Outpatient anterior cervical discectomy and fusion for cervical disk disease: a prospective consecutive series of 96 patients

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Objectives – To evaluate surgical complications and clinical outcome in a consecutive series of 96 patients undergoing anterior cervical discectomy and fusion (ACDF) for cervical disk degeneration (CDD) in an outpatient setting. Methods – Pre-, per-, and postoperative data on patients undergoing single- or two-level outpatient ACDF at the private Oslofjord Clinic were prospectively collected. Results – This study includes 96 consecutive patients with a mean age of 49.1 years. 36/96 had a two-level ACDF. Mean postoperative observation time before discharge was 350 min, and 95/96 were successfully discharged either to their home or to a hotel on the day of surgery. The surgical mortality was 0%, while the surgical morbidity rate was 5.2%. Two (2.1%) patients developed postoperative hematoma, 2 (2.1%) patients experienced postoperative dysphagia, and 1 (1%) experienced deterioration of neurological function. Radicular pain, neck pain, and headache decreased significantly after surgery. 91% of patients were satisfied with the surgery, according to the NASSQ. Conclusion – ACDF in carefully selected patients with CDD appears to be safe in the outpatient setting, provided a sufficient postoperative observation period. The clinical outcome and patient satisfaction of outpatients are comparable to that of inpatients.

Introduction

The vast majority of patients with symptomatic cervical disk degeneration (CDD) respond well to conservative treatment (1–4). For those who do not respond to conservative treatment, surgical treatment using anterior cervical discectomy and fusion (ACDF) is an option for selected patients (2,4,5). In a time of limited healthcare resources, there is a need to create and implement efficient and cost-effective treatments. Outpatient surgery, when safe and feasible, is a more cost-effective option than inpatient surgery. Because of short OR time and moderate postoperative pain, ACDF may be well suited for outpatient surgery (6–9). However, potential complications of ACDF, such as postoperative hematoma, may preclude the safety of this procedure in an outpatient setting (10–21).

We have recently suggested that a 6-h postoperative observation period after ACDF, followed by discharge from the neurosurgical unit, is likely to be just as safe as a lengthier observation period in the inpatient setting (18). This suggestion was based on a detailed prospective study of complications following ACDF for CDD.

In this article, we report our experience with 96 consecutive patients undergoing ACDF for CDD, in the outpatient setting. Complications and clinical outcome were prospectively studied.

Materials and methods

This is a prospective single-center study of patients who underwent single- or two-level ACDF for CDD as outpatients during the time period 2008–2010. The study was performed at the Oslofjord Clinic (www.oslofjordklinikken.no), a private neurosur-
litical clinic, located in a suburb just outside of Oslo. The main neurosurgical department in this health region is located at the Oslo University Hospital (www.oslo-universitetssykehus.no). The government covers all surgery performed at Oslo University Hospital, while private health insurance and/or the patients themselves pay for outpatient ACDF surgery at the Oslofjord Clinic.

Indications for ACDF surgery

1 One or more of the following symptoms and signs of CDD:
   - Persistent, severe radicular pain lasting for more than 3 months that has failed to respond to conservative treatment.
   - Cervical radiculopathy with progressive paresis.
   - Selected cases of myelopathy secondary to cervical spinal canal stenosis that can be adequately decompressed with ACDF.
   - Selected cases where neck pain and headache are the chief complaints, and there is a lesser degree of radicular pain.

2 MRI-documented CDD with compression of cervical nerve roots and/or spinal cord that correlates well with the clinical symptoms and signs.

Exclusion criteria

- Cervical trauma within the past 4 weeks.
- Cervical spine neoplasia.
- Ongoing cervical infection.
- Patients unable to care for their own needs.
- Patients with significant cognitive impairment.
- Medical comorbidity anticipated to require more than 6 h of postoperative observation. However, smokers and patients with diabetes mellitus requiring insulin treatment were not excluded.

