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Causes of same-route reoperations in degenerative cervical spine disease after a primary anterior approach

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ABSTRACT

Introduction: An anterior approach is most commonly used in procedures performed in cases of degenerative cervical spine disease (DCSD). Although generally considered safe, they are not free of complications that may result in the need for reoperation. The aim of the study is to analyse causes of reoperation via the same approach for DCSD in patients who have previously undergone one of the anterior cervical approaches.

Materials and methods: Of the 2,794 patients managed with a surgical procedure performed from an anterior approach, a total of 38 were reoperated on via the same anterior route between year 2004–2019 at a single tertiary centre. Retrospective assessment was conducted based on medical records and radiological imaging. Subjects were grouped into 2 categories: early revision surgeries (within 90 days of the 1st procedure) and late revision surgeries (after 90 days).

Results: The incidence of same-route reoperation was 1.36%. Late reoperations were over twice as frequent as early ones (n = 26 vs n = 12). The main cause for reoperation in the late group was adjacent segment disease (ASD; n = 25, 96.15%) whereas in the early group, persistent stenosis and implant dislocation were equally prevalent (each n = 3, 27.3%). The reoperations which were conducted earliest were due to emergent post-operative prevertebral hematomas (n = 2, 16.67%).

Conclusion: The risk of needing a same-route reoperation after anterior approaches in DCSD is relatively low with late revisions being more prevalent. Adjacent segment disease is the most common cause. Implant dislocation as well as persistent spinal canal stenosis are the main causes behind early revisions.

Keywords: degenerative cervical spine disease; anterior cervical approaches; anterior cervical discectomy with fusion; reoperation.

INTRODUCTION

Subject chosen by authors is a well-known problem for the majority of neurosurgeons. Therefore the aim of this study is to analyse causes of anterior cervical reoperations among patients in our institution. Anterior cervical discectomy and fusion (ACDF) is the most common procedure employed to treat cervical degenerative spine disease [1]. Anterior cervical discectomy and fusion as well as its kin techniques: anterior cervical corpectomy with fusion (ACCF) and total disc replacement (TDR), collectively termed anterior cervical approaches, have been proven to provide satisfactory outcomes, in both early and late degenerative cervical spine disease (DCSD) [2]. Nevertheless, they are known to pose a risk of specific complications requiring another surgery [3]. A higher comorbidity burden (ASA class >2), being older, diabetes mellitus, smoking, bleeding disorder and a longer surgery duration are risk factors responsible for increased reoperation rate as identified in a recent study [4]. Re-entering the same surgical anterior corridor is technically challenging and has a high risk of complications. This is due to the altered anatomical relations within the anterior cervical triangle, tissue fibrosis, and difficulties in identifying crucial neurovascular and visceral structures. Investigating complications of anterior cervical approaches which lead to the need for same-route reoperation is essential for their successful prevention or, if they happen, to address them as effectively as possible. It is now clear that our nervous system has a minimal ability of regeneration, therefore the most important task in coping with undesirable sequelae of neurosurgery is in promptly identifying the culprit. Although complications of anterior cervical approaches have been known for years, there is a growing demand for modern ways of managing them.

The majority of cases where same-route reoperation is required occur several years after primary surgery due to the progression of the DCSD. We can then afford an accurate consideration of a consecutive therapeutic process. In a recent study, Wong et al. described characteristics of patients vulnerable to developing an adjacent segment disease (ASD), hence we are able to assess the possibility of its development [5]. However, when it comes to early complications which mostly require taking immediate measures, neurosurgeons should know precisely how to act in various circumstances. On occasion, it will be necessary to cooperate with a cardiothoracic surgeon, for instance, in cases of mediastinitis caused by an esophageal perforation [6]. Certain complications can be managed by conservative treatment. Postoperative recurrent laryngeal nerve palsy can be treated pharmacologically by methylprednisolone for a few days with good results [7]. Several cases of multilevel cervical spondylotic myelopathy will require anterior as well as posterior

decompression at once to ensure a supplementary stability of the spinal cord [8].

