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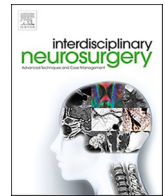
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## Anterior or posterior approach in the surgical treatment of cervical radiculopathy; neurosurgeons' preference in the Netherlands

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### ABSTRACT

**Objectives:** Several surgical techniques are available for the treatment of cervical degenerative disease. For resolving cervical nerve root compression, anterior cervical discectomy with fusion (ACDF) or posterior cervical foraminotomy (PCF) can be applied. Amongst neurosurgeons, there seems to be a tendency to prefer ACDF, even though there are some advantages in favor of PCF. The objective of present study is to evaluate which factors determine the choice for an anterior or posterior surgical approach in patients with cervical radiculopathy based on foraminal pathology.

**Methods:** A web-based survey was sent to all 133 neurosurgeons in the Netherlands. The study followed a mixed methods cross-sectional design. The first part of the survey focused on general perceived (dis)advantages of ACDF and PCF. The second part concerned questions about the choice between the two procedures. Furthermore, it was analyzed if exposure during training, amount of performed surgeries, assumed reoperation and complication rates influenced the choice of procedure by conducting Chi-square tests with post-hoc analysis.

**Results:** A total of 56 neurosurgeons responded (42%). An overall preference for ACDF was observed, even when differentiating for a pure disc prolapse, a spondylotic or a combined stenosis of the neuroforamen. The most relative important factors for motivating the preference for either ACDF or PCF were: the assumed best decompression of the nerve root (18%), congruence with current literature (16%), exposure during residency (12%), personal comfort (11%) and experience (11%) with the technique.

**Conclusion:** In this survey, there was an overall preference for ACDF above PCF for the surgical treatment of a foraminal cervical radiculopathy. In addition to subjective factors as "experience" and "comfort", the respondents often motivated their choice as "the best one according to literature". As there is currently no evidence about the superiority of any of the procedures in literature, this assumption is remarkable.

### 1. Introduction

Several surgical techniques are available for the treatment of cervical degenerative disease. For a central disc prolapse, an anterior cervical discectomy with fusion (ACDF) is the gold standard and is therefore frequently used among neurosurgeons [1,2]. However, for resolving nerve root compression due to a foraminal disc prolapse or spondylotic narrowing of the neuroforamen, both an ACDF and a posterior cervical foraminotomy (PCF) can be applied.

Advantages of PCF are that the route of approach avoids the possible

serious complications that can be accompanied with ACDF, such as injury to the carotid artery, the esophagus or recurrent laryngeal nerve [3–5]. PCF also allows to preserve mobility of the treated vertebral segments and does not include the use of implants. Some papers reported a higher rate of reoperations in PCF [6,7], but other studies did not find any difference between ADCF and PCF [8–13]. No significant clinical differences were observed [6,8–10,13], although it is suggested that postoperative neck-pain occurs more frequently after PCF [14].

In Western countries neurosurgeons seem to prefer the ACDF technique for a radiculopathy based on foraminal pathology [15]. In the

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absence of scientific evidence for the superiority of ACDF above PCF this preference is curious, since PCF seems a very straightforward, safe and cheap procedure when compared to ACDF. The reasons for neurosurgeons to choose either ACDF or PCF have, to our knowledge, never been studied. Factors such as surgical experience, feeling comfortable with a certain technique or assumed differences in complication or reoperation rates could contribute to the choice. In order to understand the selection of a surgical technique for a patient with a cervical foraminal radiculopathy, these factors should be elucidated.

The objective of the present study was to evaluate which factors determine the choice for an anterior or posterior approach for the surgical relief of cervical radicular symptoms caused by foraminal degenerative pathology.

## 2. Material and methods

### 2.1. Survey population and design

In preparation of this manuscript, the guidelines for cross-sectional studies of “The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies” were used [16]. The Medical Ethical Committee of the University Medical Center Groningen granted a waiver for this study.

