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Clinical Article

Disc height loss after anterior cervical microdiscectomy with titanium intervertebral cage fusion

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Summary

Background. The use of a graft in cervical inter-vertebral disc repair is still a controversial procedure. The aim of the treatment is to restore the physiological disc height and to achieve fusion. This study was performed to determine the rate of narrowing of the cervical intervertebral disc after using a titanium cervical intervertebral cage (BAK-C; Sulzer Spine Tech, Minneapolis, MN).

Methods. 43 patients were included in the study. Each had a cervical disc protrusion, resulting in radiculopathy. All underwent surgery involving an anterior one level cervical microdiscectomy and fusion with a cylindrical titanium cage. The mean follow-up time was 18 ± 5 months.

Findings. The extent of the mean narrowing rate of disc space was $35.6 \pm 9\%$. The fusion rate was 98% and the mean time to fusion was 6 months.

Interpretation. The use of a cervical intervertebral cage in anterior cervical microdiscectomy does not prevent the loss of the height of the cervical disc space after the operation.

Keywords: Cervical discectomy; cervical spine; cervical fusion; cage.

Introduction

The treatment for cervical inter-vertebral disc degenerative diseases is still controversial [6, 16, 17]. When this operation is employed, an anterior inter-body fusion is performed [3, 14, 18]. The aim of the procedure is to create adequate decompression with restoration of the disc height and to subsequently cause fusion. A central discectomy is performed and the inter-vertebral space is filled with a bone graft, bone cement, biodegradable polymers, ceramics, or inter-body fusion cages [3, 5–9, 11, 13, 17]. Implantation of inter-body fusion cages for this disease was introduced in the 1980s [2]. These small, porous, hollow, cylindrical or nearly cubical in shape implants, restore physiological disc height and allow the growth of bone through the implant and consequent bony fusion. The cages were developed to prevent disc-space collapse and decrease morbidity at the donor site, which was reported to follow the use of bone grafts [1]. Another potential advantage of using cages is that the inter-body fusion stops spur formation which prevents the buckling of the ligamentum flavum and consequently decreases postoperative pain [3, 6–9, 13]. Nevertheless, complications can include subsidence into the adjacent vertebrae, with the collapse of the inter-vertebral space and kyphotic deformation of the affected segment. Dislocations of the cage and non-union with instability are further complications.

The aim of this study was to determine radiologically the changes in inter-vertebral disc height after anterior cervical microdiscectomy and insertion of a titanium cage device (BAK-C; Sulzer Spine Tech, Minneapolis, MN).

Clinical material and methods

The patients studied underwent surgery between October 1998 and October 2000 (mean follow-up of 18 months). Each had a one level cervical disc herniation which had caused radiculopathy. All patients underwent an anterior cervical micro-discectomy and fusion using a cage. All the procedures were performed by the same neurosurgeon.

Patient population

43 patients were studied; (19 women and 24 men), ranging from 24 to 63 years age (mean 43 years). Selection for surgery was based on the clinical examination, history, imaging studies, and the lack of response to conservative management. Each patient had radiculopathy

due to a soft disc herniation and/or osteophytes. None of the patients had myelopathy. Post operatively, all patients were evaluated at 1 week, 6 weeks, 6 months, and a variety of times between 12 to 32 months.

Before surgery and at follow-up, the severity of the radicular pain was assessed using a visual analog scale (VAS) with a range of responses from 0 (no pain) to 10 (maximal pain). Muscle strength was classified according to the Medical Research Council (MRC) grading system and assigned a score from 0 (no contraction) to 5 (normal). Sensation was graded as absent (anesthesia), normal, or abnormal (hypoesthesia or hyperesthesia). Reflex abnormalities were graded as normal or abnormal (absent or hypoactive).

The patients were also asked to describe their subjective perception of the results of their surgery which was graded as excellent, good, fair, or poor.

Operation

A general anesthetic was used for each patient. Anterior cervical microdiscectomy and/or osteophytectomy were performed. All disc tissue, including the herniated disc fragments and osteophytes were removed, thereby decompressing the nerve roots and the spinal cord. The segment was then fused with the cage and the end plates were lightly curetted. The posterior longitudinal ligament was removed when a disc sequestration was suspected or when the ligament had a widespread in growth of osteophytes. Tapping and placement of either a 10 or 12 mm cage was performed. A cervical collar was not used post operatively.

