




Short-term post-operative complications in 207 patients with multi-level degenerative cervical myelopathy: the effect of surgical approach

Ran Harel¹ , Maya Nulman², Gil Kimchi¹, Nachshon Knoller¹

¹Spine Surgery Division, Department of Neurosurgery, Sheba Medical Centre, Ramat-Gan, Israel, affiliated to Sackler Medical School, Tel-Aviv University, Israel

²Hez programme, Sackler Medical School, Tel-Aviv University, Ramat-Gan, Israel

ABSTRACT

Introduction. Degenerative cervical myelopathy (DCM) is a common condition often treated by surgical decompression and fusion. The objective of this paper was to compare short-term post-operative complication rates of patients with multi-level DCM treated with decompression and fusion using either an anterior or a posterior cervical approach.

Material and methods. A retrospective evaluation of patients' charts, imaging studies and operative reports of patients operated for multilevel subaxial DCM from 2011 to 2016 at a single institution was performed. Patients who were operated upon for the treatment of three stenosed spinal levels or above and who underwent anterior cervical discectomy and fusion, or anterior cervical corpectomy and fusion, or posterior cervical laminectomy and fusion, were included. Short-term post-operative complications were compared between the anterior and posterior approaches.

Results. Overall, 207 patients were included in this study. 156 were operated via an anterior approach and 51 via a posterior approach. The mean number of treated levels was 3.4 and 4.3 for the anterior and posterior approach groups, respectively ($p < 0.001$). In the posterior approach group, the proportion of stenosed spinal levels within all operated levels was significantly lower than in the anterior approach group ($p = 0.025$). Early post-operative neurological status change was favourable for both groups. Deep wound infection rate was significantly higher in the posterior approach group (7.8% vs. none; $p = 0.001$).

Conclusions. Posterior cervical laminectomy and fusion is significantly associated with an increased rate of deep wound infection and wound revision surgery compared to the anterior approach. We recommend the anterior approach as the valid option in treating multi-level DCM.

Key words: cervical surgery, anterior approach, posterior approach, complications, multi-level, degenerative cervical myelopathy (*Neurol Neurochir Pol 2022; 56 (5): 404–409*)

Introduction

Degenerative cervical myelopathy (DCM) is a common condition in which degenerative changes in spinal osseous and ligamentous structures cause neuronal compression and clinical deterioration. For decades, the mainstay of treatment has been surgical decompression of stenosed segments. Frequently, fusion is added at the surgeon's discretion to prevent

the development of spinal instability and post-laminectomy kyphosis [1, 2]. Subsequent to its introduction in 1958, the anterior approach has been the most popular [3–5]. In multilevel cases, however, the treating surgeon faces a challenge when selecting a patient-specific approach that considers individual variations in sagittal alignment, ossification of the PLL, soft tissue anatomy etc. We have previously reported the surgical complication rates at our institution comparing anterior and

Address for correspondence: Ran Harel, Department of Neurosurgery, Sheba Medical Centre, Ramat-Gan, Israel; e-mail: harelran@gmail.com

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posterior cervical approaches [6]. A significant increase in deep wound infection and total complications rate was noted in the posterior approach group. However, the applicability of our results was impeded by an unequal number of treated levels in each group. The current study compares short-term post-operative complications of multilevel cervical myelopathy involving three or more spinal segments operated by either an anterior or a posterior cervical approach.

Material and methods

Following the Institutional Review Board's approval for this study, a retrospective evaluation of imaging studies, patient charts, and operative reports of patients who were operated for multilevel subaxial DCM between 2011 to 2016 at a single institution was performed (n = 406). Patients who were operated for the treatment of three stenosed spinal levels or above (rendering four or more instrumented levels) and who underwent anterior cervical discectomy and fusion, or anterior cervical corpectomy and fusion, or posterior cervical laminectomy and fusion, were included (n = 207). Exclusion criteria included (1) paediatric patients (< 18 years), (2) primarily combined posterior and anterior approaches, (3) revision surgery, and (4) constructs involving the C1 vertebra or occiput. All patients were evaluated pre-operatively by the senior treating neurosurgeon. The neurological examination included a detailed motor and sensory evaluation, deep-tendon and pathological reflex assessments, and gait evaluation. In addition to the pre-operative evaluation, the aforementioned neurological assessment was performed by a neurosurgery resident or by the senior surgeon, and was recorded on post-operative day 1, again at discharge, and again six weeks post-operatively.