A web-based survey was sent to all members of the Dutch Association of Neurosurgeons. After 2 months, a reminder was sent. Responses were collected until December 2018. The survey was designed in collaboration with P.F.M. Krabbe PhD, psychologist and specialist in psychometrics at the department of Epidemiology at the University Medical Center Groningen, The Netherlands.

The primary objective was to assess the factors of relevance for the surgeon's choice between an anterior or posterior approach. Items that were questioned: anatomical and radiological aspects, per- and post-operative complications, post-operative recovery, accordance with literature, the neurosurgeon's amount of training, experience and comfort with the techniques.

The study followed a mixed methods cross-sectional design, with a survey consisting of 41 closed and 10 open questions. It started with questions about general experiences and personal opinions about ACDF and PCF. Participants were asked to mark several advantages and disadvantages of the procedures, and to divide 10 points among the marked (dis)advantages to indicate the relevance of these factors for their clinical decision making. The relative importance of each (dis)advantage was evaluated by calculating the mean of the total amount of points given to each (dis)advantage.

The second section of the survey concerned questions about the choice between ACDF and PCF for three surgical indications, namely 1) a foraminal disc prolapse, 2) a distinct spondylotic foraminal stenosis and 3) a disc prolapse combined with a spondylotic foraminal stenosis. General information about the participant was collected, such as years of surgical experience and volume of ACDF and PCF cases per year.

### 2.2. Statistical analysis

Descriptive statistics were used for the characteristics of the participants and the general information about the surgical techniques. We evaluated which factors influenced the choice between ACDF and PCF by conducting Chi-square tests with post-hoc analysis. Cramer's Phi was used as a correlation coefficient. All data were analyzed with IBM SPSS Statistics software, version 23.

## 3. Results

A total of 56 neurosurgeons (42% of the 133 members of the Dutch Association of Neurosurgeons) responded. Of the respondents, 77% perform more than 10 ACDF annually and 25% perform more than 10 PCF per year. Three respondents did not perform any ACDF or PCF cases

annually, which were excluded from the analyses. The neurosurgeons' characteristics are shown in Table 1.

### 3.1. ACDF

A standard right-sided approach is used by 80% and an intervertebral spacer in 92% of the respondents. The detailed characteristics are presented in Table 2. Relative advantages of ACDF were fast post-operative recovery (19%), good anatomical overview (16%) and the familiar route of approach (13%). Other advantages are presented in Fig. 1. The most important relative disadvantages for ACDF were the possibility of adjacent segment disease (33%), the difficulty to approach foraminal osteophytes (31%) and potentially severe complications (22%). All mentioned disadvantages are presented in Fig. 2.

### 3.2. PCF

PCF is performed via an open foraminotomy by 83% of the respondents. They remove between 20% and 60% of the facet joint, with a median of 35%. Other characteristics of PCF are listed in Table 2. In this survey, the highest rated relative benefit of PCF was the low risk of severe complications (20%), followed by a good view of the exiting nerve root (19%) and the preservation of mobility of the vertebral segments (18%). Other advantages are listed in Fig. 3. The most important named disadvantages of PCF were substantial postoperative neck pain (17%), the fact that the respondents have little experience with the technique (16%) and the respondents dissatisfaction about operative results (residual or worsened symptoms after surgery) (16%). Other perceived disadvantages are presented in Fig. 4.

### 3.3. Preferred techniques for different indications

The preferences for ACDF or PCF for the surgical treatment of a foraminal disc prolapse, a spondylotic stenosis or a combined stenosis are listed in Table 3. The assumed decompression of the nerve root (18%), perceived congruence with the current literature (16%), exposure to the technique during residency (12%), personal comfort with the procedure (11%), and experience performing the specific surgical technique (11%) were the most important reasons for motivating a preference for either ACDF or PCF.

