Case Report

Clinical outcomes of multilevel anterior corpectomy and fusion as a revision surgery of the cervical spine: report of seven cases

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Study Design: Report of seven cases.

Objective: There is no general consensus on the best surgical procedures for late-onset complications of cervical operations. We reported seven patients who had been treated effectively by multilevel anterior corpectomy and fusion (ACF) as revision surgery of the cervical spine.

Setting: Gifu University Hospital, Gifu, Japan.

Method: Multilevel ACF using autogenous fibular strut graft as revision surgery was performed on seven patients: four patients having disorders of adjacent discs after anterior discectomy and fusion and three patients having postlaminoplasty disorders. Japanese Orthopedic Association scores (JOA scores) of the cervical myelopathy and severity of radicular and axial pains were used to evaluate outcomes.

Results: Rigid osseous fusion was achieved in all patients. JOA scores of the cervical myelopathy and the radicular pain, which had worsened just before the revision surgery, were improved significantly.

Conclusion: In the present seven patients who had variety of pathological conditions with various previous surgeries, multilevel ACF using strut graft was effective as a revision procedure in ameliorating their symptoms.

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Introduction

Developments of various surgical procedures, such as anterior^{1–3} and posterior decompression surgery^{4–6} for cervical spondylotic myelopathy and ossification of the posterior longitudinal ligament (OPLL) have provided patients with satisfactory outcomes.^{1–6} Several long-term follow-ups of these operations, however, have indicated late-onset complications, including degeneration of adjacent discs and pseudoarthrosis after cervical fusion,^{7–9} and recurrence of spinal canal stenosis after expansive laminoplasty.^{6,10,11}

Complications in such cases often involve a combination of factors, such as instability, compression of the spinal cord and nerve roots by spurs, herniated discs, ossified masses, and malalignment of the cervical spine.^{6,10–12} As revision procedures for these complications, posterior approaches such as interspinous wiring,^{13,14} foraminotomy,¹⁵ and posterior fusion,¹⁶ or

anterior corpectomy and fusion (ACF)^{9,17,18} have been performed in accordance with the pathological conditions. Here, we report efficacies and pitfalls of multilevel ACF using a fibular strut graft as revision cervical surgery. Although this study reviews only a small number of patients as a preliminary study, it is suggested that multilevel ACF using strut graft is one of the effective solutions for a variety of symptoms following failed cervical surgery.

Materials and methods

Materials

Seven patients, six men and one woman, with a mean age of 53.6 years, participated in this study (Table 1). They had all undergone surgical treatment for cervical myelopathy, but the outcomes were unsatisfactory. Four patients who had undergone anterior discectomy and fusion exhibited new disorders at adjacent discs (patients 1–4) (Figure 1a and b) and three patients who had undergone laminoplasty exhibited a

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Table 1 Summary of seven patients who underwent subtotal corpectomy as revision surgery

Patient no.	Age	Sex	First operation		Second operation (revision surgery)			
			Initial diagnosis	Method of operation	Diagnosis at the second operation, or reason for failure	Corpectomy levels	Duration between first and second op. (years)	Postop. follow-up period (years)
1	58	M	Disc herniation	^a AF (C5–6), ^b PW (C5–6)	Disorder of adjacent discs (C4–5, C6–7) radiculo/myelopathy	C5,6	2.2	5.8
2	68	M	Disc herniation	^a AF (C3–4, C5–6–7)	Disorder of adjacent discs (C4–5, C7–T1) myelopathy	C5,6,7	13.0	4.3
3	54	F	Disc herniation	^a AF (C5–6)	Disorder of adjacent discs (C4–5, C6–7) radiculo/myelopathy	C4,5,6	5.0	2.2
4	35	M	Disc herniation	^a AF (C5–6)	Disorder of adjacent discs (C3–4, 4–5, 6–7) myelopathy	C4,5,6	9.7	1.9
5	52	M	Spondylotic myelopathy, disc herniation	Laminoplasty (C3–7)	Intraforaminal spur (C4–5, C5–6) slip (C3–4, 4–5, 5–6), radiculo/myelopathy	C4,5	2.1	3.1
6	52	M	Spondylotic myelopathy	Laminoplasty (C5–7)	Spondylotic change, disc herniation (C3–4), slip (C3–4, 6–7), radiculo/myelopathy	C4,5,6	4.5	2.8
7	56	M	OPLL	Laminoplasty (C3–7) laminectomy (C1–2)	Insufficient recovery after first surgery myelopathy	C3,4	2.2	1.5
ave. $\pm$ SD							5.5 $\pm$ 4.3	3.1 $\pm$ 1.5