Anterior cervical discectomy and fusion

In all patients, we used an anterior approach to the cervical spine with a right-sided skin incision, as originally described by Robinson and Smith (4). A self-retractor was mounted after fluoroscopic verification of the correct level (Trim Line, Medtronic, Memphis, TN, USA). Next, the disk was removed with a high-speed drill (Midas Rex, Medtronic, Memphis, TN, USA) utilizing an operating microscope. Removal of the posterior longitudinal ligament and the final decompression of the nerve roots were performed using small rongeurs. Bilateral nerve root decompression was performed, even in patients with unilateral symptoms. Distraction was applied using the Trim Line distraction system (Medtronic, Memphis, TN, USA). Fusion was attained with PEEK cages (Cornerstone, Medtronic, Memphis, TN, USA). After removal of the Trim Line distracters, the screw holes were plugged with bone wax (Ethicon, Johnson & Johnson, Somerville, NJ, USA) to prevent postoperative bleeding. Wound drainage was not routinely used. We administered either a single dose of i.v. cephalothin (30 mg/kg) or p.o. azithromycin 500 mg ×2 prior to surgery as prophylaxis against infection. As part of postoperative pain management, a single dose of i.v. dexamethasone 8 mg and local wound injection of 3–5 cc of bupivacaine hydrochloride 5 mg/cc with adrenaline 5 μg/cc were given upon initiation of surgery. All ACDF procedures were scheduled for morning surgery to allow for sufficient postoperative observation and discharge before 9 p.m. on the day of surgery. Surgery was performed by two experienced board-certified neurosurgeons. A neck brace was not used.

Postoperative care

The patients were observed in a recovery unit for 3–12 h following surgery. Two hours after surgery, the patients were mobilized and allowed to walk about the recovery unit. Patients were discharged if the following post-op checklist was satisfactory: adequate pain control, adequate wound hemostasis, stable neurological status, and ability to drink, to void and to ambulate. Patients who had a travel distance >1.5 h by car were advised to stay overnight at a hotel adjacent to the clinic. All patients were strongly advised to have a family member or a close friend monitor them the first night after surgery. Patients were requested to call the clinic with any questions or concerns. One of the board-certified neurosurgeons can be contacted directly 24 h a day, 7 days a week by phone. The day after surgery, the patients were contacted either by a trained nurse or by a neurosurgeon. A telephone-consultation was performed after 6 weeks. A final follow-up outpatient clinical examination was performed 6 months after surgery for registration of complications and clinical outcome according to a defined protocol.

Prospective registration of clinical parameters

The following pre- and peroperative parameters were registered: age; sex; previous surgery for
CDD; radicular pain; neck pain; headache; myelopathy (the diagnosis of myelopathy required neurological signs of upper motor neuron lesion, such as a positive Babinsky sign, hyperreflexia, and/or increased muscular tone); number of levels fused (single- or two-level fusion); level fused (C3/C4, C4/C5, C5/C6, C6/7, or C7/Th1); time from initiation to completion of anesthesia (min); time from initiation to completion of surgery (min); time from completion of surgery to discharge (min); and successful discharge from day surgery unit (yes/no). Each of the three pain categories was scored using Visual analogue scale (VAS), where 0 indicated no pain and 10 indicated extreme pain (22). The following parameters were registered during the follow-up visit in our outpatient clinic: radicular pain; neck pain; and myelopathy. As the clinical impact of a change in VAS score of $\pm 2$ is unclear, we calculated the number of patients who had a change in VAS scores of more than $\pm 2$ for the three pain categories (23,24).

The following surgery-related complications were recorded: death within 30 days after surgery; injury to the carotid or vertebral artery; injury to the common intern jugular vein; injury to the esophagus; injury to the recurrent laryngeal nerve; postoperative hematoma requiring surgical evacuation; wound infection; dural tear with cerebrospinal fluid (CSF) leak; urinary tract infection and pneumonia presenting within 1 week after surgery; and thromboembolism presenting within 1 month after surgery. Patient satisfaction with surgery was measured by using the NASSQ (North American Spine Society Questionnaire) (25,26).

Patient selection for ACDF in outpatients vs inpatients in our health region

Patient characteristics from the present study were compared to patient characteristics from our previous study; a study of complications in an inpatient setting within the same health region. The complication study was published in 2008 and included prospective registration of 390 consecutive ACDFs (18).

Database and statistical analyses

We investigated the distribution of variables by kernel density graphs and present the median or mean with interquartile range or standard deviation, as appropriate. Groups were compared with Welch’s two-sample $t$-test in normally distributed, continuous data and with Fisher’s exact test in count data. The paired $t$-test was used to compare VAS scores prior to and following surgery VAS. SPSS v 15.0 (SPSS Inc., Chicago, IL, USA) and R v 2.13 (www.r-project.org) were used for all statistical analyses. A $P$-value $< 0.05$ was considered statistically significant.

