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| RESEARCH ARTICLE

Peri-surgical Complications Related to Anterior Cervical Spine Surgery: Smith-Robinson Approach

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| ABSTRACT

The primary goal is to identify the genuine incidence of peri-surgical complications associated with anterior cervical spine surgery in a low-income country. The secondary goal is to identify any risk factors predisposed to these complications; Especially dysphagia, as it is the most common perioperative complication, and to clarify the prognosis of these complications, as well as their proper management. This is a retrospective case-control study, including 109 patients who underwent anterior cervical spine intervention from the right side in Tishreen University Hospital in Lattakia, Syria, during the period between 1-1-2018 and 15-12-2021. Data was collected regarding gender, age, diagnosis *(radiculopathy or myelopathy)*, surgical procedure, number of levels, plate addition, smoking, diabetes mellitus, and peri-surgical complications occurred during surgery proceeding to the next 14 days of follow-up. Male: female ratio was (1.4:1), 30.3% of cases were from a grouping (41-50) years of age. Myelopathy consists 56% of cases, anterior cervical discectomy and fusion *(ACDF)* consist of 47.7% of procedures. Intervention at one level represented the highest percentage at 52% of cases. The peri-surgical complication rate was 12.8%; divided into dysphagia 6.4%, recurrent laryngeal nerve (RLN) injury, superficial infection 1.8% each, dural tear, compressive hematoma, and neurological deterioration 0.9% each. Plate addition, 3 or more levels of intervention, and (*ACDF+P*) or (*ACCF*) surgery are all determined to be risk factors for the development of perioperative dysphagia. The majority of peri-surgical complications of anterior cervical spine surgery are minor and can be managed conservatively with a good prognosis. Early recognition of these complications with appropriate management is of paramount importance for improving the outcomes. Plate addition, 3 or more levels of intervention, and (*ACDF+P*) or (*ACCF*) surgery are all determined to be risk factors for the development of perioperative dysphagia.

| KEYWORDS

Cervical spine surgery, complications, dysphagia, risk factors

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1. Introduction

Most of the traumatic or degenerative pathologies affecting the cervical spine anteriorly compress neural structures, such as disc herniation, posterior osteophytes, or thickening of the posterior longitudinal ligament (PLL). Which in many cases followed by ligament calcification. Cervical symptoms may also result from segmental instability or deformity of cervical curvature. The anterior cervical approach is the most commonly used approach in subaxial cervical spine surgery. As it gives relatively easy access to the cervical column, enabling managing the aforementioned pathologies, hence releasing the anterior compression directly where it is situated. Also, it enables correcting deformities, restoring the normal curvature, as well as normal alignment of the cervical column. All of these are satisfactory results in most cases. In 1958 Robinson and Smith described their technique to anteriorly decompress cervical neural structures followed by fusion at the target level (Smith et al., 1958). This paved the way for one of the most common cervical spine surgeries. Several modifications followed with the contributions of Cloward (Cloward, 1958), Baily and Badgly (Bailey et al., 1960). Since then, many methods for anterior decompression have been developed. However, the Smith-Robinson approach remains the most widely used. Despite these satisfactory results, the anterior approach may be accompanied

by some complications. In rare cases, they may be troublesome or even life-threatening. Sometimes, complication management is more expensive than the surgery itself, which adds more burden on the health system, especially in low-income countries. Avoiding complication occurrence is more cost-effective than managing them. Additionally, many of these complications reported in articles are within a wide range. Complications may present in the perioperative period or can be delayed after a period of follow-up. Good knowledge of complications related to and following surgery, early detection, and proper management is crucial to avoid their occurrence. In this study, we aim to report our experience in this field, as one of the low-income countries.

2. Patients and methods

This study is a retrospective case-control study conducted on patients admitted to the department of neurosurgery at Tishreen University Hospital in Lattakia, Syria, whose diagnosis was either cervical *radiculopathy* or *myelopathy* in the period between 1-January-2018 to 15-December-2021.

Inclusion criteria: All patients underwent anterior cervical spine surgery from the right side.
Exclusion criteria: neoplastic cases, trauma cases, recurrent cases, patients with a history of neck irradiation or previous neck surgery for non-neurological reasons, patients with a history of chronic corticosteroids use, and patients with a concomitant posterior compression requires an additional posterior approach.

109 patients were enrolled. Charts of these patients were reviewed and data (regarding gender, age, diagnosis, surgical procedure, number of levels, plate addition, smoking, DM, and peri-surgical complications) was collected and tested for their potential role as risk factors. Any complication occurring during surgery up to the 14th day of surgery was considered a perioperative complication. Patients were divided into two groups: Complicated patients served as a case group; non-complicated patients served as a control group.

