Original Article

Surgical tactics of two-segmental cervical degenerative diseases: risk factors retrospective assessment and preoperative planning

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Background: Currently, in the specialized literature there are no substantiated clinical and radiological indications for differentiated use of anterior cervical discectomy and fusion (ACDF) and anterior cervical corpectomy and fusion (ACCF) in the treatment of patients with two-segmental cervical degenerative diseases. The objectives of this study were to (I) identify risk factors that were associated with unsatisfactory results of two-level ACDF and one-level ACCF in the treatment of patients with cervical degenerative diseases despite current perioperative management, and (II) develop a clinical and radiological algorithm for personalized surgical tactics.

Methods: We retrospectively identified risk factors for the development of unsatisfactory clinical postoperative results after two-level ACDF (n=81) and one-level ACCF (n=78), operated in the period of 2009–2019 for two-segmental cervical degenerative disease.

Results: Satisfactory clinical results after two-level ACDF were noted in cases with total kyphotic deformity of less than 15°; local kyphotic deformity less than 10°; the absence of circumferential spondylotic cervical stenosis; the absence of a myelopathic lesion at the level of the vertebral body; absence of migrating intervertebral disk (IVD) hernia more than 1/3 of the vertebral body; T1 slope vertebra less than 15°; IVD degeneration according to Suzuki A. 0–II; facet joint (FJ) degeneration according to Okamoto A. I–III; interbody height (IH) more than 2 mm. Satisfactory clinical results after single-level ACCF were registered in cases with IVD degeneration according to Suzuki A. III; FJ degeneration according to Okamoto A. IV–V; IH 3 mm or less; regardless of the cervical lordosis, the angle of local kyphotic deformity and T1 slope, the presence of circumferential spondylotic cervical stenosis, the localization of the myelopathic lesion and the distance of migration IVD herniation.

Conclusions: Individual planning and differentiated implementation of ACDF and ACCF in patients with two-segmental cervical degenerative disease, taking into account a comprehensive preoperative clinical and radiological assessment, contributes to the effective elimination of existing neurological symptoms, reducing the intensity of neck pain and upper limbs pain, restoring the functional state and quality of patients' lives in the minimum 24 months postoperative period, as well as reducing the number of postoperative complications

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and reoperations.

Keywords: Two-segmental cervical degenerative diseases; anterior cervical discectomy and fusion (ACDF); anterior cervical corpectomy and fusion (ACCF); risk factors; differentiated tactics

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Introduction

Cervical degenerative disease often causes the development reason of the compressive neurological symptoms with severe pain syndrome and significant decrease of life quality (1). Polysegmental lesion is considered to be more common form of pathology (2,3). Anterior approach with 1 and 2 segmental cervical degenerative disease has good clinical outcomes and high fusion rate (4). Wherein, in these cases posterior access is more traumatic, and also associated with high risk of some complications' development, such as C5 nerve root palsy, axial neck pain, segmental instability and progressive cervical kyphosis (5).

To treat patients with two-segmental symptomatic cervical spondylosis, degenerative disc disease and circumferential cervical spondylotic spinal stenosis (6), accompanied by some nerve roots and/or the spinal cord compression, methods of two-level anterior cervical discectomy and fusion (ACDF) and one-level anterior cervical corpectomy and fusion (ACCF) are widely used (7). Specified surgical techniques allow to use the decompression of neural structures effectively, to recover the cervical spine stability and to implement the sagittal balance correction (8). Of course, for two-level cervical spondylosis, the preferred and less traumatic method of treatment is two-level ACDF, while corpectomy or osteotomy is indicated for patients with severe cervical deformity and imbalance. Also, in patients with cervical spinal stenosis combined with ossification of posterior longitudinal ligament (OPLL) and local kyphotic deformity, the use of an anterior approach is preferable with a lower incidence of respiratory problems and dysphagia after ACDF compared with ACCF (9).

Contradictory outcomes of two-level ACDF and one-level ACCF are indicated in the specialized literature. According to some data: (I) one-level ACCF is associated with the best clinical results and the frequency of fusion rate compared with two-level ACDF (10); (II) one-level ACCF and two-level ACDF have similar long-term clinical and radiological results (11,12); (III) one-level ACCF is associated with greater blood loss, injury risk of the dura mater and vertebral artery, high frequency of developing pseudoarthrosis compared with two-level ACDF (13,14). In the described clinical series, an autograph was used for corpectomy as well as a mesh implant with anterior cervical plate fixation. Studies on the use of telescopic prostheses f

Highlight box

Key findings

- Patients with symptomatic two-segmental cervical degenerative disease have to assess the cervical alignment, T1 slope, the degree of degeneration of intervertebral disk (IVD) according to Suzuki A. and facet joint (FJ) according to Okamoto A., the interbody height (IH), the presence of cervical stenosis, the localization of the myelopathic lesion and the distance of herniated disc migration.