### 3.4. Comparison PCF and ACDF

Assumptions about the procedures are listed in Table 4. The exposure during residency, years of experience as a neurosurgeon and the

**Table 1**  
Characteristics respondents (n = 48).

	Categories	Amount in %
Years as a specialist	0–5	33
	5–10	17
	10–15	15
	15+	35
Number of ACDF <sup>1</sup> cases performed per year	0	4
	1–5	6
	5–10	12
	10–20	15
	20–30	13
	30–40	21
	40+	29
Number of PCF <sup>2</sup> cases performed per year	0	12
	1–5	40
	5–10	23
	10–20	17
	20–30	4
	30–40	4

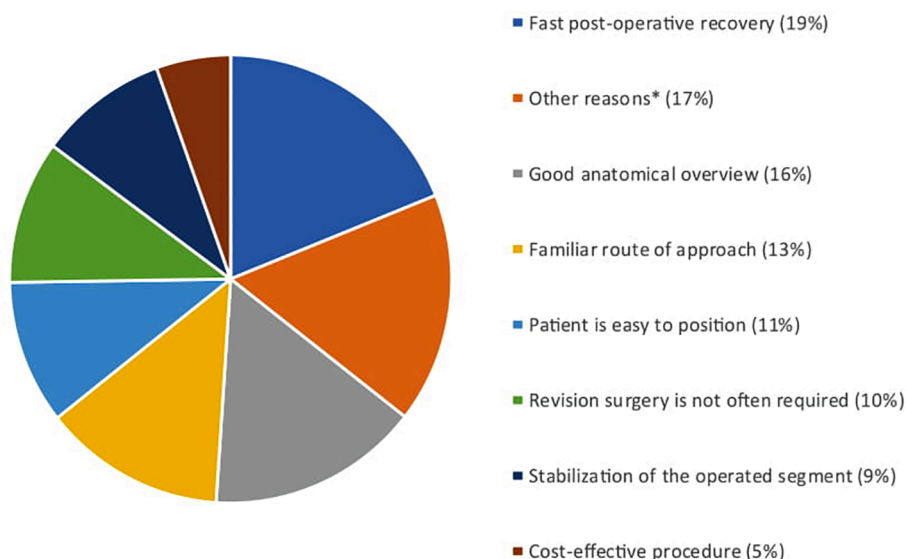
<sup>1</sup> ACDF: Anterior Cervical Discectomy with Fusion.

<sup>2</sup> PCF: Posterior Cervical Foraminotomy.

**Table 2**

Characteristics surgical techniques.

ACDF <sup>1</sup>	(n = 49)		PCF <sup>2</sup>	(n = 41)	
	Categories	Percentage %		Categories	Percentage %
Skin incision	Contralateral	14	Procedure	Open foraminotomy	83
	Ipsilateral	0		Minimally invasive	15
	Always right-sided	80		Endoscopically	2
	Always left-sided	6		Median removal	35
Use of instruments	Only punch	33	Facet joint	Always	20
	High-speed drill and punch	67		Only if visibility is obstructed	66
				Never	15
Use of intervertebral spacer	No	8	Removal of discogenic sequester	Whenever possible	61
	Cage not filled with bone	57		Only when nerve root is not fully decompressed	24
				Never	15
	Cage filled with autologous bone	14			
	Autologous bone	0			
	PMMA <sup>3</sup>	6			
	No Preference	14			
Type of cage	Titanium	12			
	PEEK <sup>4</sup>	62			
	Other	26			

<sup>1</sup> ACDF: Anterior Cervical Discectomy with Fusion.<sup>2</sup> PCF: Posterior Cervical Foraminotomy.<sup>3</sup> PMMA: Polymethylmethacrylate.<sup>4</sup> PEEK: Polyetheretherketon.**Fig. 1.** Advantages ACDF \*Possibility for bilateral decompression; Possibility to correct kyphosis.

perceived recovery time after operation, were no significant factors for deciding between ACDF and PCF. Perceived nerve root decompression and assumptions about reoperation and complication rates were weakly related to the choice between ACDF and PCF, as shown in Table 5.

