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Outpatient Cervical and Lumbar Spine Surgery is Feasible and Safe: A Consecutive Single Center Series of 1449 Patients

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BACKGROUND: There is an increasing demand for surgery of degenerative spinal disease. Limited healthcare resources draw attention to the need for cost-effective treatments. Outpatient surgery, when safe and feasible, is more cost effective than inpatient surgery.

OBJECTIVE: To study types and rates of complications after outpatient lumbar and cervical spine decompressions.

METHODS: Complications were recorded prospectively in 1449 (1073 lumbar, 376 cervical) outpatients undergoing microsurgical decompression for degenerative spinal disease at the private Oslofjord Clinic from 2008 to 2013.

RESULTS: Surgical mortality was 0%. A total of 51 (3.5%) minor and major complications were recorded in 51 patients. Three (0.2%) patients had to be admitted to a hospital the day of surgery. Twenty-two (1.5%) patients were admitted to a hospital within 3 months due to surgery-related events. The encountered complications were postoperative hematoma (0.6%), neurological deterioration (0.3%), deep wound infection (0.9%), dural lesions with cerebrospinal fluid leakage (1.0%), persistent dysphagia (0.1%), persistent hoarseness (0.1%), and severe pain/headache (0.4%). All of the life-threatening hematomas were detected within 6 and 3 hours after cervical and lumbar surgery, respectively.

CONCLUSION: This series of 1449 consecutive outpatient microsurgical spine decompressions adds to the growing literature in favor of outpatient spinal surgery in properly selected patients. In our study, 99.8% of the patients were successfully discharged either to their homes or to a hotel on the day of surgery. The overall complication rate was 3.5%, surgical mortality was 0%, and only 1.5% had to be admitted to a hospital within 3 months after surgery.

KEY WORDS: Ambulatory care, Cervical spondylosis, Discectomy, Lumbar spondylosis, Postoperative complications, Spinal degenerative diseases

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There is an increasing demand for surgical treatment of degenerative spinal disease (DSD), which can be attributed to an ever-increasing population, a higher proportion of the elderly, and increased public awareness of favorable clinical outcome after surgery for DSD.[1-7] This increased demand is problematic in a time of limited healthcare resources, and it generates the need for more efficient and cost-effective treatments. Outpatient surgery, when safe and feasible, is a more cost-effective option than inpatient surgery. Based on short operating room time and moderate postoperative pain, microsurgical decompression of the cervical and lumbar spine may be well suited for outpatient surgery. Several studies have already been published claiming the feasibility, safety, and satisfactory clinical outcome after anterior cervical decompression and fusion (ACDF) and posterior

ABBREVIATIONS: ACDF, anterior cervical decompression and fusion; **ACS-NSQIP,** American College of Surgeons National Surgical Quality Improvement Program; **ASA,** American Society of Anesthesiologists; **CSF,** cerebrospinal fluid; **DSD,** degenerative spinal disease; **DVT,** deep vein thrombosis; **PE,** pulmonary embolism

lumbar decompression in the outpatient setting.[8-16] However, there is still some skepticism regarding outpatient spine surgery, especially regarding diagnosis and management of early complications.

In order to evaluate the feasibility and safety of outpatient microsurgical decompression of the cervical and lumbar spine for DSD, we have reviewed 1449 (1073 lumbar and 376 cervical) consecutive patients undergoing microsurgical decompression for DSD in the outpatient setting at the private Oslofjord Clinic. To our knowledge, this is the largest single-center outpatient series published to date.

METHODS

This is a prospective single-center study of outpatients undergoing cervical or lumbar spinal decompression for DSD from March 1, 2008 to July 29, 2013. The study was performed at the Oslofjord Clinic (www.oslofjordklinikken.no), a private neurosurgical clinic located in a suburb of Oslo. The clinic is located adjacent to a private radiology center, which houses a state-of-the-art computed tomographic (CT) scanner and magnetic resonance imaging (MRI) and ultrasound scanners (www.curato.no). The main neurosurgical unit in the health region is located at Oslo University Hospital (www.oslo-universitetssykehus.no). The government covers all surgeries performed at Oslo University Hospital, whereas private health insurance or the patients themselves pay for outpatient surgery performed at the Oslofjord Clinic.

Inclusion Criteria

One or more of the following symptoms and signs of spinal degenerative disease had to be present: persistent, severe radicular pain lasting for at least 6 weeks; radiculopathy with progressive paresis; lumbar stenosis with spinal claudication; and cervical myelopathy secondary to cervical spinal canal stenosis.

MRI-documented DSD with compression of nerve roots or spinal cord correlating with clinical symptoms and signs was mandatory.

Exclusion Criteria

Exclusion criteria included spine trauma within the past 4 weeks, spine neoplasia, ongoing spine infection, nerve roots or dural sac could not be adequately decompressed using a microsurgical technique (ACDF, posterior cervical foraminotomy, posterior lumbar microsurgical decompression), patient requiring lumbar fixation or posterior cervical fixation, patients unable to care for individual needs, cognitively impaired patients, and medical comorbidity necessitating more than 6 hours of postoperative observation.