What is known and what is new?

- Currently, there are no unified clinical and radiological criteria for differentiated use anterior cervical discectomy and fusion (ACDF) and one-level anterior cervical corpectomy and fusion (ACCF) in patients with two-level cervical degenerative disease.
- The risk factors of unsatisfactory clinical outcomes of patients with two-segmental cervical degenerative disease are:
  - two-level ACDF: IH less than 2 mm, IVD degeneration III stage, FJ degeneration IV and more stage; C2-C7 lordosis less than 15°; local kyphotic angle less than 10°; circumferential spondylotic cervical stenosis; T1 slope more than 15°; migration of IVD herniation more than 1/3 of the vertebral body; localization of the myelopathic lesion opposite of the vertebral body.
  - one-level ACCF: female, osteoporosis; IH 4 mm and more; IVD degeneration 0–I stage; FJ degeneration I–II stage.

What is the implication, and what should change now?

- Individual planning of two-level ACDF and one-level ACCF will potentially reduce risk the postoperative complications, adverse clinical outcomes, repeated hospitalizations and reoperations.
- Consider the use of clinical and radiological algorithm differentiated choice ACDF and ACCF as a useful adjunct in planning surgical treatment of patients with two-segmental cervical degenerative diseases.

with two-segmental cervical degenerative disease are few (15,16). Such differences in the results of surgical treatment of patients with two-level cervical degenerative disease according to the literature are mainly due to different indications for the use of one-level ACCF and two-level ACDF. In this regard, it is difficult to compare the clinical and radiological outcomes of such ventral decompression and stabilization interventions.

The lack of information about using one-level corpectomy reconstruction with an expandable cage comparing with two-level ACDF of patients with two-segmental cervical degenerative disease as well as the absence of common clinical and radiological criteria of differentiated use of these surgical technologies were the motivational moment to perform this project.

The objectives of this study were to (I) identify risk factors that were associated with unsatisfactory results of two-level ACDF and one-level ACCF in the treatment of patients with cervical degenerative diseases despite current perioperative management, and (II) develop a clinical and radiological algorithm for personalized surgical tactics. We present this article in accordance with the STROBE reporting checklist (available at https://jss.amegroups.com/article/view/10.21037/jss-23-99/rc).

Methods

Patients' data

A retrospective cohort study was conducted in 1398 for patients with cervical degenerative disease operated at the Neurosurgery Center of the (Irkutsk Railway Clinical Hospital) from January 2009 to December 2019. A total of 159 patients with two-level cervical degenerative disease who met the inclusion criteria and were available for analysis in the minimum 24 months after operation [32 (26–38) months] were included in the study. Therefore, all patients were included in the same analysis regardless of their specific follow-up period, aiming to increase study power. Patients who were lost to follow-up were noted as well. This study was approved by the Ethics Committee of the Irkutsk State Medical University (No. 3, dated June 18, 2019). The study was carried out in accordance with the principles of the Helsinki Declaration (as revised in 2013). Each patient gave voluntary consent to be included in the study. The participants and any identifiable individuals consented to publication of his/her images. The study design is presented in *Figure 1*.

Inclusion criteria

We included patients with cervical spinal stenosis (canal <12 mm) at two contiguous segments with radiculopathy and/or myelopathy. Most also had foraminal stenosis (vertical size <4 mm). The cervical alignment was either hypolordotic, kyphotic or neutral at the operative level.

Exclusion criteria

We excluded tandem stenosis, OPLL, hyperlordosis, asymptomatic degeneration, single-level or more than two-segmental cervical degenerative diseases, osteoporosis, previous cervical operations, traumatic, oncologic or inflammatory cervical disease.

Surgical technique

Surgical intervention was carried out by one surgical team, from left-sided retropharyngeal approach, using artificial lung ventilation and intravenous general anesthesia under optical magnification Pentero 900 (Carl Zeiss, Jena, Germany), specialized tools (Aesculap, Tuttlingen, Germany), retractor (Capar, Tuttlingen, Germany) and intraoperative X-ray control (Philips, Amsterdam, Netherlands).

The patients were divided into two groups: in the first group (n=81, ACDF) staged two-level discectomy was carried out, the resection of posterior osteophytes with subsequent interbody fusion cages (HRC Cervical, Ulrich, Germany, no conflict interest). In the second group (n=78, ACCF) one-level corpectomy was carried out, the adjacent intervertebral disks (IVDs) removal, the resection of posterior osteophytes with expandable prosthesis implantation (ADD-plus, Ulrich, Germany, no conflict interest). Patients were divided into ACDF and ACCF groups based on surgeon preference.

