared with the adjacent intact VB. The mean percentage of vertebral height improved from 39% preoperatively to 85% immediately postoperatively. A loss of correction was observed at 1 month postoperatively; however, no further loss in VB height was observed up to 1 year postoperatively. *Asterisks* show statistically significant differences compared with preoperative values. Postural Reduction = intraoperative vertebral height; S.D. = standard deviation.

ambulatory without any assistance, and eight were able to ambulate with a cane or walker (Table 1). The mean preoperative VAS score was 79 mm (range 68–100 mm), and postoperatively the mean score improved to 16 mm (range 3–40 mm), which was a statistically significant difference ($p < 0.001$).

The percentage of vertebral height was measured in nine VBs in eight patients for whom follow up was 1 year or greater (range 12–27 months). The mean percentage of vertebral height improved significantly, from 38.4% of that of the adjacent intact VBs before treatment to 67.2% intraoperatively, and to 85.2% after treatment ($p < 0.05$, compared with the preoperative value). A loss of correction was observed at 1 month postoperatively, and no further loss in vertebral height was documented up to 1 year postoperatively (Fig. 4 and Table 2). Recurrence of pain was not demonstrated during the follow-up period. New bone or callus formation was documented in all cases at the anterior parts of the fractured VBs.

TABLE 1

Changes in ambulatory status stratified by procedure

	No. of Cases	
	Preop	Postop
ambulatory w/o assistance	0	6
ambulatory w/ cane or walker	4	8
nonambulatory (wheelchair or bedrest)	10	0

Illustrative Case

This 66-year-old woman presented with a 9-month history of progressive back pain. Preoperative lateral radiography revealed an intravertebral instability of the T-12 VB (Fig. 5A and B). On MR imaging we observed an abnormally low signal intensity on T_1-weighted sequences and a high signal intensity on T_2-weighted sequences in the T-12 VB (Fig. 5C and D). Vertebroplasty was performed after induction of general anesthesia. A balloon was inflated in the VB, and sufficient space was cleared to inject the CPC filler (Fig. 5E). A lateral radiograph obtained immediately after surgery revealed sufficient CPC filling and correction of kyphosis (Fig. 5F). The patient reported a marked reduction of pain. A mild loss of correction was seen 1 year postoperatively; however, new bone formation was seen in the anterior portion of the T-12 VB, and the pain did not recur (Fig. 5G).

Discussion

Percutaneous vertebroplasty was first described for the treatment of aggressive vertebral hemangioma in 1987.[10] The indications for this procedure were subsequently expanded to the treatment of painful VCFs.[11,16] In patients with painful osteoporotic compression fractures, vertebroplasty is commonly performed by injecting PMMA cement into the VBs.[1,12,22,33] This technique has been shown to allow patients to return to activities of daily living because their prolonged intractable pain has been relieved. In this study, we have described a new technique of vertebroplasty for the treatment of chronic painful osteoporotic VCFs. This new procedure involves the resection of granulation tissue in the VB under endoscopic observation. The space within the VB is then filled with nonheat-

TABLE 2

*Chronological change in percentage of vertebral height**

Case No.	Change in Vertebral Height (%)							
	Preop	Postural Reduction	Postop	1 Wk	1 Mo	3 Mos	6 Mos	1 Yr
1	59	100	101	100	76	70	73	74
2	27	56	100	78	78	76	74	70
3	54	78	100	89	77	82	85	86
4	30	50	61	46	51	59	56	53
5†	58	60	85	60	64	61	67	67
	28	74	85	78	62	67	68	66
6	24	28	67	59	42	43	53	54
7	28	75	83	69	72	73	75	72
8	38	84	85	72	60	67	61	61
mean‡	38.4 ± 14.5	67.2 ± 21.1	85.2 ± 14.2	72.3 ± 16.4	64.7 ± 12.5	66.4 ± 11.3	68.0 ± 10.1	67.0 ± 10.3

* The percentage of VB height is determined in relation to the adjacent intact VB.
† The patient in Case 5 sustained two VB fractures, one at T-12 and one at L-2.
‡ The mean values are presented ± standard deviations.

generating CPC that hardens and helps to reestablish mechanical support.

Polymethylmethacrylate has been used commonly as an injectable material for vertebroplasty because of its high mechanical strength, but it has several disadvantages such as the toxicity of its monomer, thermal damage to surrounding tissue, and lack of osteoconductive capacity.[2,3,8,45,46] In contrast, CPC does not generate heat and has osteoconductive properties.[14] The viscosity of this material can be controlled by adjusting the mixing ratio of CPC powder and liquid to avoid leakage outside the VB or into vessels, which would otherwise potentially cause severe complications. In addition, the hardened CPC gradually turns into HA, which has been widely used as a bone substitute in spinal surgery because of its osteoconductive capacity. Clearly, the presence of HA would be beneficial for bone growth, which in turn would be essential for repair of the fracture.[7,41,43] In terms of the mechanical strength of these materials, CPC is inferior to PMMA, but the mechanical strength of CPC appeared to be sufficient