Surgery

Each surgery was always performed by 2 experienced board-certified neurosurgeons. A total of 5 neurosurgeons have worked at the Oslofjord Clinic during the study period. All procedures were done under total intravenous anesthesia. Free airways were secured with a laryngeal mask during lumbar surgery and with orotracheal intubation during cervical surgery. For posterior lumbar microsurgical decompression, the Caspar technique was used, with the patients in a knee-chest-elbow position on an Andrews table.[17] Anterior cervical decompression and fusion was performed in accordance with the technique originally described by Robinson and Smith.[18] A right-sided skin incision was used, and fusion was attained with PEEK cages (Medtronic; Cornerstone, Memphis, Tennessee; and Synthes; Cervios, Oberdorf, Switzerland). In patients with more severe root canal stenosis, without disc-associated anterior stenosis, microsurgical posterior cervical foraminotomy was performed with patients in a prone position using the Caspar tubular retractor.[19,20] Neck collars were not used after cervical surgery.

Wound drainage was not routinely done. We administered either a single dose of cephalothin (30 mg/kg) intravenously or an oral dose of azithromycin 500 mg × 2 prophylactically, prior to surgery. As part of postoperative pain management, a single dose of intravenous dexamethasone 8 mg and local wound injection of 20 mL of bupivacaine hydrochloride 5 mg/mL with adrenaline 5 μg/mL were administered on initiation of surgery.

Postoperative Care

All cervical surgeries were scheduled for the morning in order to allow for sufficient postoperative observation and discharge before 9 pm on the day of surgery. The patients were observed in a recovery unit that had 3 beds, 5 resting chairs, and was staffed with 1 specialty trained nurse. The observation was continuous and both neurosurgeon and anesthesiologist were available at all times. Our protocol for outpatient surgery is observation for 6 hours and 3 hours after cervical and lumbar spine decompression, respectively. After 2 hours, the cervical patients were mobilized and permitted to walk about the recovery unit. The lumbar patients were mobilized 1 hour after surgery. Patients were discharged if the following postoperative checklist was satisfactory: adequate pain control, adequate wound hemostasis, stable neurological status, and ability to drink, urinate, and walk. Patients who had a travel distance >1.5 hours 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. One of the board-certified neurosurgeons can be contacted by mobile phone 24 hours a day, 7 days a week and patients were requested to call the clinic with any question or concerns. The day after surgery the patients were contacted by either a specialty trained nurse or by a neurosurgeon. A follow-up telephone consultation was routinely done 6 weeks after surgery. If the patients had problems or complaints during this consultation, they received further supervision.

The following variables were registered: age, sex, height (cm), bodyweight (kg), body mass index (kg/m^2), smoking history, medication(s), American Society of Anesthesiologists class (ASA 1-5), previous surgery for DSD, primary or repeat surgery (repeat surgery defined as surgery on the same level and side), type of surgery (ACDF, ACDF with anterior plating, posterior foraminotomy, lumbar discectomy, lumbar decompression without discectomy), number of levels operated (single, 2, or 3 levels), time from initiation to completion of anesthesia (minutes), time from initiation to completion of surgery (minutes), time from completion of anesthesia to discharge (minutes), discharge to home/hotel or hospital, admission to a hospital within 12 weeks after surgery, reoperation within 12 months (inadequate decompression, recurrent disc herniation, or decompression of another level/other side), death within 30 days after surgery, postoperative hematoma requiring surgical evacuation, deep postoperative infection requiring antibiotic treatment, dural tear with cerebrospinal fluid (CSF) leak, thromboembolism presenting within 1 month after surgery, neurological deterioration, persistent dysphagia at 3 months, persistent hoarseness at 3 months, and admission to a hospital for whatever reason. The parameters were registered as yes/no where no other options are specified. The prospective

registration of complications was done as follows: before discharge by a neurosurgeon, the day after surgery by a neurosurgeon or specialty trained nurse, at the follow-up telephone consultation 6 weeks after surgery by a neurosurgeon, and finally patients were requested to call the clinic with any question or concerns. All complications were prospectively registered in the patient's chart.

Database

The data were entered into an Excel spreadsheet (Microsoft; Office 2007, Redmond, Washington) and then imported into a statistical analysis software (SPSS Inc.; SPSS Statistics v 16.0, Chicago, Illinois).

Ethics

The Data Protection Official at Oslofjord Clinic approved the study. The patients were given ID numbers; all patient-sensitive information was stored on a separate storage device in a locked compartment at the Oslofjord Clinic.

RESULTS

Patient Characteristics

This feasibility and complication study includes 1449 consecutive outpatients who underwent microsurgical spine decompression for DSD at the Oslofjord Clinic; there were 376 cervical and 1073 lumbar procedures. The median age at time of surgery was 50 years (range, 16-86) and 29% were female. Twenty percent of the patients had previously undergone surgery for DSD, 3% in the cervical region and 17% in the lumbar region. Patient characteristics are shown in Table 1.

Patient Time Studies

The median wait list for initial neurosurgical consultation was 7 days (range, 0-47). Ten percent (n = 152) of patients eventually treated with surgery were initially recommended conservative treatment. Median time from first consultation to surgery for patients in whom surgery was recommended was 14 days (range, 0-98) and 51 days (range, 12-178) for patients in whom conservative treatment was recommended.

Mean durations of anaesthesia, surgery, and postoperative observation for cervical surgery were 102 minutes (range, 60-195), 65 minutes (range, 25-155), and 341 minutes (range, 185-645), respectively. Mean durations for lumbar surgery were 74 minutes (range, 30-197), 45 minutes (range, 15-135), and 182 minutes (range, 70-410), respectively. Table 2 presents duration of postoperative observation after cervical and lumbar surgery in detail.

In our study, 1446 out of 1449 (99.8%) patients were successfully discharged either to their homes or to a hotel on the day of surgery.

