

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

Anne Elsina Henderika Broekema (✉ [a.e.h.broekema@umcg.nl](mailto:a.e.h.broekema@umcg.nl))

Universitair Medisch Centrum Groningen <https://orcid.org/0000-0002-2657-7540>

Rob JM Groen

Universitair Medisch Centrum Groningen

Erzsi Tegzess

Universitair Medisch Centrum Groningen

Michiel F Reneman

Universitair Medisch Centrum Groningen

Remko Soer

Universitair Medisch Centrum Groningen

Jos MA Kuijlen

Universitair Medisch Centrum Groningen

---

## Research article

**Keywords:** cervical spine, radiculopathy, anterior cervical discectomy, foraminotomy, survey

**Posted Date:** December 3rd, 2019

**DOI:** <https://doi.org/10.21203/rs.2.18113/v1>

**License:** © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

---

**Version of Record:** A version of this preprint was published at Interdisciplinary Neurosurgery on March 1st, 2021. See the published version at <https://doi.org/10.1016/j.inat.2020.100930>.

# Abstract

**Background** For cervical foraminal nerve root decompression, 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 over PCF, even though there are some advantages in favor of PCF. The object of present study is to evaluate which factors determine the choice for an anterior or posterior surgical approach in patients with a cervical radicular syndrome based on foraminal pathology.

**Methods** A web-based survey was sent to all 133 neurosurgeons in the Netherlands. The first part 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%). Of these, 77% performed more than 10 ACDF and 25% more than 10 PCF annually. An overall preference for ACDF was observed, even when differentiating for a pure disc prolapse, a spondylotic or a combined stenosis. The most relative important factors for motivating the preference for either ACDF or PCF were: the assumed best decompression of the nerve root (18%), perceived congruence with current literature (16%), exposure during residency (12%), personal comfort with the procedure (11%), and experience with the technique (11%).

**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 literature, this assumption is remarkable.

## Background

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 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.

## Methods

### 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 (METc) of the University Medical Center Groningen has reviewed this study and has granted a waiver (reference number METc 2016/512), because no patients were involved.

A web-based survey was sent to all members of the Dutch Association of Neurosurgeons. After 2 months, a reminder was sent. 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.

## 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.

## 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. The neurosurgeons' characteristics are shown in Table 1.

### Table 1 – Characteristics respondents

	Categories	Amount in %
Years as a specialist (n=48)	0-5	33
	5-10	17
	10-15	15
	15+	35
Number of ACDF cases performed per year (n=47)	0	4
	1-5	6
	5-10	13
	10-20	15
	20-30	11
	30-40	21
	40+	30
Number of PCF cases performed per year (n=47)	0	12
	1-5	40
	5-10	23
	10-20	17
	20-30	4
	30-40	4

ACDF: Anterior Cervical Discectomy with Fusion; PCF: Posterior Cervical Foraminotomy

### *ACDF*

A standard right-sided approach is used by 78% 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 Figure 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 Figure 2.

**Table 2 - Characteristics surgical techniques**

ACDF			PCF		
	Categories	Percentage %		Categories	Percentage %
Skin incision (n=50)	Contralateral	14	Procedure (n=46)	Open foraminotomy	74
	Ipsilateral	0		Minimally invasive	13
	Always right-sided	78		Endoscopically	2
	Always left-sided	6		Never performs PCF	11
	Never performs ACDF	2	Facet joint (n=41)	Median removal	39
	Use of instruments (n=49)	Only punch	33	Removal of epidural venous cuff (n=40)	Always
High-speed drill and punch		67	Only if visibility is obstructed		65
			Never		15
Use of intervertebral spacer (n=49)	No	8	Removal of discogenic sequester (n=40)	Whenever possible	60
	Cage not filled with bone	57		Only when nerve root is not fully decompressed	25
	Cage filled with autologous bone	14		Never	15
	Autologous bone	0			
	PMMA	6			
	No Preference	14			
Type of cage (n=34)	Titanium	12			
	PEEK	65			
	Other	23			

ACDF: Anterior Cervical Discectomy with Fusion; PCF: Posterior Cervical Foraminotomy; PMMA: Polymethylmethacrylate; PEEK: Polyetheretherketon

## *PCF*

PCF is performed via an open foraminotomy by 74% 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 Figure 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 Figure 4.