^aAF = anterior fusion
^bPW = posterior wiring

Figure 1 (a, b) Representative findings of patient 3. Pain recurred in the left upper extremity of this 54-year-old woman after C5–6 anterior discectomy and fusion. (a) Sagittal MR image demonstrating disc protrusions at the adjacent discs (C4–5, C6–7) (white arrows). (b) Lateral radiograph of the cervical spine 3 months after the corpectomy of C4, 5, and 6 and anterior fusion from C3 to C7

worsened neurological status (patients 5–7) (Figures 2, 3a and b). There were a variety of reasons for the postlaminoplasty disorders (Table 1). All patients had cervical myelopathy or radiculomyelopathy due to spinal cord compression.

Figure 2 (a, b) Representative findings of patient 5. Pain and paresthesia remained in the left arm of a 52-year-old man who had undergone laminoplasty from C3 to C7 for cervical spondylotic myelopathy. (a) CT-myelogram demonstrated disc bulging and spur formation in the left neural foramen (black arrow) at the C5–6 level. (b) CT scan after two-level corpectomy shows successful anterior decompression

Two- or three-level ACF using autogenous fibular strut graft was performed in all the patients as revision surgery. The indications of this procedure was strictly limited to multilevel anterior lesions or evidence of multilevel intervertebral instabilities of the cervical spine, as demonstrated by physical examinations, dynamic X-rays, MRI, and myelo-CT studies. The mean interval between the first and revision operations was 5.5 years. The patients were followed up after the revision operation for 3.1 years on average.

Surgical procedures

A subtotal anterior corpectomy, with microscopic removal of the discs and all vertebral body but the lateral walls of the vertebra, was performed in all patients. The posterior longitudinal ligament was cut open in the median line. Then, autogenous fibula strut

Figure 3 (a, b) Representative findings of patient 7. A 56-year-old man had undergone C3–7 laminoplasty for OPLL. However, the neurological recovery was insufficient. (a) Sagittal MR image demonstrating C2–5 OPLL. After the laminoplasty, decompression for the spinal cord was insufficient (white arrows). (b) MR image after the corpectomy of C3 and 4, and anterior fusion from C2 to C5. Ossified masses were removed and spinal cord shifted anteriorly

graft was swedged into end plate. Four patients (patients 2, 3, 4 and 6) had three-level ACF employing fibula strut autograft, while three (patients 1, 5 and 7) had two-level ACF. An anterior cervical plate (PEAK anterior cervical plate, Depuy-AcroMed, MA, USA) was

employed in two patients (patients 5 and 7) who were immobilized with a hard collar until osseous fusion was confirmed. The five patients were immobilized for 3 months with halo vests, after which they worn hard collars until osseous fusion was confirmed.

Evaluation of clinical outcomes

Radiographic evaluations

Osseous fusion: The state of the osseous fusion was evaluated from plain X-ray films and CT. Trabecular continuity between adjacent vertebra and the fibular strut graft and, on lateral X-ray films, stability during flexion and extension of the cervical spine were evaluated. The time taken to achieve osseous fusion after the second surgery was also noted.

Symptoms

Neurological status: The neurological status was evaluated according to the Japanese Orthopedic Association (JOA) scoring system¹⁹ (Table 2), in which the maximum score is 17. Patients were evaluated just before the first surgery, 6 months after the first surgery, just before the second surgery, and at the final follow-up.

Other symptoms: The presence of radicular pain and axial pain was evaluated. The axial pain included posterior neck pain, neck stiffness, and shoulder stiffness.^{20,21} We paid particular attention to these pains because the JOA scoring system does not evaluate the pain (Table 2). The severity of pain was graded according to the classification by Robinson *et al.*,¹ with modification.¹⁴ The pain was classified as mild if there was no limitation of activities, moderate if there was minimal limitation of activities with occasional use of anti-inflammatory medications, and severe if there was apparent limitation of activities with frequent use of anti-inflammatory medications for the relief of pain.¹⁴

Complications Intraoperative and postoperative complications were evaluated.