MATERIALS AND METHODS

A search in the tertiary centre's database and retrospective evaluation of patients with DCSD were conducted. Those managed with anterior cervical approaches between December 2004 and January 2019 were enrolled in the study. Furthermore, the eligibility criteria required that the revision surgery was conducted via the same route. Therefore, exclusion criteria included reoperation entirely by means of posterior cervical approaches, initial procedure due to non-spondylogenic causes, insufficient medical records or lack of radiological imaging in the institutional database. The analysis was performed by 2

TABLE 1. Demographics and other characteristics of each patient included in the study

Case #	Age	Sex	TTR (days)	Early/Late	Initial stabilisation level	Reason for revision	Revision description
1.	57	F	17	early	C4-C7	CSF leakage	duraplasty
2.	67	M	15	early	C4-C7	ASD + myelopathy	C3-C7 fixed & decompressed
3.	45	F	550	late	C6-C7	ASD	C5-C7 fixed
4.	40	F	450	late	C6-C7	ASD	C5-C7 fixed
5.	60	F	49	early	C4-C5	implant dislocation	implant removal
6.	60	F	70	early	C5-C7	dysphagia	restabilized
7.	45	M	69	early	C3-C4	persistent stenosis	restabilized
8.	52	F	238	late	C5-C6	ASD	C3-C6 fixed
9.	42	M	1,036	late	C6-C7	ASD	C4-C5 & C6-C7 fixed
10.	63	M	66	early	C3-C4	persistent stenosis	restabilized
11.	56	M	795	late	C3-C4	ASD	C3-C5 fixed
12.	35	F	1,652	late	C6-C7	ASD	C5-C7 fixed
13.	43	F	1,566	late	C4-C6	ASD	C4-C7 fixed
14.	52	F	1,475	late	C5-C6	ASD	C5-C7 fixed
15.	49	F	55	early	C5-C7	persistent stenosis	restabilized
16.	57	M	156	late	C4-C6	ASD	restabilized
17.	47	F	792	late	C6-C7	ASD	C5-C7 fixed
18.	47	F	539	late	C6-C7	ASD	C5-C7 fixed
19.	52	F	470	late	C4-C6	ASD	restabilized
20.	52	F	140	late	C4-C7	keloid scar	keloid resected
21.	25	F	694	late	C4-C6	ASD	C4-C7 fixed
22.	54	F	291	late	C4-C6	ASD	C4-C7 fixed
23.	50	F	125	late	C3-C5	ASD	C3-C6 fixed
24.	43	F	37	early	C5-C7	implant dislocation	restabilized
25.	58	F	1,202	late	C5-C6	ASD	C5-C7 fixed
26.	37	F	380	late	C4-C6	ASD	C4-C7 fixed
27.	55	M	92	late	C5-C6	ASD	C4-C7 fixed
28.	51	M	361	late	C6-C7	ASD	C4-C7 fixed
29.	67	F	2,408	late	C4-C6	ASD	C3/C4 decompressed
30.	58	F	3,728	late	C3-C6	ASD	C3-C7 fixed
31.	34	F	3,553	late	C6-C7	ASD	C4-C5 & C6-C7 fixed
32.	50	F	18	early	C4-C7	implant dislocation	restabilized
33.	47	F	455	late	C5-C7	ASD	C4-C7 fixed
34.	37	F	496	late	C5-C6	ASD	C4-C6 fixed
35.	47	F	5	early	C6-C7	wrong-level surgery	C6-Th1 fixed
36.	50	F	2	early	C5-C7	hematoma	decompressed
37.	56	F	2,144	late	C5-C7	ASD	C4-Th1 fixed
38.	50	F	1	early	C4-C7	hematoma	decompressed