### *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.

**Table 3 - Preferred surgical technique for various indications**

<b>Preference</b>	<b>ACDF (%)</b>	<b>PCF (%)</b>	<b>Equally suitable (%)</b>
Foraminal disc prolapse (n=53)	75	6	19
Foraminal spondylotic stenosis (n=52)	34	31	35
Combined discogenic and spondylotic foraminal stenosis (n=50)	48	4	48

ACDF: Anterior Cervical Discectomy with Fusion; PCF: Posterior Cervical Foraminotomy

### 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 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.

**Table 4 – Assumptions about ACDF and PCF**

Assumption	ACDF (% of respondents)	PCF (% of respondents)	Equal (% of respondents)
<i>Most experience during training (n=49)</i>	61	0	39
<i>Fastest recovery (n=48)</i>	71	2	27
<i>Highest reoperation rate (n=45)</i>	7	44	49
<i>Optimal nerve root decompression (n=48)</i>	38	8	54
<i>Highest complication rate (n=48)</i>	27	23	50

ACDF: Anterior Cervical Discectomy with Fusion; 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 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
Less than 5 PCF per year are performed	<0.01	0,23
More likely to choose PCF when:		
It is assumed ACDF and PCF have equal reoperation rates	<0.01	0,23



## Discussion

In this survey, we analyzed the factors that influenced neurosurgeons to choose for the ACDF or PCF technique, 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 Phi = 0,22). Although the respondents suspected a difference in reoperation and complication rates between the two techniques, recent systematic reviews detected no significant difference in reoperation and complication rates [6,10].

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[20].

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 [21,22].

In summary, for cervical foraminal nerve root decompression there was an overall preference for ACDF. For the respondents, “feeling comfortable” and “having experience with the procedure” was of major importance. 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 “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 randomized controlled trials (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[23] and Foraminotomy ACDF Cost-Effectiveness Trial (FACET)].

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.

## 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. Hopefully, the results of the currently running RCTs on the subject will provide a fundament for a guideline for the surgical treatment of foraminal cervical radiculopathy.

## List Of Abbreviations

ACDF anterior cervical discectomy with fusion

PCF posterior cervical foraminotomy

STROBE The Strengthening the Reporting of Observational Studies in Epidemiology statement: guidelines for reporting observational studies

PMMA Polymethylmethacrylate

PEEK Polyetheretherketon

NASSThe North American Spine Society

RCTrandomized controlled trials

FACETForaminotomy ACDF Cost-Effectiveness Trial

## Declarations

### Ethics approval and consent to participate

The Medical Ethical Committee (METc) of the University Medical Center Groningen has reviewed this study and has granted a waiver (reference number METc 2016/512), because no patients were involved.

### Consent for publication

Not applicable.

### Availability of data and materials

The complete questionnaire (in Dutch) is available on request. The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

**Competing interests:** The authors declare that they have no competing interests concerning the materials or methods used in this study or the findings specified in this paper.

**Funding:** this research did not receive any source of funding

### Author's contributions

JK and AB initiated and designed the study. AB and ET collected, analyzed and and interpreted the data. AB and ET drafted the first manuscript. JK, MR, RS and RG substantially revised the manuscript. All authors read and approved the final manuscript.

**Acknowledgements:** we would like to thank Dr PJM Krabbe for his valuable advice regarding the design of our survey and Mrs. Diane Steenks for her help in preparing the manuscript.