Surgical Mortality

The surgical mortality rate, defined as death within 30 days of surgery, was 0%.

Complications

A total of 51 major and minor complications were recorded in 51 individual patients. Detailed summaries of these 51 complications are shown in Tables 3 and 4.

Hospital Admission

Three (0.2%) patients had to be admitted to hospital the day of surgery.

- Patient 1: A 49-year-old female had immediate left arm paresis and involuntary limb movements after 1-level ACDF. A cerebrovascular event was suspected, albeit never confirmed on MRI. The patient has not fully recovered.
- Patient 2: A 62-year-old male had immediate left-sided hemiparesis after 1-level ACDF. A cerebrovascular event was suspected, and MRI showed an infarction in the right cerebral hemisphere. The patient has not fully recovered.
- Patient 3: A 75-year-old male woke up with acute abdominal pain after 1-level lumbar discectomy. Intraoperatively there had been an episode of profuse bleeding from the disc space lasting less than 1 minute. A retroperitoneal bleeding/hematoma was suspected and an abdominal CT was done emergently at the radiology center adjacent to the Oslofjord Clinic. A retroperitoneal hematoma was confirmed. The patient was stable and was emergently transferred to Oslo University Hospital. He received 2 units of packed cells and was managed conservatively. The patient fully recovered.

A total of 22 (1.4%) patients were admitted to a hospital within 3 months due to postoperative complications; they are listed in Table 3. Six of these patients were admitted for observation due to severe headache or back pain. CSF leak or deep infection was suspected in these patients, but was not confirmed. All but 1 (patient 19 in Table 3) recovered without the need for further interventions. Diagnostics did not reveal the cause of the patient's symptoms. Patients 1 to 3 are described in detail above.

Postoperative Hematoma

A clinically significant postoperative hematoma was seen in 9 out of 1449 (0.6%) patients, 2 after cervical and 7 after lumbar surgery. Three of the 9 patients were on medication containing acetylsalicylic acid. Postoperative hematoma occurrence was significantly higher in patients containing acetylsalicylic acid (Fisher's exact test, $P < .02$).

Eight of the 9 postoperative hematomas were discovered and treated with clot removal prior to discharge from the Oslofjord Clinic. The patients were then discharged either to their homes or to a hotel on the day of surgery; they had no further complications and recovered without sequelae. The ninth patient is patient 3 in Table 3 and is described in detail in previous sections.

Infection

Deep postoperative infection was seen in 13 out of 1449 patients (0.9%). Median time from surgery to diagnosis of infection was 27 days (range, 14-103). The infection rate was 13

TABLE 1. Patient Characteristics[a]

	N (%)
Total number	1449 (100)
Lumbar surgery	1073 (74.1)
Cervical surgery	376 (25.9)
Females	414 (28.6)
Age (y)	
<20	4 (0.3)
20-34	120 (8.3)
35-49	566 (39.1)
49-64	553 (38.2)
65-79	184 (12.7)
>80	22 (1.5)
Previously surgery	288 (19.9)
Smoker	
Yes	301 (20.8)
Missing data	5 (0.3)
BMI	
<18.5	8 (0.6)
18.5-24.9	511 (35.3)
25-29.9	707 (48.8)
30-34.9	184 (12.7)
35-39.9	26 (1.8)
>40	1 (0.1)
Missing data	12 (0.8)
ASA	
1	513 (35.4)
2	887 (61.2)
3	40 (2.8)
4	0
5	0
Missing data	9 (0.6)
Medication	
Antiplatelet, aspirin (acetylsalisylic acid)	109 (7.5)
Antiplatelet other than aspirin (ie, clopidogrel)	8 (0.6)
Anticoagulant (dicumarol or dabigatran)	15 (1.0)
Immunosupressants (mainly glucocorticoids)	27 (1.9)
Broncholytics	89 (6.1)
Antihypertensives	243 (16.8)
Insulin or peroral antidiabetics	55 (3.8)
Medication for other endocrine disease (mainly thyroxine)	59 (4.1)
Surgery	
Primary	1339 (92.4)
Repeat (same level and side)	110 (7.6)
Type of surgery	
ACDF 1 level	219 (15.1)
ACDF 2 levels	126 (8.7)
ACDF 1 level w/plate	6 (0.4)
ACDF 2 levels w/plate	4 (0.3)
Cervical foraminotomy 1 level	13 (0.9)
Cervical foraminotomy 2 levels	8 (0.6)
Lumbar discectomy 1 level	683 (47.1)
Lumbar discectomy 2 levels	20 (1.4)
Lateral recess/foraminal stenosis 1 level	96 (6.6)
Lateral recess/foraminal stenosis 2 levels	26 (1.8)
Lumbar spinal stenosis 1 level	168 (11.6)
Lumbar spinal stenosis 2 levels	71 (4.9)
Lumbar spinal stenosis 3 levels	9 (0.6)

(Continues)

TABLE 1. *Continued*

[a]ACDF, anterior cervical decompression and fusion; ASA, American Society of Anesthesiologists class; BMI, body mass index.

out of 1073 (1.2%) after lumbar surgery and 0 out of 373 after cervical surgery. The infection rate after lumbar discectomy was 12 out of 703 (1.7%), compared to 1 out of 370 (0.3%), after lumbar decompression without disruption of the disc space. There was no correlation between age/sex and infection rate. In 6 out of 13 patients, an abscess at the surgical site was found; these patients were treated with surgical drainage of the abscess followed by long-term antibiotics therapy. In 7 out of 13 patients, a discitis was diagnosed on MRI; these patients were treated with long-term AB therapy. In our study, 11 out of 13 patients have fully recovered or have only minor sequelae after deep postoperative infection; the remaining 2 still have symptoms post infection and subsequently, have a reduced capacity to work and quality of life.