Descriptive statistics were used to calculate the frequencies and percentages for qualitative variables; measures of central tendency, as well as measures of dispersion for quantitative variables. For inferential statics, all variables were tested according to univariant regression. Each variable did not fulfill the term to stay in the study *(not statistically significant)* using Chi-square or Fisher exact test *(to study the relationship between qualitative variables)* was excluded. Afterward, statistically significant variables were entered into the multivariate analysis equation to identify the most variables correlated to complications. Results are considered statistically significant when P-value $<5\%$. We used IBM SPSS statistics (Version 20) to calculate the statistical parameters and analyze the results.

3. Results

3.1 Patients' demographic and clinical characteristics

109 patients were included in this study. Males' number was 65(59.6%), while females' number was 44(40.4%), and the male: female ratio was (1.4:1). Patients' ages ranged between 27 and 79 years (mean 51±11.4). The age group (41-50 years) represented the highest percentage (30.3%), followed by the group (51-60 years) with (28.4%). Smokers' number was 62(56.9%), while non-smokers were 47(43.1%). The majority of patients were non-diabetic 92(84.4%), and diabetics were 17(15.6%). Preoperative diagnosis was myelopathy in 61(56%), and radiculopathy in 48(44%).

Table (1) Patients' demographic and clinical characteristics

Demographic variables	Patients		Total	P-value
	Case	Control		
Gender				
Male	8(12.3)	57(87.7)	65	0.8
female	6(13.6)	38(86.4)	44	
Age				
≤50	5(9.4)	48(90.6)	53	0.3
>50	9(16.1)	47(83.9)	56	
Diagnosis				
Myelopathy	8(13.1)	53(86.9)	61	0.9
radiculopathy	6(12.8)	42(87.5)	48	
Smoking				
Smoker	8(12.9)	54(87.1)	62	0.9
Non-smoker	6(12.8)	41(87.2)	47	
DM				
Diabetic	2(11.8)	15(88.2)	17	0.8
Non-diabetic	12(13)	80(87)	92	

3.2 Patients' surgical characteristics

52(47.7%) patients underwent anterior cervical discectomy and fusion ACDF, 36(33%) patients underwent anterior cervical discectomy and fusion with plating ACDF+P, and 21(19.3%) underwent anterior cervical corpectomy and fusion ACCF. Single level fusion was performed in 50(45.9%) patients, two levels of fusion in 42(38.5%), three and four levels of fusion in 16(14.7%) and 1(0.9%), respectively. We added the plate in 57(52.3%) patients. The remainders were non-plated patients with a number of 52(47.7%).

Table (2) Patients' surgical characteristics

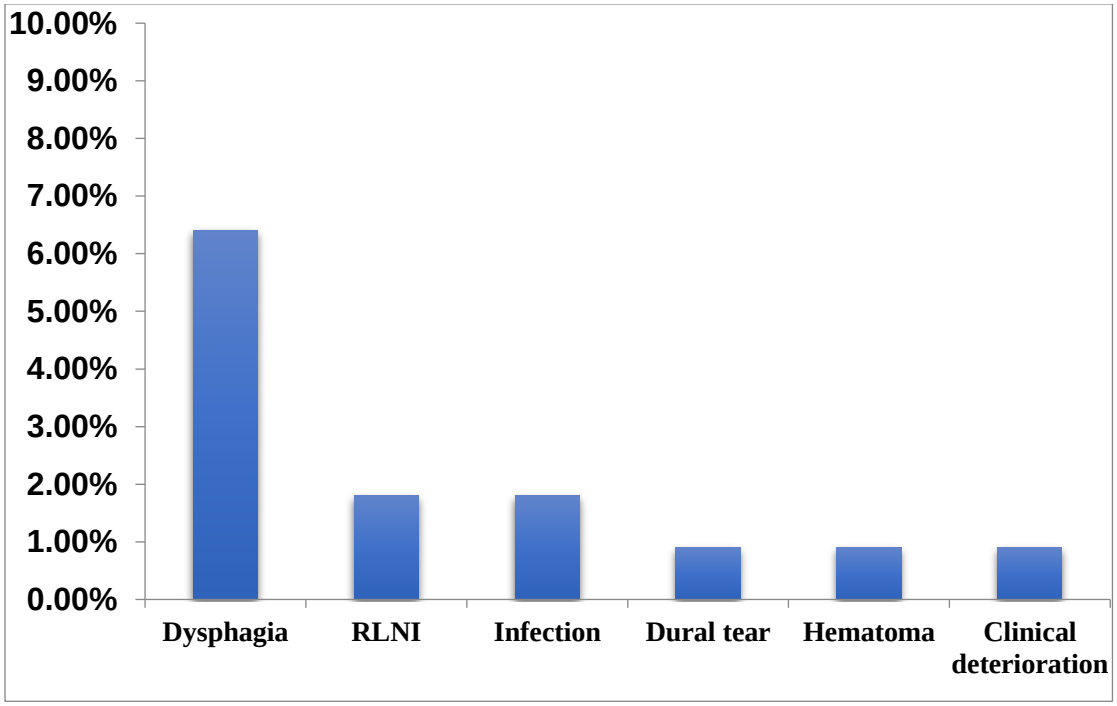
Surgical variables	Patients		Total	P-value
	Case	Control		
surgery				
ACDF	2(3.8)	50(96.2)	52	0.01
ACDF+P	6(16.7)	30(83.3)	36	
ACCF	6(28.6)	15(71.4)	21	
Levels				
1	5(10)	45(90)	50	0.02
2	4(9.5)	38(90.5)	42	
≥3	5(29.4)	12(70.6)	17	
Plate				
+P	12(21.1)	45(78.9)	57	0.007
-P	2(3.8)	50(96.2)	52	