Post-operative complications were compared between the anterior and posterior approach groups using Student t-test and Chi-square test. Risk factors for complications were assessed using logistic regression multivariate analysis (SPSS 23, IBM, Armonk, NY, USA).

Patient selection

The dorsal approach was preferred for normal lordosis patients, while the ventral approach was preferred for cases aiming to improve the spinal alignment to physiological lordosis. OPLL was not considered a contraindication for the anterior cervical approach.

Surgical technique

The surgical technique of these procedures has been previously described in detail, and is beyond the scope of this paper. Pre-operative antibiotics were administered prior to skin incision, and were discontinued post-operatively.

The following outlines various nuances in our surgical technique that may influence post-operative complications:

Posterior approach: Pre-operative prophylactic antibiotics were administered in all cases. Midline incision was followed by splitting of paraspinal muscles to expose the laminae and facet joints. Laminectomy was performed by bilateral troughs drilled with a high-speed drill and the lamina-spinous process complex elevated. 14 x 3.5 mm polyaxial lateral mass screws were our routine choice for the subaxial cervical spine. Following bilateral rod fixation, standard wound closure and drain placement were performed.

Anterior approach: We commonly opted for hybrid constructs of anterior cervical corpectomy and fusion (ACCF) and anterior cervical discectomy and fusion (ACDF). Translational, rotational plates were used in all cases. Commonly, 15 mm screws were placed to secure the plate at the shortest distance possible from the fused endplate [7]. Drains were placed in all cases and usually removed the day after surgery. Patients were normally discharged one day following drain removal.

Results

Overall, 156 patients were included in the anterior approach group and 51 patients in the posterior approach group. Table 1 sets out patient characteristics. Notable differences between the groups included an older age in the

Table 1. Patient characteristics and risk factors

	Anterior approach	Posterior approach	P-value
Number	156	51	
Mean age (years)	59	66	0.001
Gender (males), %	112 (71.8%)	42 (80%)	0.22 ⁺
ASA score (1 & 2 grades), %	88 (56.4%)	22 (48.8%)	0.39 ⁺
ASIA D & E, (%)	140 (89.8%)	42 (82.4%)	0.18 ⁺
Smoking, %	64 (41%)	10 (20%)	0.006 ⁺
Obesity, %	49 (31%)	11 (21%)	0.18 ⁺
Diabetes mellitus, (%)	39 (25%)	18 (35%)	0.15 ⁺
IHD [†] , (%)	32 (20.5%)	10 (20%)	0.89 ⁺
HTN [‡] , (%)	66 (42.3%)	24 (47%)	0.55 ⁺
Kyphosis, (%)	20 (12.8%)	1 (2%)	0.03 ⁺

ASA — American Society of Anaesthesiologists; IHD[†] — ischaemic heart disease; HTN[‡] — hypertension; ⁺ — Chi squared