Swallowing and Hoarseness After ACDF

Two patients had difficulties with swallowing and 2 patients had hoarseness lasting for more than 6 months after 1-level ACDF. A unilateral vocal cord paresis was diagnosed in 1 patient; in the remaining 3, no definite cause could be established.

Dural Tears and CSF-Leakage

In our study, 15 out of 1449 (1.0%) patients had a dural tear with CSF leakage: 1 out of 376 (0.3%) cervical and 14 out of 1073 (1.3%) lumbar. Thirteen of these had a small dural tear and CSF leakage was recognized intraoperatively. These small dural defects

TABLE 2. Length of Postoperative Observation (Minutes)

	N (%)
Cervical	
<240 min	6 (1.6)
240-299 min	42 (11.2)
300-359 min	203 (54.0)
>360 min	111 (29.5)
Missing data	14 (3.7)
Lumbar	
<120 min	31 (2.9)
120-149 min	143 (13.3)
150-179 min	315 (29.4)
>180 min	521 (48.6)
Missing data	63 (5.9)

TABLE 3. Overview of the 51 Patients With Complications[a]

Patient No.	Age	Sex	Type of Surgery	Hospitalized[b]	Time PO[c]	Diagnosis	Treatment	Recovered[d]
1	49	F	Cervical	Yes	0 d	Stroke	Observation and rehabilitation	No
2	62	M	Cervical	Yes	0 d	Stroke	Observation and rehabilitation	No
3	75	M	Lumbar	Yes	0 d	Retroperitoneal hematoma	Observation and blood transfusion	Yes
4	35	M	Lumbar	Yes	20 d	Back pain	Observation	Yes
5	75	M	Lumbar	Yes	21 d	Deep infection	Evacuation of abscess and AB	Yes
6	31	M	Lumbar	Yes	11 d	Headache	Duraplasty	No
7	58	M	Lumbar	Yes	13 d	Neck pain	Duraplasty	Yes
8	44	F	Lumbar	Yes	14 d	Deep infection	Evacuation of abscess and AB	Yes
9	48	M	Lumbar	Yes	27 d	Deep infection	AB	Yes
10	59	M	Lumbar	Yes	24 d	Deep infection	Evacuation of abscess and AB	No
11	52	F	Lumbar	Yes	6 d	Headache	Observation	Yes
12	46	M	Lumbar	Yes	19 d	Headache	Observation	Yes
13	61	M	Cervical	Yes	7 d	Muscular weakness arm	Observation and rehabilitation	Yes
14	42	F	Lumbar	Yes	1 d	Muscular weakness leg	Observation	No
15	61	F	Lumbar	Yes	26 d	Deep infection	Evacuation of abscess and AB	Yes
16	78	F	Lumbar	Yes	20 d	Deep infection	AB	Yes
17	64	M	Lumbar	Yes	32 d	Deep infection	Evacuation of abscess and AB	Yes
18	49	M	Lumbar	Yes	5 d	Back pain	Observation	Yes
19	49	F	Lumbar	Yes	33 d	Back/leg pain	Observation	No
20	37	M	Lumbar	Yes	41 d	Back pain	Reexploration	Yes
21	41	M	Cervical	No	240 m	PO Hematoma	Evacuation	Yes
22	36	M	Lumbar	No	60 m	PO Hematoma	Evacuation	Yes
23	39	F	Cervical	No	135 m	PO Hematoma	Evacuation	Yes
24	32	M	Lumbar	No	80 m	PO Hematoma	Evacuation	Yes
25	77	F	Lumbar	No	60 m	PO Hematoma	Evacuation	Yes
26	86	M	Lumbar	No	105 m	PO Hematoma	Evacuation	Yes
27	70	M	Lumbar	No	160 m	PO Hematoma	Evacuation	Yes
28	64	F	Lumbar	No	155 m	PO Hematoma	Evacuation	Yes
29	37	M	Lumbar	Yes	82 d	Deep infection	AB	Yes
30	51	M	Lumbar	No	41 d	Deep infection	AB	Yes
31	57	M	Lumbar	Yes	90 d	Deep infection	AB	No
32	69	M	Lumbar	No	49 d	Deep infection	Evacuation of abscess and AB	Yes
33	44	M	Cervical	No	0 d	Dysphagia	Otolaryngology	No
34	53	M	Cervical	No	0 d	Dysphagia	Otolaryngology	No
35	44	M	Cervical	No	0 d	Voice problems	Otolaryngology	No
36	55	F	Cervical	No	0 d	Recurrent laryngeal nerve palsy	Otolaryngology	No
37	53	F	Lumbar	No	Intraop	CSF leak	TachoSil	Yes
38	59	M	Lumbar	No	Intraop	CSF leak	TachoSil	Yes
39	78	M	Lumbar	No	Intraop	CSF leak	TachoSil	Yes
40	59	M	Lumbar	No	Intraop	CSF leak	TachoSil	Yes
41	70	F	Lumbar	No	Intraop	CSF leak	TachoSil	Yes
42	66	F	Lumbar	No	Intraop	CSF leak	TachoSil	Yes
43	69	M	Lumbar	No	Intraop	CSF leak	TachoSil	Yes
44	64	M	Cervical	No	Intraop	CSF leak	TachoSil	Yes
45	76	F	Lumbar	No	Intraop	CSF leak	TachoSil	Yes
46	74	M	Lumbar	No	Intraop	CSF leak	TachoSil	Yes
47	68	F	Lumbar	No	Intraop	CSF leak	TachoSil	Yes
48	47	M	Lumbar	No	Intraop	CSF leak	TachoSil	Yes
49	57	F	Lumbar	No	Intraop	CSF leak	TachoSil	Yes
50	35	F	Lumbar	No	14 d	Deep infection	AB	Yes
51	32	M	Lumbar	No	103 d	Deep infection	AB	Yes