Study outcomes

Anthropometric [gender, age, body mass index (BMI)] and anamnestic (the fact of smoking, the duration of the disease) data were studied.

Before the operation, at discharge and at last follow-up [32 (26–38) months), patients were actively called for a comprehensive clinical and radiological examination. Clinical parameters (the level of neck pain neck pain and upper limbs pain according to visual analog scale (VAS), neck disability index (NDI), functional state according to

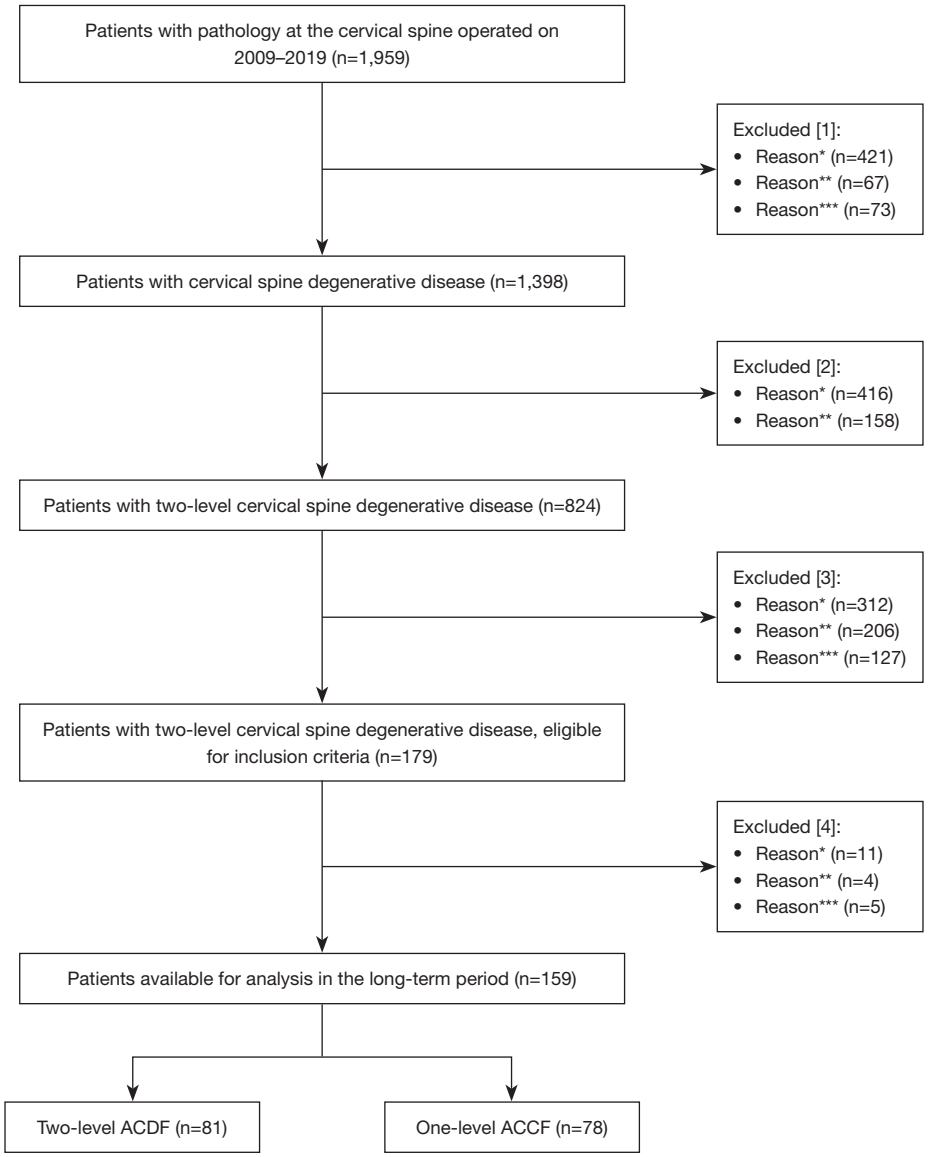

Figure 1 Patients' study flowchart. Exclude reason [1]: Reason*, cervical spine injury; Reason**, inflammatory cervical spine diseases; Reason***, tumor of the spine/roots of the spinal cord. Exclude reason [2]: Reason*, single-level cervical spine degenerative disease; Reason**, multilevel (more than 2 levels) cervical spine degenerative diseases. Exclude reason [3]: Reason*, operated by other anterior surgical techniques (ACF, TDR, TDR + ACDF); Reason**, operated by posterior surgical techniques (PCF, LE, LP, LE + fusion); Reason***, operated with a combination of anterior and posterior surgical techniques. Exclude reason [4]: Reason*, loss of follow-up; Reason**, refusal to participate in the study; Reason***, death unrelated to the operation (there were no postoperative complications). ACDF, anterior cervical discectomy and fusion; ACCF, anterior cervical corpectomy and fusion; ACF, anterior cervical foraminotomy; TDF, total disk replacement; PCF, posterior cervical foraminotomy; LE, laminectomy; LP, laminoplasty.