#### 4. Discussion

In this survey, we analyzed the factors that influenced neurosurgeons to choose for ACDF or PCF, in cases of cervical radiculopathy due to foraminal pathology. There was an overall preference for ACDF, even when differentiating for a pure disc prolapse, spondylotic stenosis or a combined foraminal stenosis.

Irrespective of the procedure of choice, determining factors for the neurosurgeon's preference appeared to be "feeling comfortable" and "having experience". It is obvious that both go hand in hand [17–19], and it is logical that surgeons feel more comfortable with ACDF as the approach is part of the routine for other procedures as well. Also the

exposure to the PCF technique during residency was minor in 61,2% of the respondents, which could contribute in feeling less comfortable with the PCF technique.

Furthermore, one of the most influential factors was the respondent's perception that his or her technique of choice is the best according to literature and in achieving an adequate decompression of the cervical nerve root. For foraminal pathologies, the Dutch [1] and The North American Spine Society (NASS) [2] guidelines for cervical radiculopathy state that both procedures can be considered and have equal clinical outcome in homogeneous groups of patients. As there is no evidence that the outcomes of ACDF are superior to PCF (or vice versa) for foraminal radiculopathy, the respondent's assumption that one of the techniques is the best according to the literature is unfounded.

The respondents who think PCF has a higher reoperation rate (44.4%) choose ACDF significantly more often ( $p < 0.01$ , Cramer's Phi = 0,23). Similarly, the respondents who think that PCF has a higher risk of complications, chose ACDF slightly more often ( $p < 0.01$ , Cramer's

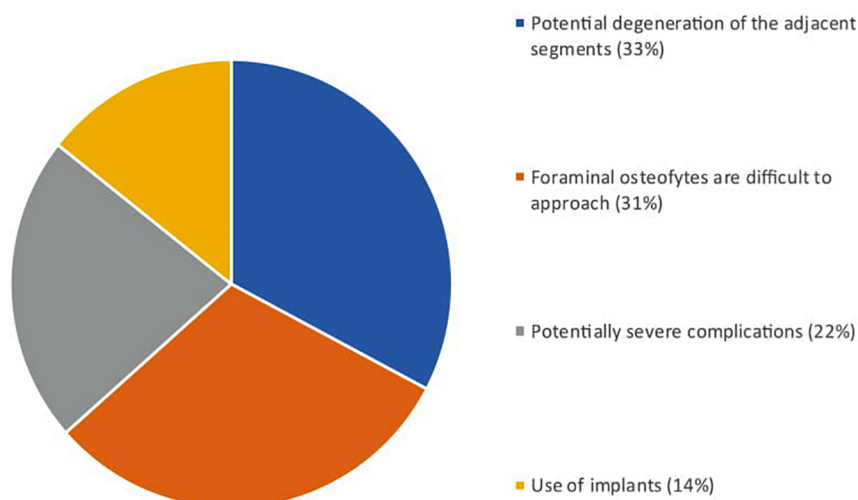


Fig. 2. Disadvantages ACDF.

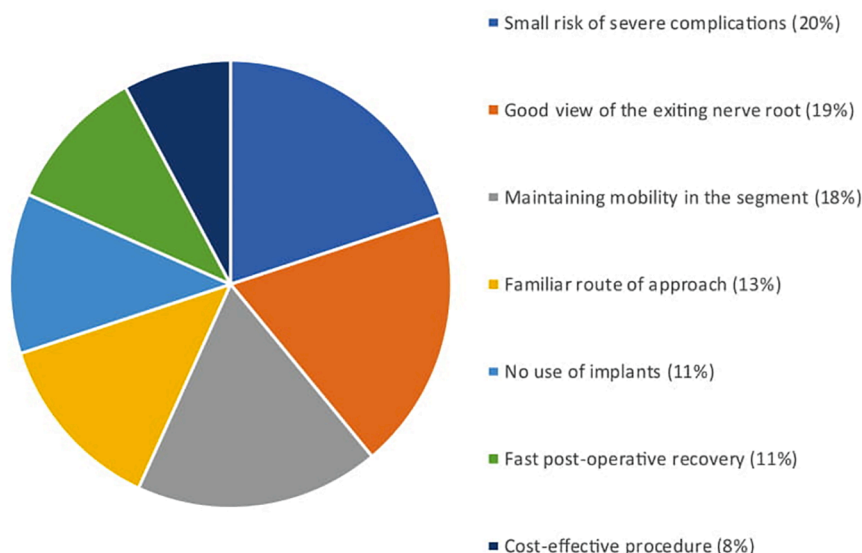


Fig. 3. Advantages PCF.