[a]AB, antibiotics; F, female; Intraop, intraoperative; M, male; PO, postoperative.
[b]Hospitalized due to surgical complication.
[c]Time PO: time from surgery to diagnosis of surgical complication (d, days; m, minutes).
[d]Recovered: fully recovered from the signs and symptoms caused by the complication within 12 months after surgery.

TABLE 4. Summary of Complications After Cervical and Lumbar Surgery

Event	Cervical (n = 376), N (%)	Lumbar (n = 1073), N (%)
Postoperative hematoma	2 (0.5)	7 (0.7)
Neurological deterioration	3 (0.8)	1 (0.1)
Persistent dysphagia	2 (0.5)	0
Persistent hoarseness	2 (0.5)	0
Deep postoperative infection	0	13 (1.2)
Dural lesion	1 (0.3)	14 (1.3)
Thromboembolism	0	0
Graft dislocation	0	Not applicable
Admitted for observation	0	6 (0.6)

were closed/sealed with a double layer of TachoSil (Takeda Pharmaceuticals International GmbH, Zürich, Switzerland). All 13 patients were mobilized out of bed and discharged either to their home or to a hotel on the day of surgery and had an uneventful complete recovery. The remaining 2 patients were hospitalized at a later date due to CSF leakage with development of a pseudocyst.

- A 31-year-old male (patient 6 in Table 3) underwent uneventful lumbar spine decompression and was admitted to a hospital 11 days postoperatively due to headache and radiating pain. A lumbar pseudocyst was suspected, and the diagnosis was confirmed on MRI. Dural repair was performed, but the patient has not fully recovered: he still has radiating pain.
- A 58-year-old male (patient 7 in Table 3) underwent uneventful lumbar spine decompression and was admitted to a hospital 13 days postoperatively due to severe neck pain. A lumbar pseudocyst was suspected, and the diagnosis was confirmed on MRI. Duraplasty was performed and the patient fully recovered.

Neurological Deterioration

Neurological deterioration was seen in 4 out of 1449 patients. Two of these patients had symptoms of a stroke postoperatively and are patients 1 and 2 in Table 3; they are described in detail in previous sections. The remaining 2 patients had a postoperative paresis.

- A 61-year-old male (patient 13 in Table 3) developed sudden right-sided paresis of C5- and C6-inervated muscle 7 days after 2-level ACDF with plating; no cause could be found. After rehabilitation, the patient has recovered considerably, and at 1 year postoperatively, the patient has only minor deficits.
- A 42-year-old female (patient 14 in Table 3) had immediate leg weakness after 1-level lumbar discectomy. Postoperative hematoma with compression of the dural sac was suspected and exploration of the operated level was performed emergently; however, no compression was found. The patient was discharged and was admitted to a hospital the following day. Additional diagnostics did not reveal the cause of the patient's symptoms. The patient has not fully recovered and has reduced quality of life.

Reoperation

Within 12 months after surgery, 67 of 1449 (4.6%) patients underwent reoperation at the Oslofjord Clinic or at another hospital. In 12 out of 67 patients, the reason was inadequate decompression, in 30 out of 67 it was herniated disc recurrence, and in 25 out of 67 it was due to the need for decompression of another level or side. Reoperation rates for cervical and lumbar patients are shown in Table 5.

DISCUSSION

In a time of limited healthcare resources and steadily increasing rates of degenerative spine surgery, there needs to be a focus on efficient and cost-effective treatment.[4,7] By virtue of the fact that outpatient surgery is more cost effective than inpatient surgery, more DSD surgery should be done on an outpatient basis in the future. Several studies have already been published claiming the feasibility, safety, and favorable clinical outcome after ACDF and posterior lumbar decompression in the outpatient setting.[8-16] However, there continues to be a great deal of skepticism regarding outpatient spine surgery, especially in the diagnosis and treatment of early surgical complications such as hematomas. This series of 1449 consecutive outpatient microsurgical spine decompressions, 376 cervical and 1073 lumbar, adds to the growing literature in favor of outpatient spine surgery, in properly selected patients. In our study, 99.8% of the patients were successfully discharged either to their homes or to a hotel on the day of surgery. The surgical mortality was 0%, the overall complication rate was 3.5%, and only 1.5% had to be admitted to a hospital within 12 weeks after surgery.

Surgical Mortality

The reported mortality rate after ACDF and lumbar spine decompression without fusion in recently published large series is reported to be in the range of 0.1% to 0.3%.[14,21-23] The 2 major risk factors for surgical mortality in these series are high age and high comorbidity score. Our 30-day mortality of 0% is in agreement with these recent reports.