Ethics

The Data Protection Officials at Oslo University Hospital approved the study. All patients gave informed consent for data entry and inclusion into the prospective study.

Results

Patient characteristics

We prospectively studied 96 patients; 34% were female. The mean age at time of surgery was 49.1 years (range, 29.8–77.3). Four patients had previously undergone ACDF. Surgery was performed on 132 disk levels in 96 patients. The number of fused levels per procedure, level of fusion, and preoperative symptoms and signs are shown in Table 1. Mean duration of anesthesia, surgery, and postoperative observation time was 114 min (74–180), 72 min (45–127), and 350 min (210–764), respectively. Fifty-three patients were

Table 1 A comparison of patient characteristics in this study with patient characteristics from a previously published study within the same health region

|                      | Present study | Lied et al. (18) |
|----------------------|---------------|------------------|
|                      | N = 96        | N = 390          | $P$-value   |
| Females – no. of patients (%) | 33 (34.4) | 178 (178 (46) | 0.05$^1$   |
| Mean age (SD) – (years)     | 49.1 (8.6) | 48.1 (9.1)      | 0.28$^2$ |
| Levels per procedure – n (%) |          |                  |            |
| One level              | 60 (62.5) | 240 (61.5)      | 1.0$^3$   |
| Two levels             | 36 (37.5) | 148 (37.9)      |            |
| Three levels           | 0 (0)     | 2 (0.5)         |            |
| Level – no. of patients (%) |          |                  |            |
| C3/C4                  | 0 (0)     | 7 (1.3)         | 0.45$^5$ |
| C4/C5                  | 10 (7.6)  | 56 (10.3)       |            |
| C5/C6                  | 64 (48.5) | 266 (49.1)      |            |
| C6/C7                  | 55 (41.7) | 207 (38.2)      |            |
| C7/Th1                 | 3 (2.3)   | 6 (1.1)         |            |
| Method of fusion – n (%)   |          |                  |            |
| Autologous bone graft    | 0 (0)     | 278 (71.3)      | <0.001$^1$|
| PEEK cage$^*$           | 96 (100)  | 112 (28.7)      | 0.8$^1$   |
| Previous ACDF – n (%)    | 4 (4.2)   | 11 (5.6)        |            |
| Symptoms – no. of patients (%) |          |                  |            |
| Radiculopathy          | 80 (83)   |                  |            |
| Radiculopathy and myelopathy | 12 (13) |                  |            |
| Myelopathy             | 4 (4)     |                  |            |

ACDF, anterior cervical discectomy and fusion.

$^*$Polyetheretherketone.

$^1$Fisher test.

$^2$ $t$-test.
discharged after an observation period <6 h, two after 210–239 min, 13 after 240–299 min, and 38 after 200–259 min. 95/96 (99%) patients were successfully discharged either to their home or to a hotel on the day of surgery. One patient was admitted to a hospital after surgery (see below). None of the patients required readmission after they had been discharged from the outpatient unit. The 6-month follow-up was 100%.

Patients selected for outpatient surgery may differ from those patients who are selected for inpatient surgery. In Table 1, we compare patient characteristics from the present outpatient surgical study with patient characteristics from a recently published inpatient study within the same health region. The patient groups do not differ with respect to age, fusion level, number of levels fused, or previous surgery. However, there were significantly more females in the inpatient study. All outpatients were fused with a PEEK cage, while inpatients were fused either with a PEEK cage or with an autologous bone graft from the iliac crest. The government-covered surgery for inpatients treated at Oslo University Hospital, while private health insurance ($n=88$) or the patients themselves ($n=8$) covered outpatient surgery at the Oslofjord Clinic. As stated in materials and methods, patients with medical comorbidity anticipated to require more than 6 h of postoperative observation were not candidates for outpatient surgery.

Mortality and morbidity

The surgical mortality rate, defined here, as death within 30 days of surgery, was 0%. A total of five major and minor complications were recorded in five patients, yielding a surgical morbidity rate of 5.2%. A summary of the different complications is given in Table 2.