TTR – time-to-reoperation; ASD – adjacent segment disease; CSF – cerebrospinal fluid

independent researchers. In cases of non-congruence, a 3rd researcher was consulted. Radiological imaging included X-ray, computed tomography (CT) and magnetic resonance imaging (MRI) scans which were retrieved and scrutinized. Collected variables included the date of the 1st operation, date of the revision, perioperative neurological status, time-to-reoperation, basic demographic data, and the levels of the cervical spine which were addressed. Patients were divided into 2 groups: early reoperation if 90 days or less passed since the 1st procedure and late reoperation if more than 90 days elapsed. In total, 2,794 patients were screened for eligibility.

Patient population

The cohort consisted of 38 patients, 8 of whom were male (21.05%) and 30 who were female (78.95%). The mean age at the time of the initial procedure was 49.7 years (range 25–67 years) and the mean time-to-reoperation was 689 days (range 92–3,728 days). Table 1 shows characteristics of each patient in the analysed group.

RESULTS

Early reoperations

Same-route revision surgery within the first 90 days after the initial procedure was performed in 12 (31.58%) patients. Causes are summarized in Table 2. There was significant difference between early and late causes of revision ($p < 0.001$). One of the major challenges in early same-route revisions is that the neurosurgeon must navigate unfavourable conditions to access the same location. Unhealed tissue and active inflammation make it difficult to dissect, hence, it is a task for well-trained and experienced surgeons. In our department, we insert a nasogastric tube to ensure the oesophagus is clearly distinguishable from other tissues during cervical spine revisions. Mean time-to-reoperation in the early reoperation group was 33.7 days (range 1–70 days). Of them, 3 (25%) required re-stabilisation shortly after leaving the hospital due to persistent and progressive symptoms of either pre-existing radiculopathy or myelopathy in the course of spinal canal stenosis. The other 3 (25%) patients belonging to the "early reoperation" group required revisions due to implant dislocation. Two of these patients had dislocated screws where the anterior plate is fixed, whereas 1 patient (Case #5; Fig. 1) had an extrusion of the disc implant. Case #1, following a 3-level stabilisation, required revision with duroplasty due to cerebrospinal fluid (CSF) leakage that failed to respond to lumbar drainage. Another patient, a 60-year-old woman (Case #6) developed persistent dysphagia that intensified after a period of 10 weeks and was caused by pressure from an imprecisely implanted cervical plate. Two acute hematomata (Cases #36 and #38) occurred while the patient was still in hospital after the procedure and were treated immediately as an emergency. There was also one unintended-level exposure with subsequent wrong-level surgery (Case #35).

TABLE 2. Causes of same-route reoperations grouped into early (if within 90 days of the primary approach) and late revisions (if after 90 days)

Early revisions	n	%
Persistent spinal canal stenosis	3	25
Implant dislocation	3	25
Prevertebral hematoma	2	16.67
Cerebrospinal fluid leakage	1	8.33
Serious dysphagia	1	8.33
Adjacent segment disease	1	8.33
Wrong segment addressed	1	8.33
Late revisions		
Adjacent segment disease	25	96.15
Keloid scar	1	3.85

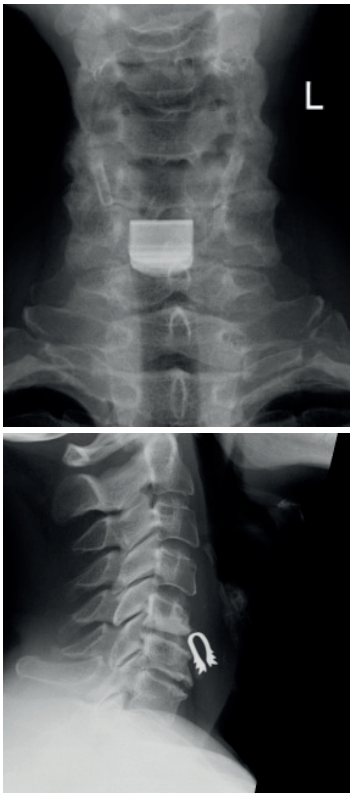

FIGURE 1. Case #5 with anterior dislocation of the C5/C6 intervertebral disc prosthesis. First figure presents lateral cervical spine X-ray along with an anteroposterior view on the right (the patient presented with cervical pain of 6 in the Numeric Rating Scale; this implant was removed and the space was refilled with biodegradable material)