$\Phi = 0,22$ ). Although the respondents suspected a difference in reoperation and complication rates between the two techniques, at the moment of conducting the survey there was no evidence in literature for statistical significant differences in reoperation and complication rates [6,10]. A recent meta-analysis did demonstrate a significant statistical difference in reoperation rates favoring ACDF. However, this meta-analysis was mainly based on retrospective studies [20]. Another recent meta-analysis comparing only RCTs did not find any statistical significant differences in complication or reoperation rates [21].

Most neurosurgeons are familiar with the concept of “adjacent segment disease” after fusion surgery such as ACDF. In this survey the respondents marked it as an important relative disadvantage of the procedure (27%). Although addressed as important disadvantage, neurosurgeons still favored ACDF over PCF, even if PCF maintains the mobility of the operated segment [22].

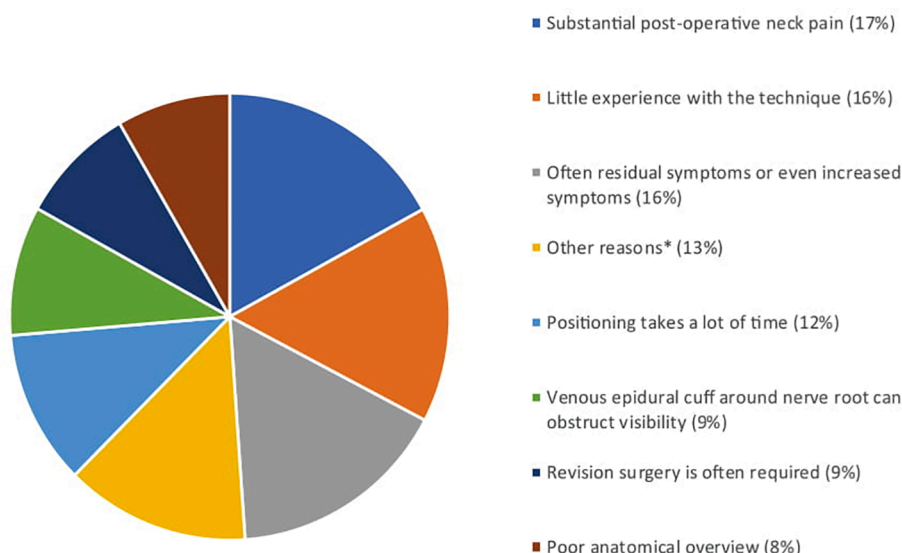
A strength of our study is that the survey was developed with consultation of a specialist in psychometrics. A possible limitation is that we had a relatively low response rate (42%) of the total population of

Dutch neurosurgeons, but as the amount of spinal procedures performed per year by our respondents is relatively high (77% perform more than 10 ACDF annually, 25% perform more than 10 PCF per year) we think that our respondents are a good representation of the spinal neurosurgeons in the Netherlands. Furthermore, we can state that a low response rate does not necessarily have to lead to response bias [23,24].

In summary, for cervical foraminal nerve root decompression there was an overall preference for ACDF. For the respondents, subjective factors as “feeling comfortable” and “having experience with the procedure” was of major importance in the decision-making process. Most surgeons gained more experience with ACDF during their training and perform annually more ACDF compared to PCF, which could both explain why they feel more comfortable with the technique.