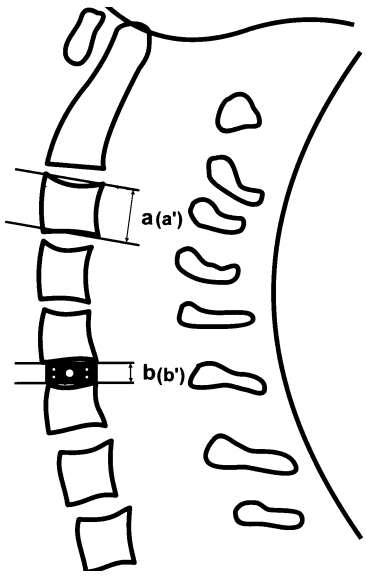
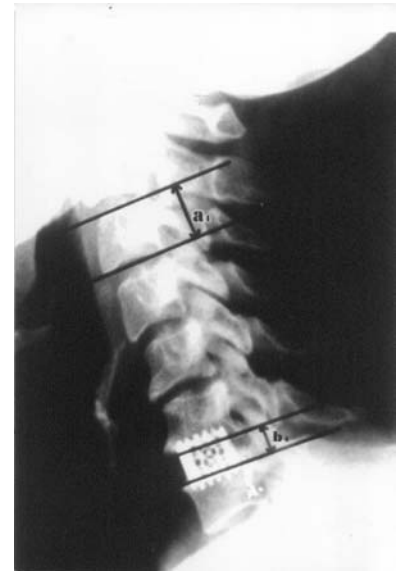


Fig. 1. Scheme for evaluation of narrowing rate. The posterior height of the C3 corpus (a: on post operative first day, and a′: on control lateral radiograph), and the "operated" disc space's height (b: on post operative first day, and b′: on control lateral radiograph) was measured. The ratio between b and a is X ratio (b/a = X ratio). The ratio between b′ and a′ is the Y ratio (b′/a′ = Y ratio). The narrowing rate (%) of "operated" disc space was measured with the equation of $[(X-Y)/X]\times 100$. b/a = X Ratio (on lateral cervical radiograph of post operative first day). b′/a′ = Y Ratio (on lateral cervical radiograph of last control). $[(X-Y)/X]\times 100$ = Narrowing Rate (%)

Radiologic analysis

All radiographs were taken in a lateral standing centralized in the C4 position. On the first post operative day, a lateral cervical radiograph was taken. Another lateral cervical radiograph was performed at the last of follow up, and compared with the lateral cervical radiograph taken on the first post operative day. On each radiograph, the posterior height of the body of C3 (as a reference), and the height of the operated disc space



a

b

Fig. 2. (a) Lateral radiograph imaged the first post-operative day of a 45-year-old man with a disc herniation at C6/7. The ratio of b_4 to a_4 is equal to the X ratio. (b) Lateral radiograph of the same patient 14 months after surgery, showing the narrowing of "operated" disc space. The ratio of b_4' to a_4' is the Y ratio

were measured. The ratio between these two measurements was taken. The "X Ratio" represented the ratio of the first post operative day's lateral cervical radiograph; and the "Y Ratio" was represented as the ratio of the control lateral cervical radiograph (Fig. 1). The "narrowing rate" was described as the $[(\text{X Ratio} - \text{Y Ratio})/\text{X Ratio}] \times 100$.

Lateral flexion-extension cervical radiographs were taken in order to determine if there was mobility or fusion. This method was chosen to be consistent with typical clinical practice. An operative segment was deemed to be fused if there was less than two degrees of segmental movement on the lateral flexion-extension views and no more than 50% radiolucency covering the implant's outer surfaces. Assessments of fusion and radiological measurements were made by an independent radiologist.

Statistical analysis

The Wilcoxon Signed Rank test and the Mann-Whitney test were used to examine the radiographic measurements.

Results

Demographic and clinical data are provided in Table 1. The most common cervical level involved was C5-C6 with Table 2 summarizing the number of levels involved. The interval to follow-up ranged from 12 to 32 months with an average follow-up of 18 ± 5 months.

Table 3 summarizes the neurological outcomes and the degree of pain relief. A statistically significant reduction in the severity of the radicular pain was indicated on the VAS at the final follow-up assessment as compared with the preoperative assessment. Improvement of muscle strength was also detected in postoperative examinations. Abnormal sensation was reported by 15 of the patients before surgery, and an improvement in sensation was reported by 9 of these patients. Abnormal reflex examination was detected in 19 patients before surgery and 10 of these patients improved after the operation. The patient's perceptions of the outcome were generally good or excellent and the median hospital stay was 1 day (range = 1–2 days) (Table 4).