3.3 Peri-surgical complications

Fourteen patients (12.8%) developed peri-surgical complications. Dysphagia occurred in 7(6.4%) patients. 6 of them improved gradually during the follow-up period, while one case persisted for more than this. Two patients (1.8%) developed RLN injury which presented as postoperative hoarseness. The diagnosis was confirmed by laryngoscopy. Both patients were treated with dexamethasone, managing to improve during the follow-up period. The superficial infection happened in two patients (1.8%). Both of them were treated with antibiotics and cured without any sequelae. During surgery, unintended durotomy occurred in one patient (0.9%), he was undergoing ACCF. However, the tear was minimal, covered with gel foam without repairing the dura. After the drainage was removed, a collection of CSF was formed under the platysma *(without leaking through the wound)*. He was treated with repeated punctures with the application of the gentle compressive dressing. The case was healed with no further complications. One patient (0.9%) developed hematoma when she underwent ACCF. The patient had difficulty improving oxygenation with difficulty breathing and Swallowing after extubation at the weaning. The next day, the patient developed weakness in the lower extremities; the diagnosis was made by CT of the cervical region, where it was found a compressive hematoma which was surgically evacuated and the drainage was occluded; which was replaced. The patient immediately improved without any sequelae. Finally, one patient (0.9%) developed neurological deterioration after ACDF procedure. She suffered from C7 weakness and started on dexamethasone doses with physiotherapy. The case tended to improve during the follow-up period. None of the patients developed early implant failure or Horner's syndrome. None had a vascular or esophageal injury.

Table(3) Perioperative complications within both case group and study sample

Complication	Case group (%)	In Sample %
Dysphagia	7 (50)	6.41
Recurrent laryngeal nerve injury	2 (14.29)	1.83
Infection	2(14.29)	1.83
Dural tear	1(7.14)	0.91
Hematoma	1(7.14)	0.91
Clinical deterioration	1(7.14)	0.91
Total	14(100)	12.8



Figure(1) Peri-surgical complications in the study. RLNI, recurrent laryngeal nerve injury

3.4 Risk factors

There are no statistically significant differences between the case group and control group consisting of demographic variables of gender (P=0.8), diagnosis (P=0.9), smoking (P=0.9), and DM (P=0.8). However, the study showed a tendency for perioperative complications to occur in the age group > 50 years. This tendency did not reach the statistical significance level (P=0.3). As for surgical variables, there was statistically association between complications and ACDF+P / ACCF surgeries (P=0.01), number of levels (P=0.02), and plate addition (P=0.007). When studying the relationship between each complication separately with surgical variables, we found that there was a statistically significant association between the development of dysphagia and ACCF/ACDF+P surgery (P=0.04); as well as surgery of three or more levels (P=0.001), and plate addition (P=0.02). While there were no statistically significant differences between the case group and the control group with regard to the association between the remaining complications with variable studied.