Modified Japanese Orthopedic Association Score (mJOA), the quality of life according to SF-36 scale—physical component score (PCS) and mental component score (MCS), complications were studied.

Radiological parameters according to cervical X-ray data (cervical lordosis, total cervical range of motion (ROM), segmental ROM, T1 slope), magnetic resonance imaging (MRI) data (IVD degeneration according to Suzuki A. (17),

Table 1 Study patients' data

Criteria	Two-level ACDF (n=81)	One-level ACCF (n=78)	P
ASA			
I	33 (40.7)	32 (41)	0.45
II	39 (48.2)	36 (46.2)	
III	9 (11.1)	10 (12.8)	
Surgery level			
C3-C4, C4-C5	10 (12.3)	8 (10.2)	0.58
C4-C5, C5-C6	22 (27.2)	22 (28.3)	
C5-C6, C6-C7	49 (60.5)	48 (61.5)	
Concomitant pathology			
Diabetes mellitus	7 (8.6)	8 (10.2)	0.41
Arterial hypertension	9 (11.1)	8 (10.2)	
Lung disease	3 (3.7)	4 (5.1)	
Kidney disease	1 (1.2)	2 (2.6)	
Smoking status	31 (38.3)	34 (43.6)	0.18
Daily use of painkillers	26 (32.1)	23 (29.5)	0.24
Follow-up, months	46 [37–55]	43 [38–57]	0.43

Data are presented as M [$Q_{25–75}$] or n (%). ACDF, anterior cervical discectomy and fusion; ACCF, anterior cervical corpectomy and fusion.

IVD migration, localization of spinal cord myelopathic lesion), CT data [facet joint (FJ) degeneration according to Okamoto A. (18), spinal canal diameter, interbody height (IH)] were analyzed.

Statistical analysis

Data were entered into Microsoft Excel and Statistics 13.5 (Stat Soft Inc., Tulsa, USA). The distribution pattern was based on the Shapiro-Wilk, Kolmogorov-Smirnov and Lil'efors tests. Taking into account the presence of significant differences according to these tests (P<0.05), the distribution was considered to be different from normal. Therefore, the significance assessment of the differences in the sample sets was made according to the criteria of nonparametric statistics; a level of P<0.05 was considered as the lower confidence limit. The data were presented as the median, the values of the 1st and 3rd quartiles [M ($Q_{25–75}$)]. The following nonparametric statistics criteria were used: the Mann-Whitney test for intergroup comparison, Friedman's criterion for dependent samples, and Fisher's exact test for binomial parameters. Logistic regression analysis to identify risk factors for the development of unsatisfactory clinical postoperative results was used. Significant influence had risk factors with a value of P<0.05.

Results

The patients general data are presented in *Table 1*. The degree of physical status according to ASA, concomitant pathology, the smoking status—no intergroup differences were found (P>0.05). More than 60% of patients of both groups operated in the C5-C6 and C6-C7 level.

All studied clinical parameters before surgery did not have a statistically significant intergroup difference: neck pain pre-operatively (P=0.53), upper limbs pain (P=0.29), NDI (P=0.44), mJOA (P=0.61), SF-36 (PCS) (P=0.44), and SF-36 (MCS) (P=0.26). The evaluation of clinical efficacy after two-level ACDF and one-level ACCF showed significant decrease of intensity of pain syndrome according to VAS in the cervical spine from 86 [81–94] to 19 [10–24] mm (P=0.02) and from 81 [76–95] to 8 [5–12] mm (P=0.01) respectively, and in upper limbs from 89 [75–92] to 8 [4–12] mm (P=0.003) and from 91 [76–93] to 2 [0–5] mm (P=0.007) respectively; improvement of NDI from 74 [60–88] to 15 [12–20] (P=0.01) and from 72 [60–84] to 8 [6–10] (P=0.01) respectively, and mJOA from 9 [9–11] to 12 [8–14] (P=0.01) and from 9 [8–12] to 15 [13–16] (P=0.01) respectively; restoring the quality of live according to SF-36 (PCS) from 26.73 [20.36–35.72] to 46.23 [44.56–49.06] (P=0.006) and from 28.72 [19.83–36.54] to 55.29 [51.83–57.29] (P=0.004) respectively, and SF-36 (MCS) from 33.19 [19.82–39.81] to 43.24 [41.39–46.81] (P=0.009) and from 32.21 [18.28–38.99] to 57.66 [51.25–59.22] (P=0.002) respectively. Intragroup analysis registered better last follow-up clinical parameters according to VAS, NDI, mJOA, SF-36 (MCS) and SF-36 (MCS) after one-level ACCF comparing with two-level ACDF (P=0.02; P=0.04; P=0.02; P=0.03; P=0.01; P=0.01, respectively).