Late reoperations

Twenty-six patients (68.42%) required same-route reoperation after a period of 90 days. In this group, 25 patients (96.15%) suffered from ASD. The highest level of prevalence of ASD was in C4/C5 (n = 9, 36%), followed by C6/C7 (n = 8, 32%) – Figure 2. Adjacent segment disease was proximal, as compared to the initial level of stabilisation, in 14 of all late ASD patients (56%), distal in 9 (36%), and both in 2 (8%). Most of the revisions for ASD regarded those who primarily had had 1-level stabilisation – n = 13 (52%), followed by 2-level – n = 11 (44%), and 3-level fusion – n = 1 (4%). The vast majority of ASD cases required elongation of the construct by 1 segment – n = 22 (88%). Three

patients, however, had 2-level ASD which necessitated 2-level construct elongation. This gives a total of 27 levels affected by late ASD. A unique cause of same-route reoperation was an extensive keloid scar (Case #20) in a 52-year-old woman. It was operated on for cosmetic reasons 140 days after the primary fusion.

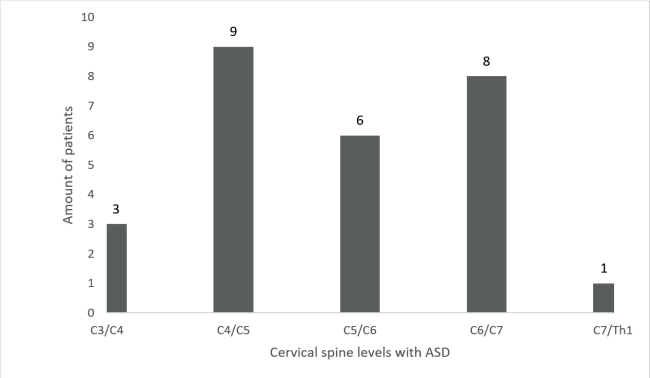

FIGURE 2. A graph illustrating the number of patients who developed adjacent segment disease (ASD) at particular levels of cervical spine

DISCUSSION

In the presented analysis, reoperations at least 90 days after the initial anterior cervical approach were over 2 times more frequent than those required earlier. Collectively, the most common cause behind same-route re-approach was ASD. As noted by Verma et al., prevalence of this complication is estimated at 2.4± 1.7% per year. In our study ASD totaled 0.89%, which would suggest that many factors such as innovative techniques and new surgical instruments contributed to a decrease in this ratio over the years [9]. Papavero et al. confirmed that the majority of ASD arising from anterior approach require same-route reoperation and we believe our study comprehensively illustrates this issue [10]. Although ASD mainly appears to be a late complication, one patient of the cohort was readmitted 2 weeks after his initial C4–C7 stabilisation with signs and symptoms of C3–C4 myelopathy. This required decompression by means of C3–C6 laminectomy and elongation of the stabilizing construct onto C3–C7. In some patients, this complication seems inevitable due to progressive degenerative spine disease and the previous segmental stabilisation. The latter alters the biomechanics of the cervical spine leading to an increase in load upon the adjoining segments [11]. What needs differentiating is asymptomatic, mere radiological degeneration of the adjacent level from an active, symptomatic disease affecting one's life. Whether these asymptomatic changes are early stages of what will later become clinically relevant is a heavily debated issue [12, 13]. Our findings appear to be in accordance with the literature, as most cases were provoked by 1-level and 2-level fusions [14, 15, 16]. As reported by Wang et al. in 2017, patients who are operated on by the age of 50 are at a higher risk of ASD [17]. In our cohort, there were 12 subjects (46.15%) who fit that range.