Table 1. *Characteristics of 43 patients*

Characteristic	Patients (43 patients)
Age	$43{,}2 \pm 6{,}4$
Male	24
Female	19
Radiculopathy	43
Sensory abnormality	15
Reflex abnormality	19
Motor *weakness*	25
Myelopathy	–

Table 2. *Levels involved*

Levels	Patients (43 patients)
C3-4	2
C4-5	18
C5-6	20
C6-7	3
Total	43

Table 3. *Changes in neurological examination and pain*

	Pre operative	Post operative	*P* value
Radicular pain* [mean-(range)]	6,8 (3–10)	1,7 (0–4)	0.001
Muscle *power*** [mean-(range)]	3,3 (2–4)	4,3 (3–5)	0.04
Sensory abnormality	15 patients	6 patients	
Reflex abnormality	19 patients	9 patients	

* Visual analog scale (*VAS*), and ** Medical Research Council (*MRC*) muscle grading system was used.

Fusion rates

Of the patients undergoing fusion, 98% (42 of 43) had a solid fusion at an average time of 6 months after the operation. We were not able to show fusion through the cage on a direct radiograph, although, signs of osseous consolidation were detected around the cage (40 of 43).

Surgical complications

One patient suffered from dysphagia for two weeks and another suffered a change in voice for three months. No other complications occurred.

Radiological measurements (narrowing rate)

Table 5 summarizes the levels operated on, X and Y ratios of each level after the first postoperative day and the last day control radiographs, as well as their

Table 4. *Hospital stay and patient's perceptions of outcome*

Variables	Patients (43 patients)
Duration of hospital stay	
< 1 day	39
> 1 day	4
Outcome	
Poor	–
Fair	–
Good	5
Excellent	38
Bony fusion	42/43 (98%)

Table 5. *Narrowing rates of the specified levels. The differences between the X and Y ratios between the first postoperative day and last control day was significant (*$p < 0{,}001$)*

Patient	Level	X ratio*	Y ratio*	Last control (month)	Narrowing rate (%)
1	C4-5	0,45	0,24	23	46
2	C5-6	0,46	0,28	14	37
3	C3-4	0,41	0,32	20	22
4	C4-5	0,46	0,30	15	36
5	C5-6	0,47	0,30	16	36
6	C6-7	0,47	0,23	14	51
7	C5-6	0,40	0,27	24	32
8	C4-5	0,47	0,24	27	49
9	C5-6	0,52	0,40	20	23
10	C4-5	0,43	0,32	21	25
11	C5-6	0,43	0,33	13	23
12	C4-5	0,47	0,24	18	49
13	C5-6	0,53	0,28	26	47
14	C4-5	0,43	0,22	19	49
15	C5-6	0,44	0,25	13	43
16	C5-6	0,40	0,30	12	25
17	C3-4	0,44	0,23	32	47
18	C4-5	0,41	0,29	15	31
19	C5-6	0,31	0,26	18	15
20	C4-5	0,37	0,23	14	38
21	C5-6	0,40	0,27	12	33
22	C4-5	0,47	0,33	13	30
23	C5-6	0,43	0,30	14	30
24	C4-5	0,42	0,29	16	31
25	C4-5	0,46	0,26	13	43
26	C5-6	0,39	0,19	16	50
27	C4-5	0,37	0,23	17	38
28	C5-6	0,42	0,29	14	30
29	C5-6	0,48	0,34	17	29
30	C4-5	0,35	0,23	24	34
31	C5-6	0,52	0,32	26	38
32	C4-5	0,51	0,25	25	51
33	C5-6	0,48	0,29	21	39
34	C4-5	0,53	0,32	16	39
35	C5-6	0,41	0,28	12	32
36	C5-6	0,48	0,27	15	44
37	C4-5	0,54	0,38	12	30
38	C5-6	0,40	0,27	14	33
39	C6-7	0,43	0,30	16	30
40	C4-5	0,47	0,38	15	19
41	C5-6	0,48	0,27	16	44
42	C6-7	0,40	0,28	17	30
43	C4-5	0,35	0,24	18	31

corresponding narrowing rates. There were significant differences between the X and Y ratios of the first and last control radiographs (Mann-Whitney test, $p < 0{,}001$). The mean narrowing rate was found to be $35.6 \pm 9\%$.