Results

Radiographic evaluations

Osseous fusion Rigid osseous fusion was achieved in seven patients 7.3 months on average (range, 5–9 months) after the second surgery.

Symptoms

Neurological status The average JOA score was 11.1 ± 3.3 (average $\pm$ SD) before the first surgery, 13.0 ± 3.4 6 months after the first surgery, 10.6 ± 4.8 just before the second surgery and 13.6 ± 2.9 at the final follow-up. In six patients, the JOA score was improved by 2–4 points after the second surgery. In one patient

Table 2 Criteria of evaluation of cervical myelopathy by the Japanese orthopaedic association (JOA) score

<i>I. Upper extremity function</i>	<i>II. Lower extremity function</i>	<i>III. Sensory</i>	<i>IV. Bladder function</i>
0. Impossible to feed oneself	0. Impossible to walk	A. Upper extremity 0. Severe sensory loss 1. Mild sensory loss 2. Normal	0. Complete disturbance 1. Severe disturbance (Straining, dribbling of urine)
1. Possible to eat with spoon, but not with chopsticks	1. Need cane or aid on flat floor		
2. Possible to handle chopsticks, but inadequately	2. Need cane or aid only on stairs	B. Lower extremity 0. Severe sensory loss 1. Mild sensory loss 2. Normal	2. Mild disturbance (Pollakisuria, urine hesitancy)
3. Possible to handle chopsticks, but awkwardly	3. Possible to walk without cane or aid, but slow	C. Trunk 0. Severe sensory loss 1. Mild sensory loss 2. Normal	3. Normal
4. Normal	4. Normal		

(patient 1), the JOA score was unchanged after the second surgery, but radicular pain in the upper extremities, which was his preoperative chief complaint was improved significantly. The JOA score did not fall in any of the patients (Table 3).

Axial pain Just before the second surgery, three patients complained of axial pain, including neck pain and shoulder stiffness. In one patient (patient 1), the axial pain was persistent even before the first surgery. In two patients (patients 4 and 6), who had undergone posterior procedures, axial pain onset several months after the first surgery. After the second surgery, the axial pain remained unchanged in one patient and improved somewhat in two patients. There were no new occurrences of axial pain.

Radicular pain Before the second surgery, all the patients had radicular pain in the upper extremities or trunk. After the second surgery, the radicular pain disappeared in four patients and improved in three.

Complications

There were no intraoperative complications. Postoperatively, we observed transient pain at the fibular donor site in two patients (patient 2 and 4). These complaints had continued for 2–3 months, but they disappeared in both patients after 6 months. Gait problems due to donor site pain were not observed.

Discussion

In this study, the JOA scores and the levels of radicular pain, which had worsened just before the second surgery, were improved significantly without neurological complications, after the multilevel ACF procedures. Rigid osseous fusion was successfully obtained in five patients without plates and in two patients with anterior plates. These results suggested that two- or three-level ACF using a strut graft was effective solution for these symptoms following failed cervical surgery.

After having undergone anterior discectomy and fusion, four patients in the present series (patients 1–4) had adjacent disc disorders, a common long-term complication.^{7,8,22} We performed multilevel ACF with strut graft on them, because their adjacent disc disorder involved more than two disc levels. Several surgeons have reported that strut grafting provides structural stability and multilevel arthrodesis has a high union rate.^{22,23} Bohlman *et al*² performed discectomy and interbody grafting on patients with adjacent disc disorders, but the success rate of fusion was less with multilevel procedures than with single level procedures. For the same pathological condition, Hilibrand *et al*²² demonstrated that strut grafting resulted in a higher rate (100%) of arthrodesis than did multilevel interbody grafting (63%). In the present study, by using fibular strut grafting, rigid osseous fusion was successfully

Table 3 Preoperative and postoperative clinical outcomes

Patient no.	JOA score (points)			Axial pain		Radicular pain		Symptoms at fibular donor site	Period of rigid fusion after surgery (months)
	Before the first surgery	6 months after the first surgery	Just before the second surgery	Final follow-up	Just before the second surgery	Final follow-up	Just before the second surgery		
1	15	16	16	16	Moderate	Mild	Moderate	No	9
2	11	14	11	14	None	None	Moderate	Yes	8
3	13	13	13	14	None	None	Moderate	(transient)	7
4	12	16	13	16	Moderate	Mild	Mild	No	8
5	5	7	5	9	None	None	Severe	Yes	5
6	13	15	13	16	Mild	Mild	Moderate	No	8
7	9	10	3	10	None	None	Moderate	No	6
Average±SD	11.1±3.3	13.0±3.4	10.6±4.8	*13.6±2.9					7.3±1.3