TABLE 5. Resurgery Within 12 Months

	Cervical N (%)	Lumbar N (%)
Total with observation period >12 mo	376 (100)	1073 (100)
Inadequate decompression	1 (0.2)	11 (1.0)
Decompressed at wrong level	0	0
Repeat disc herniation	1 (0.2)	29 (2.7)
Decompression of another level or side	2 (0.5)	23 (2.1)

Overall Complication Rate

The follow-up in this study was 100% and the overall complication rate was 3.5%. This is a low complication rate compared to the rates reported for general spine surgery.[21,24,25] Pugely et al[14] recently compared outpatient complication rates to inpatient complication rates after lumbar discectomy. In the study, which was based on the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database, they found an overall complication rate of 6.5% after inpatient surgery and 3.5% after outpatient surgery. This figure is almost identical to the complication rate for outpatient surgery in this study. Fineberg et al[22] compared complication rates after cervical spine surgery between teaching and nonteaching hospitals, based on data from the US Nationwide Inpatient Sample. Patients treated in teaching hospitals demonstrated a higher complication rate than those treated in nonteaching hospitals. A possible explanation for the difference in complication rates between outpatients vs inpatients and between teachings vs nonteaching hospitals could be the higher comorbidity of inpatients and patients treated at teaching hospitals. Several prominent spine surgeons have addressed the lack of uniform standards for reporting complications, both regarding type of complications and length of follow-up in which complications are recorded.[21,25,26] We acknowledge this lack of a uniform standard for reporting complications.

Stroke and Myocardial Infarction

The rates of perioperative stroke and cardiac events in surgery for DSD is reported to be 0.1% and 0.3% to 0.5%, respectively.[14,27] Although rare, these complications are feared and associated with prolonged hospitalization, increased medical costs, morbidity, and mortality.[22,27] In this study, the stroke rates after cervical and lumbar surgery were 0.5% and 0%, respectively. The higher risk of stroke after ACDF may be related to the retraction/manipulation of the carotid artery during ACDF surgery. None of the patients in our study had a perioperative cardiac event.

Postoperative Hematoma

Postoperative hematoma after ACDF can cause either airway obstruction or compression of the spinal cord. Our previous studies have shown that these complications manifest early in the postoperative period, and that a 6-hour observation period after ACDF should be a sufficient amount of time for detecting these complications.[13,28] Postoperative lumbar hematomas can be divided into 2 groups: epidural hematomas and retroperitoneal hematomas. Epidural hematomas compress the dural sac and can cause muscular weakness in the legs and cauda equine symptoms, while retroperitoneal hematomas can become massive and life threatening. Our rate of postoperative hematoma was 0.6%: 0.7% after ACDF and 0.5% after lumbar decompression. One of the lumbar hematomas was retroperitoneal. All of the hematomas in this study were detected prior to the patients being discharged from the outpatient surgery unit. The patient with the retroperitoneal hematoma was emergently transferred to a hospital for additional treatment. The other patients with postoperative hematomas were reoperated immediately at the outpatient clinic and discharged either to their homes or to a hotel the same day; all recovered without hematoma-associated sequelae.

The reported rate of postoperative hematoma after ACDF and lumbar decompression without fusion in modern series are in the range of 0.3% to 0.6%[11,13,25,28,29] and 0.2% to 1.0%, respectively.[6,8,30,31] Retroperitoneal hematoma, also known as the nightmare of lumbar discectomy, has an incidence of less than 0.1% according to the existing literature.[32-35] If a postoperative hematoma compressing the airways or dural sac is suspected, we recommend emergent surgery without preoperative imaging. If a retroperitoneal hematoma is suspected, we recommend immediate stabilization of the patient followed by a CT scan of the retroperitoneal area. If a retroperitoneal hematoma is confirmed, the patient must be emergently transferred to a hospital that has expertise in vascular surgery and endovascular intervention.

Dysphagia After ACDF

Dysphagia is a common complaint in the immediate postoperative period. It is a subjective symptom and can therefore be difficult to classify. Some consider dysphagia to be given, and therefore not a complication of ACDF.[36] In a prospective study, Bazaz et al[37] reported dysphagia in 50% of patients 1 month after ACDF surgery, while only 4.9% had persistent dysphagia at 6 months. In our study, 0.5% of patients reported dysphagia at 6 months postoperatively. Siska et al[38] compared dysphagia rates after ACDF and posterior lumbar surgery. There was more dysphagia in the ACDF group when compared to the posterior lumbar surgery group at 3 weeks after surgery, but no difference at 1.5 years after surgery; the conclusion being that the increased amount of dysphagia in the early postoperative period after ACDF was caused by anterior cervical dissection and not intubation. Recently, Radcliff et al[39] reported that long-term dysphagia rates after posterior cervical surgery were similar to those after ACDF; they also found that dysphagia correlated with postoperative pain.