Current guidelines advocate both procedures to be suitable for a foraminal cervical radiculopathy, with similar results in clinical outcome and complication rates. It is therefore most surprising that a majority of the respondents motivated their preference for ACDF as “based on the literature”, besides from the perceived subjective factors





**Fig. 4.** Disadvantages PCF \*Less suitable for bilateral decompression; Experienced higher wound infection rate; Difficult approach in obese patients.

**Table 3**

Preferred surgical technique for various indications (n = 52).

Preference	ACDF <sup>1</sup> (%)	PCF <sup>2</sup> (%)	Equally suitable (%)
Foraminal disc prolapse	77	4	19
Foraminal spondylotic stenosis	35	31	34
Combined discogenic and spondylotic foraminal stenosis	50	4	46

<sup>1</sup> ACDF: Anterior Cervical Discectomy with Fusion.

<sup>2</sup> PCF: Posterior Cervical Foraminotomy.

**Table 4**

Assumptions about ACDF and PCF.

Assumption	ACDF <sup>1</sup> (% of respondents)	PCF <sup>2</sup> (% of respondents)	Equal (% of respondents)
Most experience during training	61	0	39
Fastest recovery	71	2	27
Highest reoperation rate	7	44	49
Optimal nerve root decompression	38	8	54
Highest complication rate	27	23	50

<sup>1</sup> ACDF: Anterior Cervical Discectomy with Fusion.

<sup>2</sup> PCF: Posterior Cervical Foraminotomy.

**Table 5**

Correlations of assumptions and amount of cases per year on choice for ACDF or PCF.

More likely to choose ACDF <sup>1</sup> when:	p-value	Cramer's Phi
It is assumed that PCF has a higher reoperation rate	<0.01	0,23
It is assumed that ACDF is better for nerve root decompression	<0.01	0,30
It is assumed that PCF has a higher complication rate	<0.01	0,22
More than 20 ACDF per year are performed	<0.01	0,23
<5 PCF per year are performed	<0.01	0,23
More likely to choose PCF <sup>2</sup> when:		
It is assumed ACDF and PCF have equal reoperation rates	<0.01	0,23

<sup>1</sup> ACDF: Anterior Cervical Discectomy with Fusion.

<sup>2</sup> PCF: Posterior Cervical Foraminotomy.

“comfort” and “experience”, to favor the anterior approach.

However, the available evidence about the two techniques is mainly based on retrospective studies and prospective cohort studies. High quality RCTs are needed to provide us with more direct evidence about the presumed differences in clinical outcome, complications, reoperation rates, and cost-effectiveness. Therefore, we eagerly await the results of currently running RCTs; the ForAC trial [25] and Foraminotomy ACDF Cost-Effectiveness Trial (FACET) [26].

In case of favorable results regarding PCF, the next challenge will be to advocate and to promote this technique as an indispensable tool in the box of the contemporary spinal neurosurgeon, as “comfort” and “experience” proved to be important factors for choosing a certain technique.

## 5. Conclusions

In this survey, there was an overall preference for ACDF above PCF for the surgical treatment of a foraminal cervical radiculopathy. In addition to subjective factors as “experience” and “comfort” with the procedure, the respondents often motivated their choice as “the best one according to literature”. As there is currently no evidence about the superiority of any of the procedures in the literature, this assumption is remarkable.

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## Ethical standards

The Medical Ethical Committee of the University Medical Center Groningen granted a waiver for this study.

## CRediT authorship contribution statement

**Anne E.H. Broekema:** Conceptualization, Methodology, Software, Formal analysis, Investigation, Writing - original draft, Visualization, Project administration. **Rob J.M. Groen:** Conceptualization, Methodology, Writing - review & editing, Supervision. **Erzsi Tegzess:** Software, Formal analysis, Investigation, Data curation, Writing - original draft. **Michiel F. Reneman:** Conceptualization, Methodology, Writing - review & editing, Supervision. **Remko Soer:** Conceptualization, Methodology, Writing - review & editing, Supervision. **Jos M.A. Kuijlen:**

Conceptualization, Methodology, Data curation, Writing - review & editing, Supervision, Project administration.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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