Discussion

An anterior cervical discectomy is widely considered to be the procedure of choice for the treatment of segmental degenerative diseases of the cervical spine. Cloward, Robinson and Smith first described an anterior discectomy combined with bone graft placement [4, 15]. Anterior discectomy with inter-body fusion removes the source of compression and immediately relieves pain in most patients [6, 7, 10, 13, 14, 19]. Bone grafts distract the disc space, increase the size of inter-vertebral foramina at the appropriate level and prevent postoperative settlement [12]. A frequent criticism of the classic cervical fusion approach is the morbidity associated with the iliac crest donor site [1]. Some reports suggest that the pain may continue for as long as 12 to 24 months after the operation [1, 6, 13].

Avoidance of iliac crest morbidity has prompted some to use alternative procedures such as cervical inter-body cage implants. The ideal cervical fusion approach would offer fusion rates and clinical success of 100% with minimal expense, avoid painful autograft sites, incorporate quickly, obviate the need for a cervical orthosis, and have no associated soft tissue morbidity [6, 13].

In a previous study, autografts, allografts, or xenografts were used for a single-level cervical Cloward procedure. Most of the patients healed with a rigid fusion independent of which graft was used, but the healing process took longer than expected [9]. In another study, the BAK/C cages showed a greater tendency to subsidence than the WING and AcroMed cages [19]. Bone cement had the smallest risk of subsidence. The two factors that influence the tendency to subsidence of an intervertebral implant are the shape of the implant and the preparation of the endplates. A large contact surface, together with intact endplates, decreases the tendency to subsidence, whereas a small surface area and destructive preparation of the end plates increases the risk of subsidence. However, the contact areas of the WING cage and the AcroMed cage are well known and seem to be larger than the area of the BAK/C cage. Furthermore, the BAK/C cage must be drilled into the intervertebral space. A small contact area and the drilling of the end plates reduce the risk of subsidence and promote bone in growth. In accordance with this concept, we have found that measure of a cage was associated with a high rate of fusion. Although fusion through the cage is difficult to show with the usual radiological techniques, signs of osseous consolidation can be detected around the cage [13]. Of greater importance, we found that insertion of the cervical intervertebral cages was predominantly followed by good or excellent ratings of outcome.

Interestingly, the ''operated'' disc spaces showed significant narrowing. This narrowing is in direct contradiction to the purpose of inter-vertebral cages, which are designed to keep the height of the disc space constant following surgery. We believe that the cages went into the bones. The loss of disc space height did not preclude an excellent or good clinical outcome and the rate of fusion was high. We have not changed our operative technique.

In conclusion, this study showed that, in anterior cervical microdiscectomy operations, the use of cervical intervertebral cages (BAK-C) does not prevent the loss of height of the operated cervical disc space but it is associated with clinical benefit. Cervical intervertebral cages still require definitive assessment in prospective, randomized clinical studies.

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Disclosure

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Comment

Recently observed widespread moves towards use of interbody distractive devices in cervical spine surgery have occurred. A variety of these devices is now commercially available. They differ in design that affects their biomechanical characteristics, ability to preserve postoperative distraction, and histological characteristics of intervertebral bone matrix formation. Generally two basic designs of intervertebral spacers are in clinical use: cylinder- and box-shaped each of these with its advantages and drawbacks. There is an increasing number of comparative studies either laboratory or clinical focused on biomechanical and clinical performance of these two basic designs. One of parameters assessed in such studies is the ability to restore and maintain the disc height following discectomy. It is believed that preservation of disc height affects the good long-term results of decompression due to protection from decrease of space in the foraminal area and consequent radiculopathy.

The author has performed a valuable service in re-visiting the ability of a cylinder-designed cage to preserve postoperative distraction of discectomized cervical interspace. Their results are in accordance with what has so far been published in the literature: intervertebral implants that require the destruction of the vertebral endplates as described in the Cloward dowel-technique have a high risk of sintering into the adjacent vertebral bodies with consequent decrease of disc height.

This decrease is however less when artificial spacers are used instead of a bone graft alone. Sparing endplates reduces sintering into vertebral bodies thus box-shaped spacers better prevent post-

operative decrease of disc height. On the other hand we know that the majority of cases present with a good outcome despite postoperative loss in the height of interspace and regardless of the design of interbody device.

A systematic review of the literature relating to cervical interbody fusion still only provides limited evidence supporting the use of cervical interbody fusion device in place of autologus bone. The clinical and health economic implications of the widespread introduction of interbody implants in the absence of sound evidence cannot be ignored. They still merit further study and this work certainly contributes to a closer look into this problem.

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