Radiological parameters are presented in *Table 2*. At discharge and preoperation, all radiological parameters were comparable in both groups (P>0.05). The C2-C7 lordotic Cobb angle significantly increased post-operatively in ACDF group (P=0.03) and ACCF group (P=0.02). At last follow-up, the significant decrease of cervical lordosis after ACDF comparing to ACCF was noted (P=0.01). The total ROM of the cervical spine decreased significantly in both groups (P<0.05), there were not statistically significantly

Table 2 Study patients' radiological parameters' changes

Criteria	Two-level ACDF (n=81)			One-level ACCF (n=78)		
	Before	Discharge	Last follow-up	Before	Discharge	Last follow-up
Cervical lordosis, °	9.5 [8–11]	21.5 [19.5–24]*	17.5 [16–19] **	10.5 [9–12]	24.5 [21.5–28]*	23 [21–26]
ROM of the cervical spine, °	47.7 [41.2–53.7]	38.1 [34.8–45.5]*	22.9 [21.1–26.7]**	49.4 [42.5–55.8]	39.2 [33.3–47.1]*	24.2 [21.9– 27.3]**
ROM of the adjacent segment, °						
Upper	8.8 [7.1–9.4]	8.9 [7.0–9.5]	9.2 [8.1–10.1]	8.7 [7.0–9.6]	8.5 [7.1–9.4]	8.4 [7.3–9.7]
Lower	8.7 [7.3–9.2]	8.5 [7.4–9.0]	7.4 [6.5–8.0] **	8.9 [7.5–9.8]	8.6 [7.4–9.5]	8.8 [7.3–9.3]
IH, mm						
Upper	7.4 [6.0–7.7]	7.2 [5.9–7.5]	5.3 [4.7–5.9] **	7.1 [6.2–7.8]	7.0 [6.0–7.6]	6.8 [6.1–7.5]
Lower	7.3 [6.2–7.8]	7.2 [6.0–7.7]	6.0 [5.4–6.6] **	7.0 [6.1–7.5]	6.9 [6.0–7.3]	6.7 [6.1–7.3]
IVD degeneration according to Suzuki A						
Upper	0 [0–I]	0 [0–I]	II [I–III] **	0 [0–I]	0 [0–I]	I [I–II]**
Lower	0 [0–I]	0 [0–I]	I [I–III]	0 [0–I]	0 [0–I]	I [0–I]
FJ degeneration according to Okamoto A						
Upper	I [I–II]	I [I–II]	III [II–IV]**	I [I–II]	I [I–II]	II [II–III]**
Lower	I [I–II]	I [I–II]	III [II–IV]**	I [I–II]	I [I–II]	II [I–II]

Data are presented as M [$Q_{25–75}$]. *, P_w<0.05 between before operation and discharge; **, P_w<0.05 between discharge and last follow-up. ACDF, anterior cervical discectomy and fusion; ACCF, anterior cervical corpectomy and fusion; ROM, range of motion; IH, interbody height; IVD, intervertebral disc; FJ, facet joint.

different at discharge (P=0.36) and at last follow-up (P=0.63).

Statistically significant greater adjacent segments degeneration after ACDF comparing with ACCF was registered (P<0.05).

At last follow-up, symptomatic adjacent segment degenerative disease and revision surgery cases were identified—after ACDF (n=5, 6.2%) and ACCF (n=4, 5.1%).

Pseudoarthrosis according to Bridwell classification were verified among 8 (9.9%) patients after two-level ACDF and 10 (12.8%) patients after ACCF (P=0.36).

Analysis of preoperative clinical and radiological data in patients after two-level ACDF and one-level ACCF identified patients who had unsatisfactory clinical results at last follow-up. The outcomes can be classified as unsatisfactory since the patients have neck pain and/or upper extremities pain higher than 20 mm according to VAS, NDI more than 20 and mJOA less than 12 points. The results of logistic regression analysis are presented in *Table 3*.