![Table 2](image)

| Event                          | Rate |
|--------------------------------|------|
| Neck hematoma                  | 2/96 (2.1%) |
| Neurological deterioration     | 1/96 (1%) |
| Dysphagia                      | 2/96 (2.1%) |
| Injury to a major artery       | 0/96 (0%) |
| Injury to the esophagus        | 0/96 (0%) |
| Vocal cord paralysis           | 0/96 (0%) |
| Wound infection                | 0/96 (0%) |
| CSF leak                       | 0/96 (0%) |
| Thromboembolism                | 0/96 (0%) |
| Pneumonia                      | 0/96 (0%) |
| Urinary tract infection        | 0/96 (0%) |
| Anterior graft dislocation     | 0/96 (0%) |

- A 40-year-old woman experienced dysphagia 1 h after surgery, but no respiratory distress. A postoperative hematoma was suspected, and the patient was immediately reoperated. A prevertebral hematoma was removed, without the identification of any major sources of bleeding; the patient fully recovered.
- A 41-year-old man sustained an injury to the internal jugular vein during the approach; the bleeding was controlled with compression and repaired with Tacoseal (Nycomed, Oslo, Norway). Four hours after the procedure, the patient was asymptomatic, but he had palpable mass indicating a subcutaneous hematoma. The wound was explored in local anesthesia; a small blood clot in relation to the jugular vein was found and removed. The patient fully recovered.
- A 40-year-old woman experienced uncontrolled movement of the left upper extremity 4 h following surgery. The patient was transferred to Oslo University Hospital for further examination. A thorough diagnostic work-up, including cerebral MRI and CT angiograms of precerebral arteries and cerebral arteries, could not explain the uncontrolled movements. The patient has not fully recovered, and a diagnosis has not been established.
- Two patients experienced dysphagia postoperatively. In a 45-year-old man, it was mild and fleeting, while in a 53-year-old man, it was more pronounced and permanent until the last follow-up after 6 months. Follow-up MRI, X-ray examination of the esophagus, and ENT examinations did not reveal any specific pathology.

Postoperative pain relief

We found a significant reduction in radicular pain, neck pain, and headache after surgery (Table 3). The reduction was most pronounced for radicular pain and neck pain. Radicular pain improved $\geq 2$ VAS points in 78.5% of the patients, while it worsened $\geq -2$ VAS points in 2.5% of patients. Neck pain improved $\geq 2$ VAS points in 85% of the patients, while it worsened $\geq -2$ VAS points in 3% of patients. Headache improved $\geq 2$ VAS points in 47% of the patients, while it worsened $\geq -2$ VAS points in 1% of patients (Table 4).

Persistent radiculopathy at 6 months postoperatively

At surgery, 96% (92/96) of the patients had radiculopathy, and 77% had a VAS score $\geq 5$. At
6-month follow-up, 56% (45/79) had no radiculopathy, and 19% still had radicular pain with VAS/C0 < 5.

Persistent myelopathy at 6 months postoperatively

Complete data for preoperative and postoperative myelopathy were available in 79 patients. Of the 79 patients, 16 patients had myelopathy at surgery, while only one patient had persistent myelopathy at 6 months postoperatively.

Patient satisfaction

Patient satisfaction with surgery was measured using the NASSQ. Of the 81 (84%) patients who answered the question ‘How would you rate the overall results of your treatment for your neck or arm pain?’, 91% were excellent to good, 3% were faire, and 6% were poor. One of the dissatisfied patients was reoperated 7 months following the ACDF procedure; with a posterior foraminotomy at the same level.

Discussion

Advances in surgical techniques and anesthesiology have made outpatient surgery possible in several fields, including neurosurgery (7,8). Because of short OR time, early mobilization and moderate postoperative pain, ACDF may be well suited for outpatient surgery. We have recently suggested that a 6-h postoperative observation period after ACDF, followed by discharge from the neurosurgical unit, is likely to be just as safe as a lengthier observation period in the inpatient setting (18). This suggestion was based on a detailed prospective study of complications following ACDF for CDD. In this study, we have shown that outpatient ACDF in properly selected patients appears to be feasible, safe and has a clinical outcome comparable to inpatient ACDF.

A number of complications following ACDF have been reported (10). A total of five major and minor complications were recorded in our series. The encountered complications included postoperative hematoma, neurological deterioration, and dysphagia.

Postoperative hematoma is a potentially life-threatening ACDF-related complication (18).