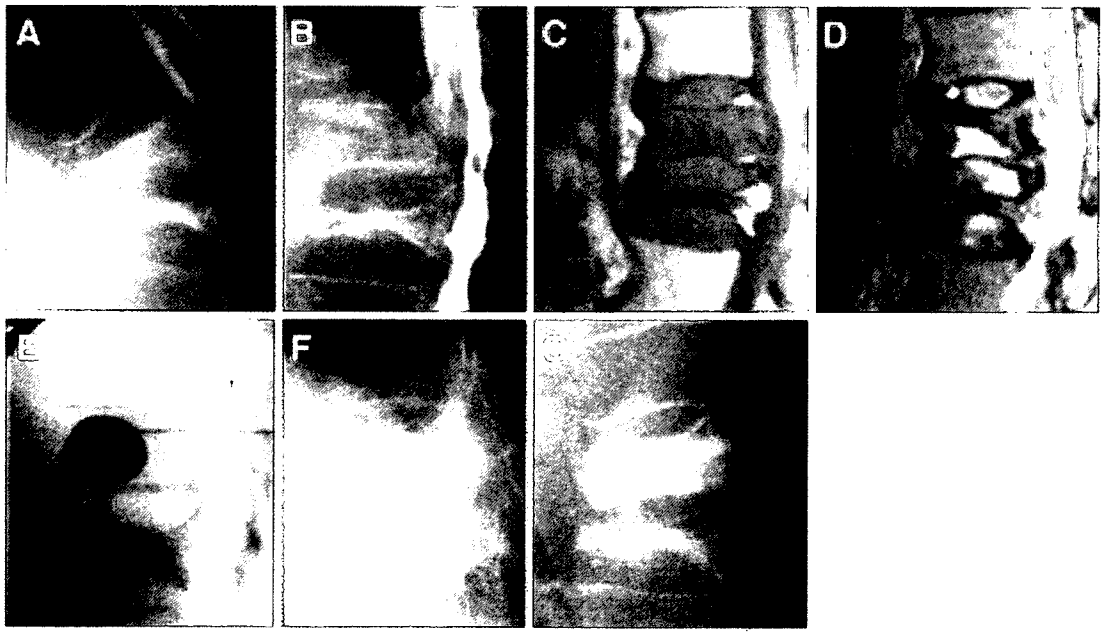

FIG. 5. Illustrative case. Preoperative plain radiographs and MR images demonstrating a T-12 chronic painful osteoporotic vertebral fracture. A and B: Preoperative lateral radiographs demonstrating intravertebral instability, as evidenced by changes in the anterior VB height between flexion and extension x-ray films. C and D: Sagittal MR images demonstrating fluid collection in the VB with a low-intensity signal on T_1-weighted sequences and a high-intensity change on T_2-weighted sequences, respectively. E: Intraoperative fluoroscopic image showing expansion of the balloon and reduction of VB height. F: Postoperative lateral radiograph demonstrating sufficient CPC filling and correction of VB height. G: Postoperative lateral radiograph obtained 1 year after surgery, revealing bone formation in the anterior portion of the VB.

to restore the strength of the fractured VB because breakage of the CPC blocks was not seen postoperatively. If the CPC is mixed with blood, however, its strength is markedly reduced.[38] Continuous irrigation with saline and suction before injection of the CPC is essential. The successful results achieved in our cases may be due in part to the injection technique.

The authors of previous studies have reported that the pseudarthrotic VB contained a significant amount of granulation tissue.[15] To obtain direct contact between the injected material and the host bone, curettage of this granulation tissue was necessary and the use of an image intensifier to achieve this outcome has been reported.[29] Curettage of the granulation tissue could be seen directly with an endoscope, and the inflation of a balloon within the pseudarthrotic VB facilitated this process.

Recently, an inflatable bone tamp (KyphX; Kyphon, Inc., Sunnyvale, CA) was developed to restore the height of fractured vertebrae.[5,17,21,23] Because this system is available only in the US, Europe, and Korea, however, we used a urinary balloon for the procedures described in this report. Our methods differ from Kyphon's kyphoplasty in that we use an endoscope, urinary balloon, and CPC injection. The principal advantages of using a urinary balloon are its relatively low cost and its availability. However, the correction that it affords may not be equal to that of the Kyphon balloon. The advantage of using an endoscope and CPC is obtaining direct host bone–CPC contact, which facilitates new bone formation. This is very important in improving long-term outcome. The initial strength immediately after the procedure, however, is much higher in PMMA-based vertebroplasty, despite its monomer reaction and heat production.

Recently, endoscopes have been utilized for less invasive spinal surgery; thoracoscopic and laparoscopic procedures have been described in numerous reports.[24,25,27,34] In one report, a balloon was used to dilate the retroperitoneal space so as to generate sufficient space for the procedure.[30] In a similar manner, we used a urinary balloon catheter for our new vertebroplasty technique. This technique may also prevent major systemic complications such as pulmonary embolism due to the high-pressure injection of cement.[19,31,37,44]

Conclusions

We have described a new vertebroplasty technique for the treatment of chronic painful VCFs. The technique involves the endoscopic resection of granulation tissue after dilation of the intravertebral space with a urinary balloon. Calcium phosphate cement was used as a filling material, and good surgical results were obtained. Because the fractured VBs were stabilized, back pain was consistently relieved, ambulatory function restored, and patients were able to return to activities of daily living.

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Manuscript received May 1, 2006.
Accepted in final form August 2, 2006.
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