## References

- [1] Arts M, Bartels R, Bouma GJ, Donk R, Verbeek A, Verhagen W. Richtlijn behandeling van cervicaal radiculair syndroom ten gevolge van een cervicale hernia nucleii pulposi. 2010
- [2] Bono CM, Ghiselli G, Gilbert TJ, Kreiner DS, Reitman C, Summers J, et al. Clinical Guidelines – Diagnosis and treatment of cervical radiculopathy from degenerative disorders. 2010
- [3] Härtl R, Alimi M, Abdelatif Boukebir M, Berlin CD, Navarro-Ramirez R, Arnold PM et al. Carotid Artery Injury in Anterior Cervical Spine Surgery: Multicenter Cohort Study and Literature Review. *Global Spine Journal*. 2017;7(1\_suppl):71S-75S
- [4] Erwood MS, Hadley MN, Gordon AS, Carroll WR, Agee BS, Walters BC. Recurrent laryngeal nerve injury following reoperative anterior cervical discectomy and fusion: a meta-analysis. *J Neurosurg Spine*. 2016;25(2):198-204
- [5] Halani SH, Baum GR, Riley JP, Pradilla G, Refai D, Rodts GE Jr et al. Esophageal perforation after anterior cervical spine surgery: a systematic review of the literature. *J Neurosurg Spine*. 2016;25(3):285-91
- [6] Gutman G, Rosenzweig DH, Golan JD. Surgical Treatment of Cervical Radiculopathy: Meta-analysis of Randomized Controlled Trials. *Spine (Phila Pa 1976)*. 2018;43(6):E365-E372
- [7] Scholz T, Geiger MF, Mainz V, Blume C, Albanna W, Clusmann H et al. Anterior Cervical Decompression and Fusion or Posterior Foraminotomy for Cervical Radiculopathy: Results of a Single-Center Series. *J Neurol Surg A Cent Eur Neurosurg*. 2018;79(3):211-217

- [8] Wirth FP, Dowd GC, Sanders HF, Wirth C. Cervical discectomy. A prospective analysis of three operative techniques. *Surg Neurol.* 2000;53(4):340-6
- [9] Ruetten S, Komp M, Merk H, Godolias G. Full-endoscopic cervical posterior foraminotomy for the operation of lateral disc herniations using 5.9-mm endoscopes: a prospective, randomized, controlled study. *Spine (Phila Pa 1976).* 2008;33(9):940-948
- [10] Liu WJ, Hu L, Chou PH, Wang JW, Kan WS. Comparison of Anterior Cervical Discectomy and Fusion versus Posterior Cervical Foraminotomy in the Treatment of Cervical Radiculopathy: A Systematic Review. *Orthop Surg.* 2016;8(4):425-431
- [11] Lubelski D, Healy AT, Silverstein MP, Abdullah KG, Thompson NR, Riew KD et al. Reoperation rates after anterior cervical discectomy and fusion versus posterior cervical foraminotomy: a propensity-matched analysis. *Spine J.* 2015;15(6):1277-1283
- [12] Wang TY, Lubelski D, [Abdullah KG](#), Steinmetz MP, Benzel EC, Mroz TE. Rates of anterior cervical discectomy and fusion after initial posterior cervical foraminotomy. [Spine J.](#) 2015;15(5):971-6
- [13] Selvanathan SK, Beagrie C, Thomson S, Corns R, Deniz K, Derham C et al. Anterior cervical discectomy and fusion versus posterior cervical foraminotomy in the treatment of brachialgia: the Leeds spinal unit experience (2008-2013). *Acta Neurochir (Wien).* 2015;157(9):1595-1600
- [14] Schebesch KM, Albert R, Schödel P, Proescholdt M, Lange M, Brawanski A. A single neurosurgical center's experience of the resolution of cervical radiculopathy after dorsal foraminotomy and ventral discectomy. *J Clin Neurosci.* 2011;8(8):1090-2
- [15] [Mok JK](#), Sheha ED, [Samuel AM](#), McAnany SJ, Vaishnav AS, Albert TJ et al. Evaluation of Current Trends in Treatment of Single-level Cervical Radiculopathy. [Clin Spine Surg.](#) 2019;32(5):E241-E245
- [16] von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting

observational studies. *J Clin Epidemiol*. 2008;61(4):344-349

[17] Naveiro-Fuentes M, Rodríguez-Oliver A, Fernández-Parra J, González-Paredes A, Aguilar-Romero T, Mozas-Moreno J. Effect of surgeon's experience on complications from laparoscopic hysterectomy. *J Gynecol Obstet Hum Reprod*. 2018;47(2):63-67

[18] Dubois L, Allen B, Bray-Jenkyn K, Power AH, DeRose G, Forbes TL et al. Higher surgeon annual volume, but not years of experience, is associated with reduced rates of postoperative complications and reoperations after open abdominal aortic aneurysm repair. *J Vasc Surg*. 2018;67(6):1717-1726.e5

[19] Orri M, Revah-Levy A, Farges O. Surgeons' Emotional Experience of Their Everyday Practice - A Qualitative Study. *PLoS One*. 2015;10(11):e0143763

[20] Cho TG, Kim YB, Park SW. Long term effect on adjacent segment motion after posterior cervical foraminotomy. *Korean J Spine*. 2014;11(1):1–6