Based on the above-mentioned data, the risk factors of unsatisfactory clinical outcomes of patients with two-segmental cervical degenerative disease are:

(I) Two-level ACDF: IH less than 2 mm, IVD degeneration III degree according to Suzuki A., FJ degeneration IV and more degree according to Okamoto A.; C2-C7 lordosis less than 15°; local kyphotic angle less than 10°; circumferential spondylotic cervical stenosis; T1 slope more than 15°; migration of IVD herniation more than 1/3 of the vertebral body; localization of the myelopathic lesion opposite of the vertebral body.

(II) One-level ACCF: female, the presence of osteoporosis (the value of the T-criterion is –2.5 SD and lower according to two-energy X-ray absorptiometry); IH 4 mm and more; IVD degeneration 0–I degree according to Suzuki A.; FJ degeneration I–II degree according to Okamoto A.

Identified risk factors of the developing unsatisfactory clinical results in the minimum 24 months postoperative period in patients with two-segmental cervical degenerative disease allowed to identify indications and contraindications to perform two-level ACDF and one-level ACCF to develop the algorithm differentiated tactics, based on preoperative

Table 3 Risk factors for the development of unsatisfactory clinical outcomes in the study patients

Risk factor	Two-level ACDF (n=81)		One-level ACCF (n=78)	
	OR (95% CI)	χ^2	OR (95% CI)	χ^2
Female	4.9 (3.1–7.4)	44.7	1.7 (1.1–3.1)	24.5*
Age over 65 years	1.5 (1.2–2.4)	32.1	1.6 (1.3–1.8)	15.9*
Osteoporosis	16.9 (8.2–22.4)	52.8	2.9 (1.3–4.6)	65.8*
Smoking	1.6 (1.3–1.8)	21.9*	3.1 (2.7–4.2)	29.2*
Length of clinical symptoms	1.2 (1.1–1.7)	41.3*	1.5 (1.2–1.9)	27.4*
IH (less than 2 mm)	3.9 (2.3–5.3)	25.5*	1.7 (1.2–2.5)	18.3
IH (more than 4 mm)	2.8 (1.4–4.2)	21.8	4.3 (2.2–6.7)	31.8*
IVD hernia migration	2.7 (1.5–3.8)	21.8*	3.1 (2.3–4.4)	34.7
Cervical lordosis C2-C7	2.6 (2.3–2.9)	34.1*	1.4 (1.1–1.8)	14.3*
T1 slope	2.7 (2.3–3.2)	51.8*	1.9 (1.2–2.6)	31.7*
Local kyphotic angle	2.1 (1.7–2.8)	32.7*	3.5 (2.3–4.5)	67.3
Localization of the myelopathic lesion at the level of the vertebral body	1.3 (1.2–1.6)	23.7*	2.5 (2.3–2.8)	12.6
Circular stenosis of the spinal canal	2.0 (1.6–2.6)	24.8*	2.6 (2.2–2.9)	32.6
IVD degeneration according to Suzuki A. more than III grade	3.4 (2.2–4.5)	36.4*	2.6 (2.3–3.8)	13.9
IVD degeneration according to Suzuki A. 0–I grade	3.6 (2.1–5.7)	81.3	5.2 (3.4–8.6)	47.5*
FJ degeneration according to Okamoto A. III grade and more	2.6 (1.3–3.7)	21.9*	1.5 (1.1–1.9)	22.8
FJ degeneration according to Okamoto A. I–II grade	6.7 (3.1–9.3)	33.8	4.9 (2.1–8.6)	57.7*

*, P<0.05. ACDF, anterior cervical discectomy and fusion; ACCF, anterior cervical corpectomy and fusion; OR, odds ratio; CI, confidence interval; IH, interbody height; IVD, intervertebral disc; FJ, facet joint.

clinical and radiological data (*Figure 2*).

Discussion

At present, in the literature, there are no clear confirmed clinical and radiological indications to perform two-level ACDF and one-level ACCF for patients with two-segmental cervical degenerative disease.

The main indications of two-level ACDF and one-level ACCF are degenerative spinal stenosis and foraminal stenosis, kyphotic deformation and mainly ventral compression of the neural structures (19). At the same time, the main purpose of the surgical treatment for compression radiculopathy or myelopathy are decompression of the spinal cord and its roots with stabilization and the restoration of the sagittal profile (20).

The main contraindications of two-level ACDF and one-level ACCF are circumferential spondylotic cervical stenosis, osteoporosis and hyperlordotic cervical spine alignment (21).