Hoarseness After ACDF

Slight hoarseness is a common complaint in the immediate postoperative period after ACDF. The symptom usually resolves within a few weeks in most cases. In all probability, the hoarseness is a result of intubation, cervical dissection, and perioperative retraction of soft tissue. In some cases the hoarseness persists, as it did in 2 patients (2/376) in this study; a unilateral vocal cord paresis was found in 1 of the patients, most likely secondary to intraoperative injury of the recurrent laryngeal nerve. We always use a right-sided approach, which some have found increases the risk of injury to the recurrent laryngeal nerve when compared to a left-sided approach[40]; others have disputed this finding.[41]

Infection

The rates of deep postoperative infection after cervical and lumbar decompression in this study were 0% and 1.2%, respectively. These rates are comparable to the rates, in the lower range, published in recent series[6,9,14,29,30,42] and are much lower than infection rates reported for general spine surgery.[24,25] Pugely et al[14] recently reported, based on the ACS-NSQIP database, lower infection rates for outpatients undergoing lumbar discectomy than for inpatients. In this study, postoperative infection was more frequent after lumbar discectomy than it was after posterior decompression without discectomy, indicating that disruption of the disc space may be a risk factor for infection. Median time from surgery to diagnosis of infection was 27 days. Deep infections should be treated with systemic antibiotic therapy for 6 to 12 weeks and MR-verified abscesses should be drained surgically. Deep postoperative infections are associated with prolonged hospitalization, increased medical costs, and persistent morbidity in some patients. In our study, 11 out of 13 patients with a postoperative infection had a complete recovery.

Dural Tear, CSF-Leakage, and Pseudocyst Formation

In this series, 15 out of 1449 (1.0%) patients had a dural tear with CSF leakage. Thirteen of these CSF leakages were acknowledged intraoperatively and immediately repaired; the patients recovered completely. In the remaining 2 patients, CSF leakage was not recognized intraoperatively and the patients subsequently presented with symptomatic lumbar pseudocysts necessitating treatment. Others report the incidence of dural tear/CSF leakage after general spine surgery, ACDF and posterior lumbar decompression to be 4%, 0.2% to 0.5%, and 0.4% to 0.5%, respectively.[9,25,36,42]

Pulmonary Embolism and Deep Vein Thrombosis

Postoperative pulmonary embolism (PE) and deep vein thrombosis (DVT) are feared complications that are associated with increased mortality, prolonged hospitalization, and increased medical expenses.[23,43,44] The combined complication rates of DVT/PE in recently published, large spinal surgical studies are in the range of 0.3% to 1%.[14,23,43,44] The low rates of DVT/PE in this study are in agreement with the aforementioned studies. In our opinion, routine use of low molecular weight heparin prophylaxis is not indicated for DSD treated by microsurgery. Low molecular weight heparin should, however, be considered for high-risk patients. We strongly recommend early mobilization and the liberal use of compression stockings.

Reoperation Rate

The 12-month reoperation rate for persistent or newly discovered nerve compression was 4.6% (1.1% after cervical procedures and 5.9% after lumbar procedures). The indications for reoperation were inadequate primary decompression in 18%, recurrent disc herniation in 45%, and need for decompression at another level or side in 37%. The reoperation rate within 12 months after lumbar decompression without fusion is reported to be in the range of 5.3% to 7.4%.[6,30,45] A study based on the Thomson Reuters Market Scan including 28777 patients operated with ACDF for DSD, reported a 2-year revision rate of 10%.[46]

Waitlists for Initial Evaluation and Surgery

It is not unusual for there to be more than a 6-month waitlist from the time of referral by a general practitioner to elective surgery for DSD in Norway. The long waitlists incur unnecessary sick leave expenses, prolonged suffering for patients, and risk of suboptimal postoperative outcome.[47] Ideally, the waitlist for surgery should be no more than 3 months and healthcare systems should be organized in order to achieve this goal, as it is not only more cost effective for society, but also better for patients.

Medical Malpractice Litigation

In Norway, medical malpractice litigation is not nearly as widespread as it is in the United States, and the legal climate regarding medical malpractice is much more benign in Norway than it is in the United States. All legal claims are handled and paid through government-based programs, and there are universal, strict caps on damages, which contributes to the stable medical malpractice climate in Norway. The government-based programs have also established the following universal, strict criteria that must be fulfilled in order for patients to receive compensation: the injury/damages must result in financial loss for the patient >5000 NOK (~750 USD), the injury/damages must be a direct result of the medical treatment, and there must be a basis for liability.

As a result of the aforementioned, the outrageous claims seen in the United States that contribute to rising malpractice insurance costs, the occasional need for doctors to either shut down their practices or to uproot their practices to less litigious states, and to settlements that far exceed cost savings achieved do not exist in Norway.

Main Issues to Consider When Performing Outpatient Neurosurgical Procedures

- Selection of an experienced team that works well together. In our opinion, this is not a suitable setting for residents.
- Implementation of strict inclusion and exclusion criteria for outpatient surgery.
- Providing detailed preoperative patient information regarding outpatient surgery, the surgical procedure itself, possible complications, prognosis, discharge, and follow-up.
- Focus on complication avoidance, quality, and patient satisfaction.
- State-of-the-art equipment.
- Close observation in a recovery unit after surgery. The length of the observation period must be established on a scientific basis.
- Organize a 24-hours contact telephone for discharged patients. Our experience is that the patients appreciate the opportunity to call us, but rarely do so. The calls we have received are mostly related to sleep disturbances, pain medication, and what level of physical exercise we recommend.
- Establishing a good and open relationship with a major inpatient hospital in the event of serious complications.

Postoperative Length of Observation Prior to Discharge

Based on previous studies of complications after microsurgery for degenerative spine disease, we think that a 6-hour observation period after a cervical procedure and a 3-hour observation period after a lumbar procedure are sufficient, if the following postoperative checklist is satisfactory: adequate pain control, adequate wound hemostasis, stable neurological status, and ability to drink, urinate, and walk. To date, we have not experienced any late life-threatening hematomas. It can be argued that we have been lucky thus far. This question can only be rightfully addressed through a collaborative effort of prospective registration and publication of complications after outpatient surgery.