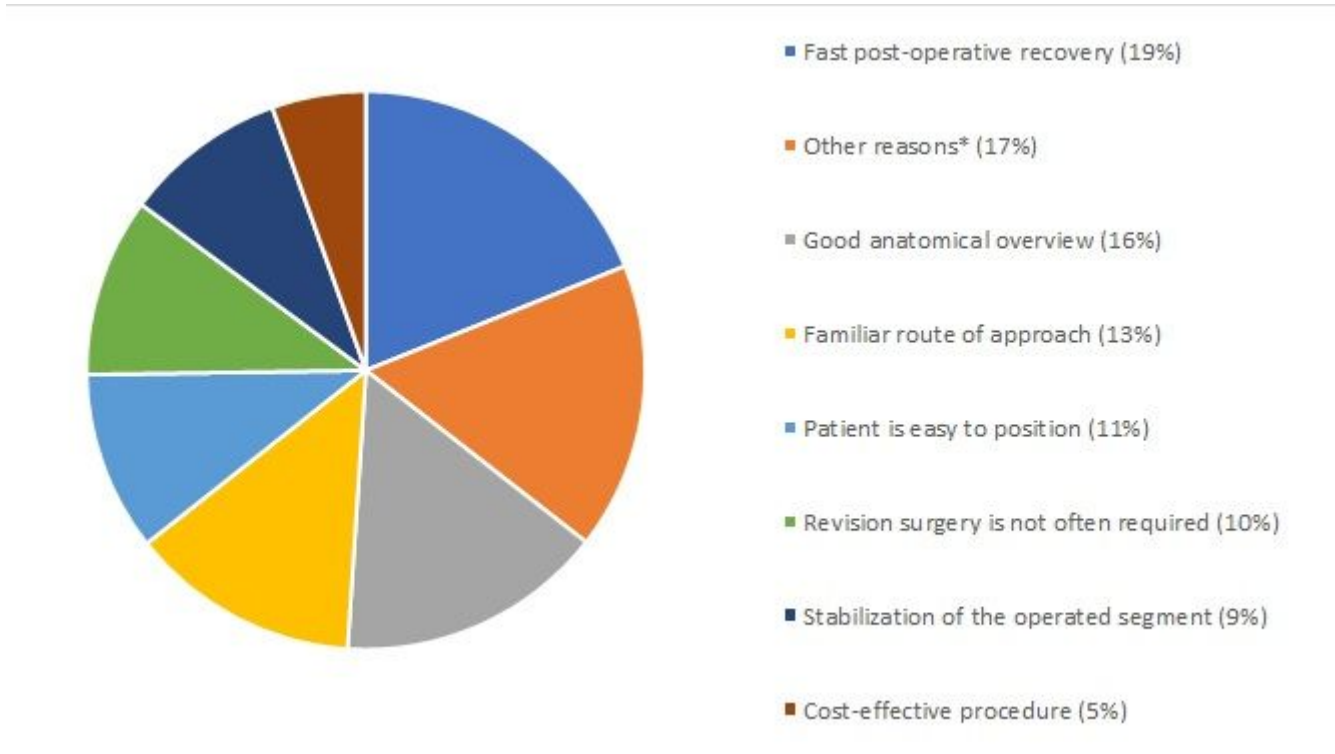
[21] Boshuizen HC, Viet AL, Picavet HS, van Loon AJ. Non-response in a survey of cardiovascular risk factors in the Dutch population: Determinants and resulting biases. *Public Health*. 2006;120:297–308

[22] af Wåhlberg AE, Poom L. An Empirical Test of Nonresponse Bias in Internet Surveys. *Basic and Applied Social Psychology*. 2015;37(6):336-347

[23] Tschugg A, Neururer S, Scheufler KM, Ulmer H, Thomé C, Hegewald AA. Comparison of posterior foraminotomy and anterior foraminotomy with fusion for treating spondylotic foraminal stenosis of the cervical spine: study protocol for a randomized controlled trial (ForaC). *Trials*. 2014;15:437