One of the most dangerous complications of anterior cervical spine surgery is prevertebral hematoma which can quickly lead to compression of the airways. Its incidence is estimated at 0.2–1.9% which is somewhat close to our findings (~0.1%) [18]. Although a single trigger is often difficult to point out, there are risk factors that might contribute, such as coagulopathies, Valsalva manoeuvres during extubation and insufficient haemostasis. There is controversy over the role of post-operative closed drainage left in the wound in order to prevent prevertebral hematoma. This method has gathered many enthusiasts as well as opponents [19]. We observed 2 hematomata in the period of 15 years studied: the 1st had a source in the ruptured superior thyroid artery and quickly led to extrathoracic airway obstruction. The other one was of a venous nature and, thus, slower in presentation – namely pain with an increase in the girth of the neck. Both were treated as emergencies and operated on rapidly.

Anterior approaches to the cervical spine run in proximity to the oesophagus and therefore pose a risk of post-operative dysphagia. There seems to be a wide spectrum of intensity in terms of swallowing difficulties which is reflected by the incidence levels given in the literature, ranging 1–79%. [20]. Subtle changes in the biomechanics of deglutition appear to be inevitable due to neurosurgical armamentarium pushing the oesophagus off the surgical corridor. Therefore, mild dysphagia is often not considered to be a complication since it is usually transient and does not affect caloric intake. Known risk factors of prolonged or more severe dysphagia include multi-level procedures, female sex, an age of over 60 years, and duration of the surgery [20]. In the presented analysis there was 1 case of persistent severe dysphagia that required revision around 10 weeks after the initial procedure. We did not observe any cases of oesophageal perforation.

Post-operative CSF leakages by accidental durotomy is estimated at 1% and happens more often if the following are present: rheumatoid arthritis, ossification of posterior longitudinal ligament, spinal deformity, multi-level surgery, long duration of procedure, advanced age and revision. The best management of this would be timely intraoperative recognition and watertight closure. External lumbar drainage (ELD) is also an option [21]. Among the analysed cohort, there was 1 patient whose accidental durotomy was overlooked, did not respond to ELD, and ultimately required same-route revision.

Another important yet preventable complication leading to same-route revision is wrong-level surgery. As medical errors must not be tolerated, this occurrence needs particular attention. Even though the mistake is often semi-justified by objective and unbiased circumstances such as a patient's obesity, congenital deformities, or poor quality of imaging, it is in the surgeon's best interests to minimize the risk. Therefore, check-lists have been introduced in the process of neurosurgery [22]. These can potentially prevent wrong site and wrong body part surgery. Nonetheless, in spinal surgery, operating on an incorrect segment may be the case even if a surgeon is scrupulous and careful.

Among the analysed cohort there was neither a case of deep wound infection nor implant contamination that would

necessitate revision. In the literature, there are examples of other specific complications leading to same-route reoperations that were not observed in the presented population, possibly because the management was solely posterior which excluded them from the study [8]. This may be a result of the authors' marked preference for a given technique, such as utilising plates during ACDF.

CONCLUSION

Although the risks of same-route reoperation after anterior approaches to the cervical spine in degenerative disease are relatively low, it might be the most common revision corridor. A comprehensive analysis of its causes is the 1st step in the process of prevention and management. Late revisions are more prevalent than early ones. For the former, ASD is the most common cause. For the latter, implant dislocation, persistent spinal canal stenosis, and prevertebral hematoma are the main reasons. In conclusion, an anterior approach seems to be the most reasonable option in cervical spine surgery management. However, we recommend that a multicentre study be conducted on this topic which could nullify a bias of single-centre research. Such studies could also include posterior approaches so as to compare outcomes and complications of these 2 access routes.

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