Patient Selection for Outpatient Surgery

Adequate patient selection is a must for outpatient surgery. For beginners, we suggest the following selection criteria:

- The indication(s) for surgery must, as usual, be well documented
- Low patient comorbidity (ASA class I and II)
- Age <70 years
- One level lumbar disc, 1 level lumbar canal stenosis, or 1 level ACDF.

Preoperative Information Prior to Outpatient Surgery

Detailed preoperative information prior to outpatient surgery is mandatory and is of utmost importance when it comes to patient satisfaction. Our information includes:

- The indication(s) for surgery
- Differences between outpatient and inpatient surgery
- The surgical procedure itself
- Expected clinical outcome
- A detailed description of potential complications, including rates, severity, and subsequent treatment. The following complications are always discussed: postoperative hematoma, neurological worsening, surgical site infection, hoarseness, swallowing difficulties, dural tear/CSF leakage, and reoperation rate. For example: the risk of dural tear/CSF leakage is 1%, of which $>90\%$ are small tears that are recognized and repaired intraoperatively. Thus, the risk of a dural tear with postoperative CSF leakage or pseudocyst formation in need of surgical repair is 0.1%.

Patients Not Suitable for Outpatient Surgery

Not all patients are candidates for outpatient surgery. Based on our experience, we recommend inpatient surgery for the following situations:

- Significant patient comorbidity (ASA class ≥ 3)
- Discharge on the day of surgery not likely (for whatever reason)
- Noncooperative patient (eg, cognitive impairment)
- Moderate/severe myelopathy
- Cervical degenerative spinal disease requiring corpectomy, laminectomy, or posterior fusion
- Lumbar degenerative spine disease requiring laminectomy or instrumental fusion.

Referral to Inpatient Surgery

We do not have exact data, but estimate that $\sim$5% of our patients with private health insurance (the insurance covers all the expenses of outpatient surgery performed at a private clinic) were referred for inpatient surgery, while $\sim$10% to 15% of patients without private health insurance (the patient has to pay out of pocket for outpatient surgery at a private clinic) were referred for inpatient surgery. Referral for inpatient surgery in patients having private health insurance was almost always as a result of comorbidity, whereas for patients without private health insurance, financial concerns were as common as comorbidity.

Strengths

Data were collected at 1 health center (The Oslofjord Clinic), thereby reducing possible confounding factors in terms of differences between multiple health centers.

Outpatient units are often located in or close to a hospital. The Oslofjord Clinic is, however, located in a shopping mall approximately 15 km from Oslo University Hospital, and this distance from the closest hospital puts the concept of outpatient surgery to a test.

Limitations

Low complication rates increase the risk for type 2 errors.

The external validity of isolated studies such as this one is low. However, the study findings add support to the growing body of evidence that outpatient surgery for DSD is feasible and as safe as inpatient surgery.[8-15]

CONCLUSION

Microsurgical decompression of the degenerative lumbar and cervical spine in carefully selected patients seems to be feasible and safe in an outpatient setting dedicated to the purpose.

Disclosures

Bjarne Lied and Kåre Ekseth are shareholders/neurosurgeons at the Oslofjord Clinic. The other authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices described in this article.

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COMMENTS

The authors provide a feasibility and safety assessment of outpatient cervical and lumbar spine surgery based on a consecutive series of 1449 patients at a single center in Oslo, Norway. The surgical procedures were selected and included primarily anterior cervical discectomy and fusion, cervical foraminotomy, lumbar discectomy, and lumbar decompression. Undoubtedly, the patients for which outpatient surgery was offered were highly selected as well. Fairly lengthy post-procedure observation periods were provided before discharge, and patients were provided with the phone number of the surgeon who could be reached at any time. The authors report complication rates that seem to be comparable to those previously reported for similar procedures. More importantly, they seem to have, at least thus far, escaped the occurrence of complications that could be argued to have been made worse by lack of inpatient care after surgery.

Certainly, the authors should be congratulated for their skill and attempts to improve patient access and reduce cost. Undoubtedly their success not only rests on their technical abilities and patient selection skills, but also on the general population of patients they serve and a legal climate that is likely much more stable than it is in many areas of the United States.

Justin Smith
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This is the largest number of outpatient spinal surgery database reported in the literature. Although there is selection bias due to location and socioeconomic situations, the pure number of cases and well-kept database make this a very interesting study. One of the strengths is the fact that the authors included more conventional cases, not focused on the minimally invasive approach, which makes this study valid in general spinal surgery population. The overall complication rate of 3.5% among 1449 consecutive patients treated in an outpatient surgery center with readily available access to an inpatient admission hospital, if necessary, is within the reported complication rate from previous studies. All the patients were managed appropriately without any delay for their complications. This article makes a strong argument for outpatient surgical care for simple cervical and lumbar microsurgical decompression.

Anthony Sin
Shreveport, Louisiana

The authors report nearly 1500 cases of outpatient spine surgery. In this modern area of cost control and pressure for improvement in quality, this is a very important aspect of spinal surgery that should be evaluated. The authors have shown that within a very controlled setting and with very strict patient selection criteria, outpatient spine surgery is feasible. Many factors which make it possible have been delineated in this article. Although the study originates from Norway, there is hope that with certain infrastructures, this can also be applied to other areas of the world. The authors do seem to have successfully implemented a practice of outpatient spinal surgery, and this will be a very useful model on which to base further evaluation of the feasibility of widespread outpatient spine surgery.

Dean Chou
San Francisco, California