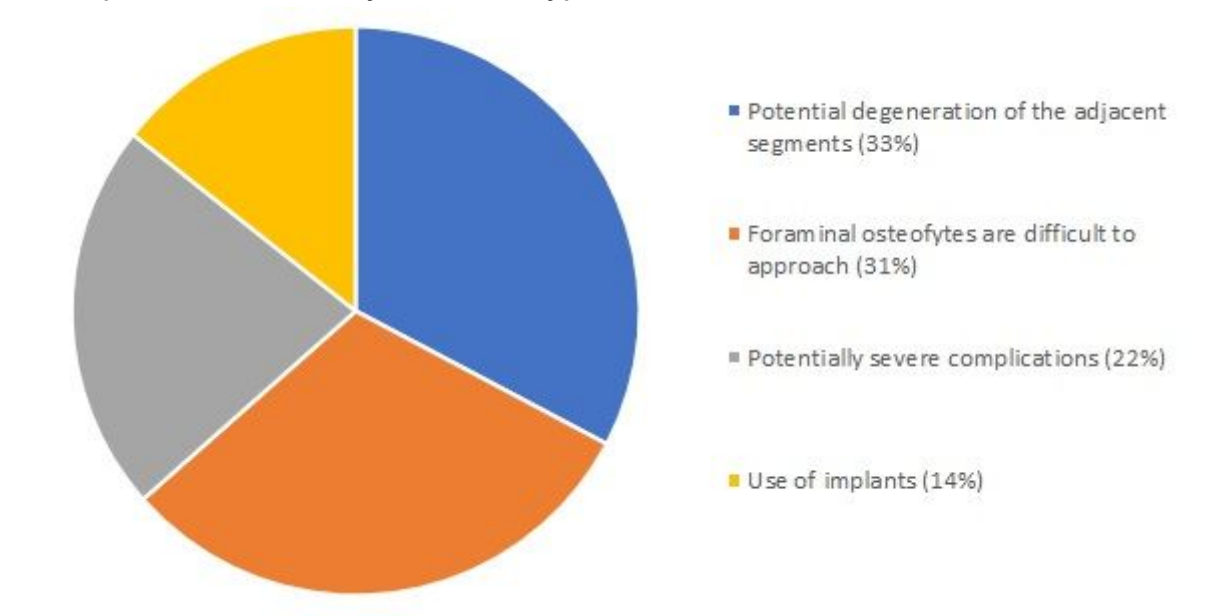
[24] Broekema AE, Kuijlen JM, Lesman-Leegte GA, Bartels RH, van Asselt AD, Vroomen PC et al. Study protocol for a randomised controlled multicentre study: the Foraminotomy ACDF Cost-Effectiveness Trial (FACET) in patients with cervical radiculopathy. *BMJ Open*. 2017;7(1):e012829