*Significant improvement, compared with the JOA score before the first surgery ($P<0.05$)*Significant improvement, compared with the JOA score just before the second surgery ($P<0.05$)

obtained in all four patients with adjacent disc disorders. In addition, autogenous grafting may be responsible for the 100% fusion rate observed in our patients.²⁴ In two patients in this series (patients 3 and 4) normal cervical lordosis was not maintained. Therefore posterior decompressive surgeries such as laminoplasty should not be reserved for these patients without well-preserved cervical lordotic curvature.²⁵

Three patients (patient 5–7) had postlaminoplasty disorders including secondary slip, spur formation, disc herniation, and insufficient decompression. These late-onset disorders following laminoplasty have been discussed only a little.^{6,10,11} In a 5-year follow of 33 patients who underwent expansive laminoplasty, Satomi *et al*⁶ observed the recurrence of spinal canal stenosis and neurological deterioration in six (18%) of them. In the present series, there was a variety of reasons for the postlaminoplasty disorders. In patient 5, radicular pain did not improve satisfactorily after the laminoplasty because of nerve root impingement at the neural foramina (Figure 2a). Baba *et al*¹⁵ showed that decompression of intraforaminal lesions by laminoplasty tends to be unsatisfactory. In patient 6, worsening of spondylotic change and disc bulging caused spinal canal stenosis at C3–4 which had not been decompressed during the laminoplasty. In a literature search, we found only two reports of adjacent disc degeneration occurring after laminoplasty.^{11,26} Wang *et al*¹¹ suggested that it occurs because of stiffening of the operated segments. In addition, in patients 5 and 6, who had spondylotic myelopathy, we observed worsening of degenerative slip (patient 5: C3–4, C4–5, C5–6, patient 6: C3–4, C6–7). Kimura *et al*¹⁰ reported that degenerative slips were worsened in four (14%) of 29 patients who underwent laminoplasty for spondylotic myelopathy during 7.1 years of follow-up. In these conditions, decompression of anterior elements and intervertebral stabilization were both necessary. In patient 7, who had undergone laminoplasty for OPLL, neurological recovery after the first surgery was insufficient. The insufficiency of the decompression was clear from the insufficient posterior shifting of the spinal cord and was probably caused by massive anterior impingement by OPLL and malalignment of the cervical spine (Figure 3a and b). Sodeyama *et al*²⁷ found that posterior shifts of the spinal cord of more than 3 mm, which is closely implicated in neurological recovery after laminoplasty, could not be expected when the cervical spine is malaligned.

Axial pain is reported to occur frequently after posterior cervical surgery such as laminoplasty.^{20,28} This is why we gave it particular attention in this study, despite it not being included in the JOA scoring system. In the present study, axial pain was remained in two patients after posterior surgery and in one patient after anterior surgery. The ACF revision surgery did not resolve this symptom completely in these patients and presumably, the axial pain may be a symptom from surgical damage or disuse atrophy of the nuchal muscles and ischemia of the shoulder muscles.^{14,21}

In contrast, several complications have occurred after ACF with strut grafting, for example, graft extrusion, migration, and pseudoarthrosis.^{29,30} Some surgeons have recently performed simultaneous posterior fusion, which is useful for avoiding graft extrusion.^{31,32} Although we observed no graft extrusion in our patients, when there is severe malalignment of the cervical spine, such as postlaminectomy kyphosis, posterior fusion is necessary.²⁹

To summarize, the ACF procedure, as a revision surgery, provided satisfactory results in all seven patients who had unfavorable results after previous cervical anterior fusion or laminoplasty. However, this procedure must be indicated after careful consideration of the patients' pathological condition. A long-term follow-up is necessary to demonstrate the efficacy of this procedure for cervical revision surgery.

Conclusion

Multilevel ACF using a fibular strut graft performed as revision surgeries in seven patients following failed cervical surgery was successful, at least according to a short- to mid-term follow-up. This report suggests that multilevel ACF can be performed effectively as revision surgeries in patients with adjacent disc disorders occurring after anterior fusion and with a variety of disorders occurring after laminoplasty.

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