Table 2. Surgical specifications and complications

		Anterior approach	Posterior approach	P-value
Number of levels: mean (range)		3.4 (3–5)	4.4 (3–6)	< 0.001
Number of stenosed levels: mean (range)		3.4 (3–5)	3.1 (2–5)	0.025
Surgery duration (min: mean ± st dev)		102 ± 29	120 ± 36	< 0.001
Delta anaesthesia duration (min)		44 ± 26	54 ± 35	< 0.001
Length of stay (days: mean ± st dev)		4.7 ± 4.6	6.2 ± 4.5	0.037
Discharge destination	Home	79.5%	69%	0.076 ^c
	Rehabilitation	17.9%	31%	
	Hospital dept.	2.6%	0%	
Post-operative haematoma		0.6%	2%	0.40 ⁺
CSF leak		0.6%	2%	0.40 ⁺
Deep vein thrombosis		0%	0%	
Pulmonary embolism		0%	0%	
Total infections		3.8%	9.8%	
Respiratory infections		3.8%	0.0%	0.001 ⁺
UTI		0.0%	2%	
Bacteremia		0.0%	0.0%	
Deep wound infection		0.0%	7.8%	
Meningitis		0%	2%	0.25 [#]
Revision of wound		0.6%	7.8%	0.004 ⁺
Instrumentation suboptimal position		1.3%	3.9%	0.24 ⁺
Dural tear		0%	2%	0.08 ⁺
Short-term neurological outcome (6-week follow up)	Improvement	75%	82%	0.2
	Stable	22%	12%	
	Deterioration	3%	6%	
Post-operative respiratory complication	Prolonged intubation	1.9%	0%	0.25
	Dyspnoea treated with steroids	3.2%	0%	
Revision of instrumentation		1.3%	3.9%	0.62 ⁺
Overall complications	Major	7.7%	13.7%	0.19
	Minor	1.9%	3.9%	
Mortality		0%	0%	
Length of follow-up (months: mean ± st dev)		2.1 ± 1.4	1.7 ± 0.4	0.003
EBL (CC)		91 ± 195	152 ± 280	0.18

CSF — cerebrospinal fluid; EBL — estimated blood loss; UTI — urinary tract infection; ⁺Chi squared; [#]Fisher exact test

posterior approach group (66 vs. 59; $p = 0.001$) and a higher rate of smokers in the anterior approach group (41% vs. 20%; $p = 0.006$). A higher rate of cervical kyphosis, defined as either focal or global, was evident in the anterior approach group (12.8% vs. 2%; $p = 0.03$). Mean follow-up period was 2.1 and 1.7 months for the anterior and posterior approach groups, respectively. Both groups had a higher proportion of males. Additional risk factors were equivalent between the groups. Table 2 sets out surgical specifications and complications. In the posterior approach group, the proportion of stenosed spinal levels within all operated levels was significantly lower

compared to the anterior approach group ($p = 0.025$). On average, 1.3 un-stenosed levels ($p = 0.009$) were treated at the posterior approach group.

Operative time and anaesthesia duration were both longer in the posterior approach group ($p < 0.001$). There was no significant difference in short-term neurological outcome between the groups ($p = 0.2$). Posterior approach patients had longer stays in hospital ($p = 0.037$) and a larger percentage were discharged to a rehabilitation facility ($p = 0.076$; not significant $p > 0.05$). Since we considered dysphagia and dysphonia to be side effects rather than complications, they were

not routinely recorded. None of the patients needed feeding through a naso-gastric tube or PEG. A much larger percentage of the posterior approach cohort suffered from infections, mainly deep wound infections (7.8% vs. 0%; $p = 0.001$) and required wound revision surgery (7.8% vs. 0.6%; $p = 0.004$). Multivariate analysis revealed no significant risk factors. Anterior approach patients had higher rates of respiratory complications, including prolonged ventilation or dyspnoea. Overall, the major complications rate was higher for posterior approach patients (13.7% vs. 7.7%; $p = 0.42$, not significant).