It has been found that ACCF in patients with OPLL allows complete decompression behind the vertebral body and cannot be performed using ACDF (22). At the same time, in this cohort of patients, ACDF is associated with a lower risk of postoperative complications, especially with multilevel implantation (23,24). Such patients were not included in this study, and for analysis we selected a homogeneous cohort of patients with common indications for ACDF and ACCF.

Comparative analysis of results two-level ACDF and one-level ACCF is ambiguous. According to Oh *et al.* (13) comparing the results of single-level ACCF and two-level ACDF, the advantages of the latter were established: operation time (P=0.001) and blood loss (P=0.001) were significantly higher in ACCF group, while the height of the operated segment (P=0.018) and postoperative cervical lordosis (P=0.009) were significantly lower in the group of ACCF. Similar data, indicating for the advantages of ACDF

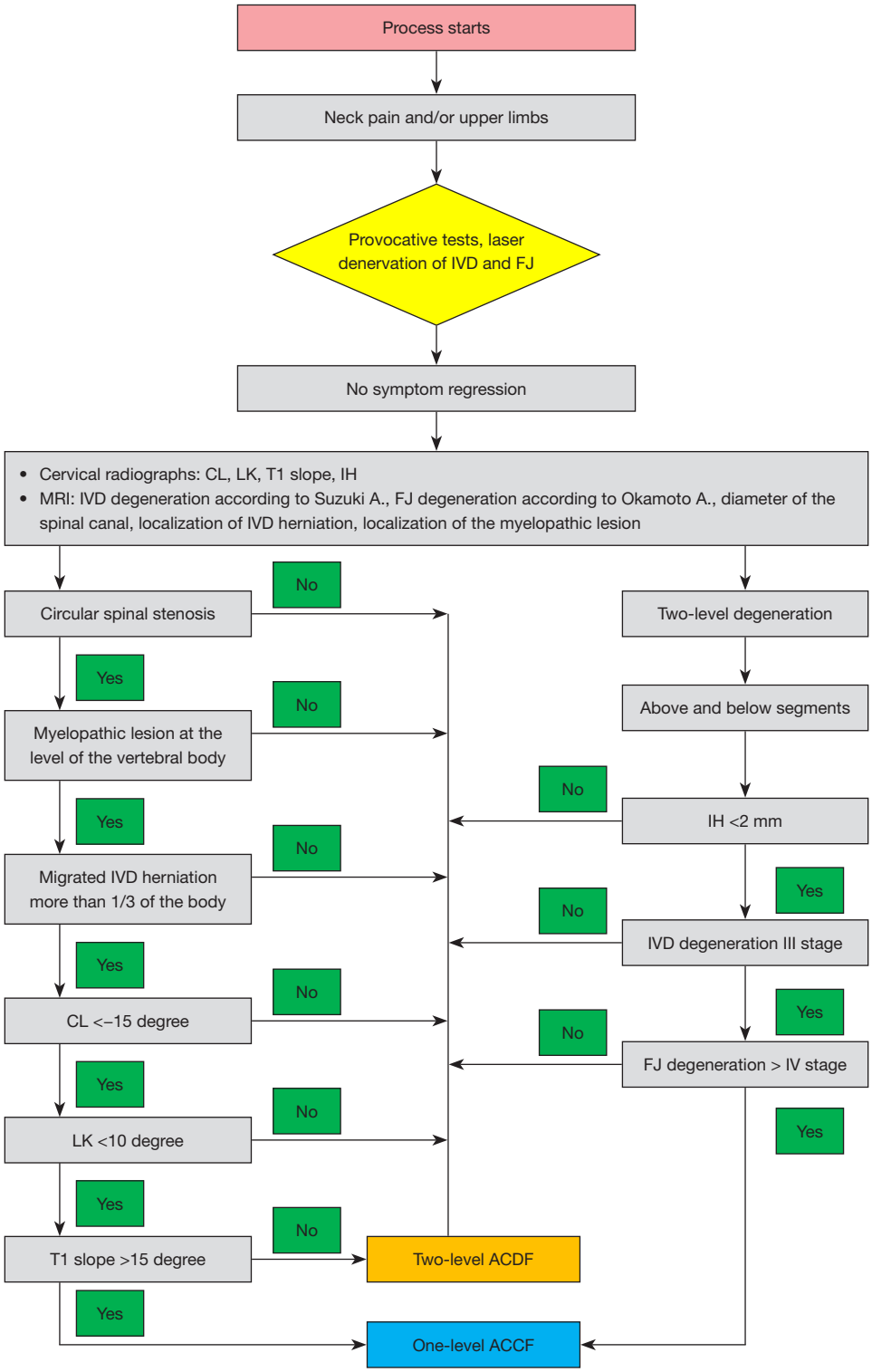

Figure 2 Clinical and radiological algorithm for the surgical treatment choice of patients with two-segmental cervical degenerative diseases. IVD, intervertebral disc; FJ, facet joint; CL, cervical lordosis C2-C7; LK, local kyphosis; IH, interbody height; MRI, magnetic resonance imaging; ACDF, anterior cervical discectomy and fusion; ACCF, anterior cervical corpectomy and fusion.