Vascular complications are most commonly recognized intraoperatively or in the immediate postoperative period. In 2008, we published a prospective study in which 5/390 patients developed neck hematomas requiring surgical evacuation. All of the hematomas occurred within 6 h of surgery, and we therefore concluded that ACDF with a postoperative observation period of 6 h was safe. There are, however, reports of life-threatening late hemorrhage; in a Yu et al. (27) case report, a patient developed a hematoma 16 days following surgery that required emergent evacuation, but this extremely rare event does not necessitate a longer postoperative observation period. In the present study, 2/96 patients developed a hematoma in the immediate postoperative period that required evacuation. Despite the complication and subsequent hematoma evacuation, the patients were still discharged on the day of surgery. In our two own studies, ref. (18) and the present study, we had hematoma rates of 1.2% and 2%, respectively. Others have reported hematoma rates as low as 0.39% (28).

In the present study, one patient developed postoperative neurological symptoms requiring admission to a neurosurgical unit, is likely to be just as safe as a lengthier observation period in the inpatient setting (18). This suggestion was based on a detailed prospective study of complications following ACDF for CDD. In this study, we have shown that outpatient ACDF in properly selected patients appears to be feasible, safe and has a clinical outcome comparable to inpatient ACDF.

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In the present study, one patient developed postoperative neurological symptoms requiring admission to a neurosurgical unit. We therefore recommend that the clinics performing outpatient ACDF work in close collaboration with the regional neurosurgical department, in the uncommon event that serious complications requiring prolonged hospitalization arise.

Dysphagia is a rather common complaint in the immediate postoperative period. It is a subjective symptom and can therefore be difficult to classify. Some consider dysphagia to be an inevitability, and therefore not a complication, of ACDF per se (12). In a prospective study, Bazaz et al. report dysphagia in 50% of patients 1 month following ACDF surgery, while only 4.9% had persistent dysphagia at 6 months (19). In our study, 2.1%
of patients reported dysphagia at 6 months postoperatively. In a study by Yue et al., (29) persistent ACDF-related dysphagia was found in 35% of the patients 7 years after surgery. In a recent study, Siska et al. compared ACDF surgery to posterior lumbar (PL) surgery; patients undergoing PL surgery were used as a control group, to eliminate confusion between intubation-related dysphagia and ACDF-related dysphagia. There was more dysphagia in the ACDF group compared to the posterior lumbar surgery group 3 weeks after surgery; however, there was no difference 1.5 years after surgery. Not surprisingly, they concluded that the reason for the increased amount of dysphagia in the patients treated with ACDF was the anterior cervical dissection, not the intubation. ACDF-related dysphagia rates are likely to be largely underestimated (30).

In our previous prospective study from 2008, in which 390 inpatients were treated with ACDF for CDD, we found a complication rate of 9% (18). The slightly higher complication rate found in the inpatient setting is most likely due to the larger proportion of patients with medical co-morbidities and probably do not reflect an inherent increased risk in inpatient vs outpatient surgery. Other groups have published results where they conclude that ACDF performed in the outpatient setting is just as safe as ACDF performed in the inpatient setting (6–9).

The effectiveness of ACDF in relieving radicular pain, secondary to CDD, is well documented both in long- and short-term follow-up studies (5,31–35). Clinical outcome and patient satisfaction following outpatient ACDF are comparable to clinical outcome and patient satisfaction following inpatient ACDF (5). This has also been reported by Silvers et al. and Liu et al. (6,7). In our study, there was a significant reduction in radicular pain and neck pain at 6 months postoperatively; 78.5% of the patients with radicular pain improved two or more points on the VAS scale, whereas 85.4% of the patients with neck pain improved two or more points on the VAS scale.

In a time of limited healthcare resources, there exists the need to create and implement efficient and cost-effective treatments. ACDF outpatient surgery, when safe and feasible, appears to be a more cost-effective option than inpatient surgery (7).

**Limitations**

Serious and life-threatening complications following ACDF are rather rare. Thus, the number of patients with complications in this series is a limitation. This study may be classified as a non-inferiority trial aiming to prove that outpatient ACDF is as safe as inpatient ACDF. Such studies have an inherent risk of type 2 errors.

**Conclusions**

ACDF in carefully selected patients with CDD appears to be safe in the outpatient setting, provided a sufficient postoperative observation period. The clinical outcome and patient satisfaction of outpatients are comparable to that of inpatients.

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**Conflicts of interest**

Bjarne Lied and Kåre Ekseth are shareholders in the Oslofjord Clinic, and Eirik Helseth works part-time as a consultant at the Oslofjord Clinic.

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