Discussion

Surgery for multilevel cervical myelopathy usually requires the extensive decompression of osseous and ligamentous structures compressing the spinal canal. Until now, the mainstay of treatment has involved one of the following: posterior laminectomy and fusion, multilevel ACDF, hybrid constructs of ACCF and ACDF, or a combination of the above. Disc replacement was also introduced, but its role in multi-level myelopathy may be limited. The decision regarding the optimal patient-specific approach is multifactorial and subject to both patient-related variations and surgeon-related preferences. An international effort has been conducted in order to answer questions regarding the nature of DCM and its optimal treatment, optimising care with treatment guidelines [8–10]. The posterior approach is designated to expand the spinal canal posteriorly even when the compressive elements are mostly ventral. Therefore, indirect decompression is its main mechanism of action. As such, an extensive multi-level decompression and fusion are required to allow the cord to subtly shift posteriorly. Often, un-stenosed segments are decompressed and fused to allow this posterior shift. This undesirable situation is less frequent in multilevel cases treated via an anterior approach, as the surgeon is able to avoid the fusion of normal segments. For that reason, it has been previously recommended to treat three-level myelopathy or less by multilevel ACDF, and four levels or more by laminectomy and fusion [11, 12]. Ghogawala et al. [13] surveyed 91 spine surgeons regarding their preferred approach in various cases. In cases with four-level stenosis or more, the great majority of surgeons opted for a posterior approach (89%). On the contrary, a survey by Nouri et al. [14] reported that 59.8% of responders were equally comfortable with performing three or more level surgery either via an anterior or a posterior approach. As the number of stenosed levels has decreased to a maximum of three, an increasing number of surgeons have performed multilevel ACDF. In the current study, the proportion of stenosed spinal levels within all operated levels in the posterior approach group was significantly lower compared to the anterior approach group ($p = 0.025$), indicating an increase in the avoidable fusion of normal segments in that group. On average, 1.3 un-stenosed levels ($p = 0.009$) were treated in the posterior approach group. Our findings demonstrate an inherent advantage of anterior

instrumentation, as it allows a selective treatment for each segment and consequently preserves motion to a greater extent.

We have previously reported the complication rates of an anterior vs. a posterior approach, demonstrating higher rates of infections, mainly deep wound infections, and overall complications related to the posterior approach [6]. The number of levels treated in the published cohort was significantly lower for the anterior approach group, reducing the applicability of the conclusion for surgical decision making. In the current cohort, only multi-level myelopathy of three levels and above were included, in order to evaluate cases that were truly debatable. Since the posterior approach usually aims to indirectly decompress the cord, hence it is our practice to extend the decompression beyond the involved segments to allow gradual cord dorsal shift, the mean operated levels in the current cohort were 1.3 levels higher than the actual pathological levels. On the contrary, anterior approach surgery allows for direct treatment of involved levels only. The posterior approach group fusion was applied to a mean of 5.4 levels, while the anterior approach group was fused for 4.4 levels.

To the best of our knowledge, the body of evidence reporting long constructs' fusion rate is lacking, although it should be considered in the clinical decision-making process.

In numerous publications, including our own previously published experience [6], an increased rate of wound infection has been noted in the posterior approach compared to the anterior approach. Kristof et al. reported a rate of 6.5% in multilevel constructs, more than double the 2.3% in the anterior approach group. Russell et al. reported their experience with the application of vancomycin powder in posterior cervical fusion. They reported an initial infection rate of 10.9%. In relation to the thickness of subcutaneous cervical fat, a 7.6% infection rate was reported in normal-weight patients, gradually increasing to 16.7% in obese patients [15].

The absence of infections in the anterior approach group demonstrates the pivotal advantage of such an approach. From a pathophysiological standpoint, this difference is usually attributed to the decreased blood supply in the posterior neck, increased dead space, and prolonged muscle retraction.

Although we do not consider the presence of OPLL to be a contra-indication to an anterior procedure, the anterior approach group had a lower rate of cerebrospinal fluid (CSF) leaks (0.6% vs. 2% in the posterior approach group). We attribute the relatively low rate of CSF leak in anterior procedures to an increased rate of corpectomies performed in our institution (96% corpectomy or hybrid corpectomy and discectomy). We find corpectomy to provide a more extensive exposure of the dura compared to discectomy which allows for improved control during the PLL dissection from the dura. Our findings stand in contrast to the publication by Hanallah et al. [16], that found corpectomy to be a significant risk factor for CSF leak (relative risk 3.15).

A review of the literature comparing anterior and posterior approaches for multi-level myelopathy, defined as two or more levels, identified eight compatible papers [17]. In this study, the

anterior approach included either corpectomy or multi-level discectomies, and the posterior approach included laminectomy with or without fusion or laminoplasty. We concluded that the posterior approach is associated with higher infection rates, although only one paper included data relating to infection rates. A more recent meta-analysis using the same inclusion criteria [18] included 10 papers (all non-randomized). There was no clear benefit to either approach.