comparing with ACCF according to the hospital stay, the blood loss, the operation time, postoperative cervical lordosis is obtained in the study to Qiu *et al.* (25). Moreover, biomechanical study on cadaver models showed greater stability of ACDF with additional fixation of the cervical plate comparing with ACCF and PEEK prosthesis (26).

Thus, Burkhardt *et al.* (27) indicate that, both techniques ACDF and ACCF for patients with two-segmental cervical myelopathy have equally good 1-year postoperative result: fusion rate for ACDF was 97.5%, for ACCF 94.7% (P=0.59); very satisfied according to Likert scale were 86.5% in ACDF group and 82.9% in ACCF group (P=0.62). In the study Ha *et al.* (28) comparable results between two-level ACDF and one-level ACCF according to clinical outcomes [Japanese Orthopedic Association (JOA) score, Odom criteria] and X-ray parameters (IH, segmental and global cervical lordosis) were identified.

In patients with a migrated disc herniation that exceeds the axial length of the vertebra, ACCF has technical advantages over ACDF. This is due to the safe revision of the epidural space and complete removal of the compression substrate when performing corpectomy (10).

Currently, there are contradictions regarding the performance of two-level ACDF and one-level ACCF for two-level cervical degenerative disease. This is due to the lack of objective clinical and radiological indications for the differentiated use of the listed ventral decompressive and stabilizing interventions.

In Russian-language literature, PubMed, Embase and Cochrane Library the absence of studies devoted to a comprehensive analysis of the influence of the above preoperative criteria on the last follow-up clinical outcome for patients with two-level cervical degenerative disease using two-level ACDF and one-level ACCF was established. At the same time, preoperative planning of the surgical intervention, taking into account the considered clinical and radiological risk factors, contributes to the adoption of differentiated surgical tactics to optimize postoperative outcomes.

Further implementation of prospective multicenter studies and randomized clinical trials with a long follow-up period is necessary to analyze the effectiveness of the proposed algorithm of personalized surgical tactics in the treatment of patients with two-segmental cervical degenerative disease.

Individual planning of two-level ACDF and one-level ACCF outcome in patients with two-segmental cervical degenerative disease taking into account the preoperative clinical and radiological assessment, contributes to the effective elimination of existing neurological symptoms, reducing the intensity of neck pain and upper limbs pain, restoring the functional state and patients' quality of life in the minimum 24 months postoperative period. In addition, it is potentially possible to prevent the formation of postoperative complications, adverse clinical outcomes, readmissions and reoperations.

Limitations

The limitations of the study are: (I) retrospective study design; (II) single-center study; (III) the absence of clinical and radiological outcomes in the early and long-term postoperative periods; (IV) study only the two-segmental symptomatic cervical degenerative diseases; (V) the presence of possible bias in the research evaluation results due to the use of known technical differences between two-level ACDF and one-level ACCF; (VI) the correlation study absence of unsatisfactory postoperative outcomes with psychosomatic status, concomitant pathology and the disease duration.

Conclusions

Patients with symptomatic two-segmental cervical degenerative disease have to assess the cervical lordosis, local kyphotic angle, T1 slope, the degree of degenerative changes in IVD and FJ, the IH, the presence of circumferential spondylotic cervical stenosis, the localization of the myelopathic lesion and the distance of migration IVD herniation.

When identifying objective data, indicating the degenerative changes of the IVD according to Suzuki A. 0–II-degree, degenerative changes of the FJ according to Okamoto A. I–III degree, the value of the C2-C7 angle is less than 15° and the local kyphotic angle is less than 10°, T1 slope is less than 15°, the absence of circumferential spondylotic cervical stenosis, migration of the disc herniation is no more than 1/3 of the vertebral body, the absence of the myelopathic lesion at the level of the vertebral body, the IH is more than 2 mm, it is possible to perform two-level ACDF. In other cases, for two-level cervical degenerative diseases, it is preferable to perform a single-level ACCF.

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Footnote

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jss.amegroups.com/article/view/10.21037/jss-23-99/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was approved by the Ethics Committee of the Irkutsk State Medical University (No. 3, dated June 18, 2019). Each patient gave voluntary consent to be included in the study. The participants and any identifiable individuals consented to publication of his/her images.

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