# Figures



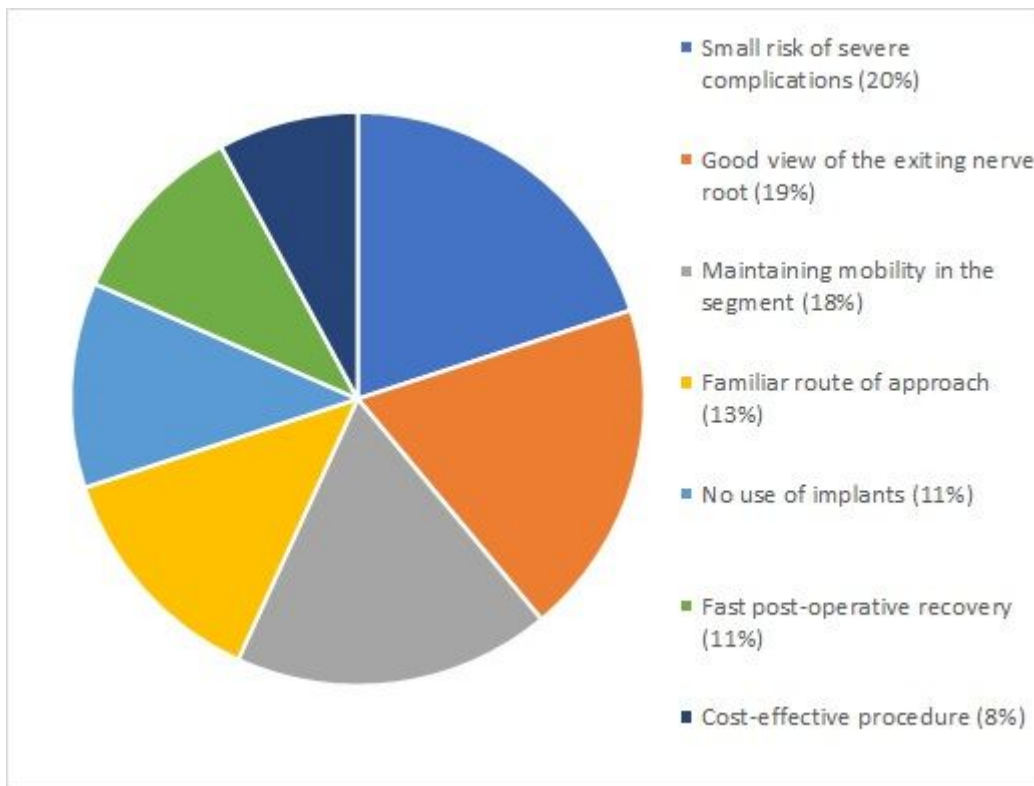
**Figure 1**

Advantages ACDF ACDF: Anterior Cervical Discectomy with Fusion \*Possibility for bilateral decompression; Possibility to correct kyphosis



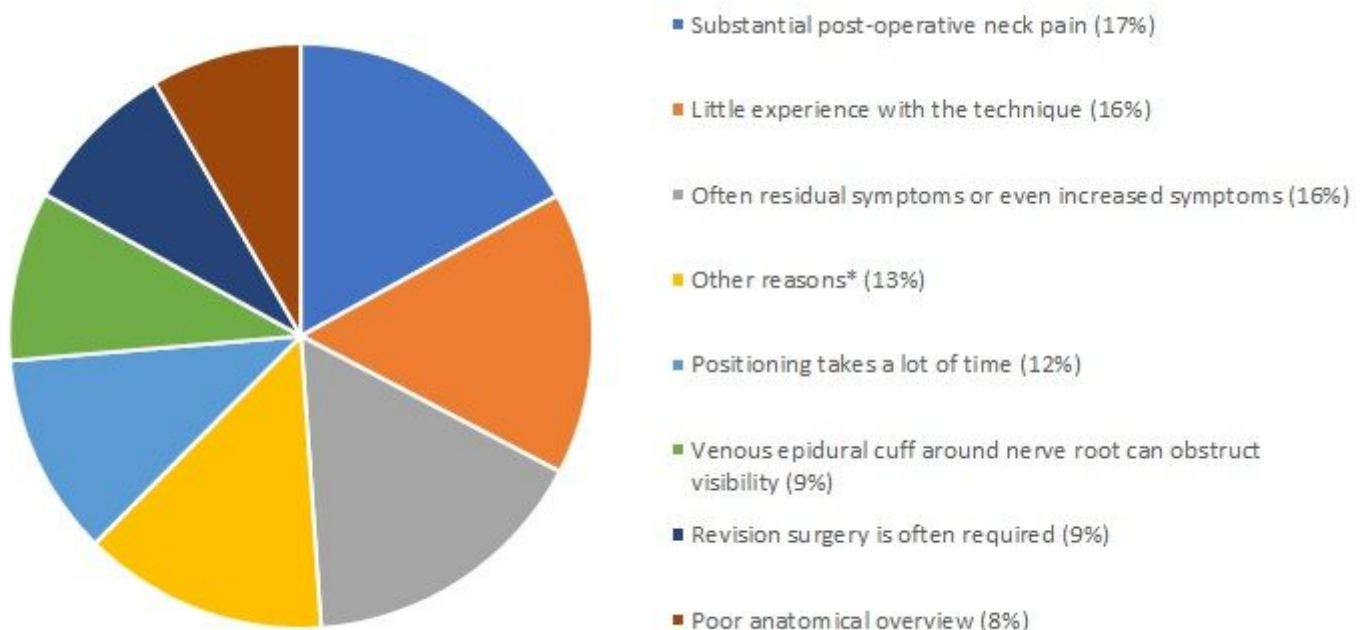
**Figure 2**

Disadvantages ACDF ACDF: Anterior Cervical Discectomy with Fusion\



**Figure 3**

Advantages PCF PCF: Posterior Cervical Foraminotomy



**Figure 4**

Disadvantages PCF PCF: Posterior Cervical Foraminotomy \*Less suitable for bilateral decompression; Experienced higher wound infection rate; Difficult approach in obese patients