A recently published meta-analysis compared multi-level ACDF to laminoplasty. Neurological outcome was not different between the groups, yet overall complication rate was higher in the anterior approach group. Nevertheless, when taken altogether, the authors concluded that the anterior approach was superior to laminoplasty in multilevel myelopathy owing to various advantages of that approach such as the ability to achieve a lordotic alignment [19]. This conclusion was supported by another study [20] that compared four-level myelopathy treated with multiple ACDFs to laminoplasty. Despite an increased overall complication rate, the anterior approach was superior in post-operative functional outcome (JOA) and neurological recovery rate.

In the current paper, three or more intervertebral levels were included, as most spine surgeon would treat one- or two-level compression with an anterior approach. While most of the anterior approach patients were treated to three or four levels (63% and 34% respectively), and very few to five levels (3%), posterior approach patients were mostly treated to four or five levels (67% and 25% respectively) and a few to three or six levels (2% and 6% respectively).

In the current paper, all included cases were instrumented and fused. We excluded laminectomy-only cases in order to achieve better standardisation of the cohorts. Most anterior approach patients had undergone multi-level corpectomies, some with discectomies as a hybrid construct. Only a minority had a hybrid construct of single level corpectomy and discectomy (14.7%) or multi-level discectomies (3.8%).

Previous studies comparing anterior vs. posterior approaches for multi-level cervical myelopathy have demonstrated conflicting results. While all studies have reported neurological improvement in the majority of patients, surgical complications have varied widely. In the current paper, neurological improvement was noticed in most patients treated by either the anterior or the posterior approach. Lawrence et al. [17] reviewed the literature in a paper published in 2013. Of eight papers included in their review, only one reported the rate of infections in operated subjects. Complications such as post-operative infections greatly impact patient outcomes in degenerative spine surgeries, and hence should be incorporated into decision making about which approach to choose [21]. While some studies have found no clear benefit to a particular approach [17, 20], others have favoured the anterior approach [19] or the posterior approach [12, 18, 22]. Liu et al. [12] concluded that three levels and above should be treated with posterior laminoplasty. Previously, our group

reported preferable results with anterior approach surgery, although the numbers of levels were not limited. In the current study, a significant difference was evident in both deep wound infection rates and revision rates. The anterior approach group had a much lower deep wound infection rate (0% vs. 7.7%; $p < 0.001$) and much less wound revision surgery (0.6% vs. 7.7%; $p = 0.04$).

Limitations

The retrospective nature of this study renders it susceptible to the inherent weaknesses of all retrospective analyses. Information regarding surgical decision making is lacking in any retrospective study, and hence the validity of the comparison is limited. The posterior approach group consisted of older patients, and the posterior approach surgeries were longer. This study aims to evaluate short-term post-operative complications. C5 palsy recording was not consistent, and hence was included as a neurological deterioration but not evaluated separately. The limited length of follow-up precludes drawing conclusions regarding the difference in fusion rates between the groups. Functional and psychosocial scales were not recorded for most patients in the cohort. As dysphagia and dysphonia are a common side effect of the anterior approach, it is frequently not recorded; hence we could not calculate the prevalence of dysphagia/dysphonia for the anterior approach. Both senior surgeons prefer the anterior approach and consider it superior in terms of safety, rendering our study subject to a possible selection bias.

Conclusions

Posterior laminectomy and fusion are associated with increased risks of wound infection and wound revision. The authors recommend that anterior decompression and fusion be considered for long fusion cases.

Conflicts of interest: *Ran Harel is a consultant for Neurocord, Surgical Theatre, Premia Spine and Mazor Robotics, none of which are related to this article; Nachshon Knoller, Mayan Nulman and Gil Kimchi have no conflict of interest.*

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Ethical approval: *All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.*

For this type of study formal consent is not required.

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