Table (4) peri-surgical complication distribution according to surgical variables

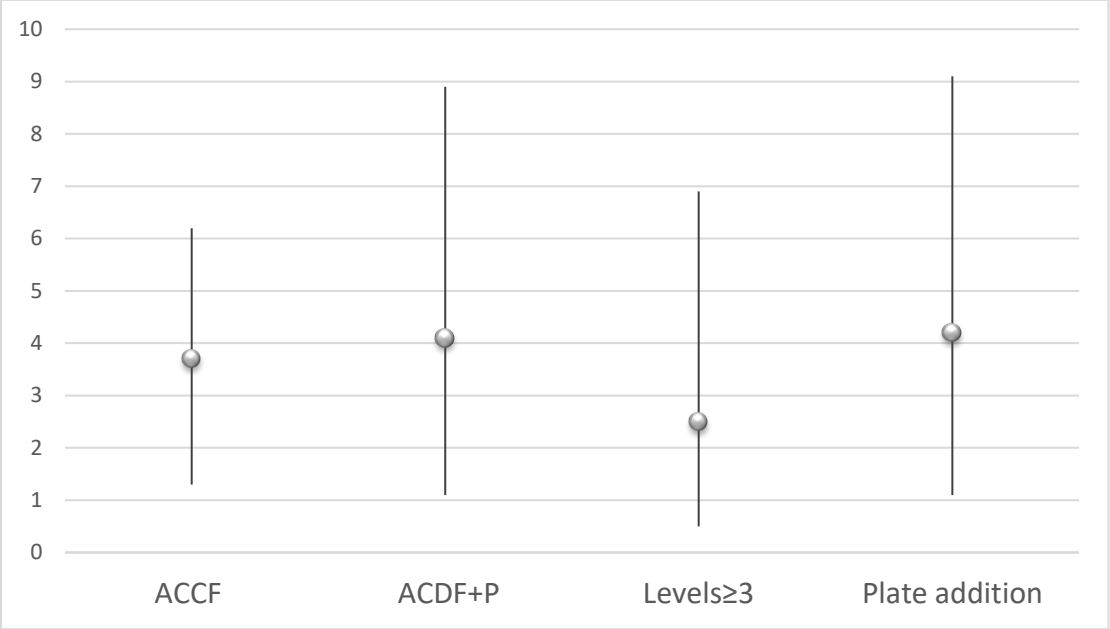
Surgical variables	**Total**	**Complications (%)**						**Total**
		RLNI	Dysphagia	Dural tear	Hematoma	Infection	Clinical deterioration	
surgery								
ACDF+P	36	1(2.8)	4(11.1)	0(0)	0(0)	1(2.8)	0(0)	6(16.7)
ACCF	21	1(4.8)	2(9.5)	1(4.8)	1(4.8)	1(4.8)	0(0)	6(28.7)
ACDF	52	0(0)	1(1.9)	0(0)	0(0)	0(0)	1(1.9)	2(3.8)
Total	109	2	7	1	1	2	1	14
Levels								
1	50	0(0%)	2(4%)	1(2%)	1(2%)	1(2%)	0(0%)	5
2	42	1(2.4%)	1(2.4%)	0(0%)	0(0%)	1(2.4%)	1(2.4%)	4
≥3	17	1(5.8%)	4(23.8%)	0(0%)	0(0%)	0(0%)	0(0%)	5
Total	109	2	7	1	1	2	1	14
Plate								
+P	57	2(3.5%)	6(10.5%)	1(1.7%)	1(1.7%)	2(3.5%)	0(0%)	12
-P	52	0(0%)	1(1.9%)	0(0%)	0(0%)	0(0%)	1(1.9%)	2
Total	109	2	7	1	1	2	1	14

RLNI, recurrent laryngeal injury; ACDF+P, anterior cervical discectomy, and fusion with plating, ACCF, anterior cervical corpectomy and fusion; ACDF, anterior cervical discectomy, and fusion

Table (5) Odds ratio for risk factors associated with postoperative dysphagia

Variables	Reference	Variant	OR	CI 95%	P-value
Surgery	ACDF	ACCF	3.7	1.3-6.2	0.005
		ACDF+P	4.1	1.1-8.9	0.001
Levels	1	≥3	2.5	0.5-6.9	0.0.002
Plate	- P	+ P	4.2	1.1-9.1	0.0001

ACDF, anterior cervical discectomy, and fusion; ACCF, anterior cervical corpectomy, and fusion; ACDF+P, anterior cervical discectomy, and fusion with plating



Figure(2) Odds ratio plot for risk factors associated with postoperative dysphagia

4. Discussion

Peri-surgical complications related to anterior cervical spine surgery include a wide range of complications such as recurrent laryngeal nerve injury, dysphagia, early implants failure, Horner's syndrome, dural tear, esophageal injury, hematoma, infection, vascular injury, and clinical deterioration (Nanda et al., 2014) (Kau et al., 2010) (Lovasik et al., 2017) (Mihaylova et al., 2020).

In the current study, the overall rate of perioperative complications was 12.8%. All but one were managed conservatively. Nanda *et al*. (2014) reported an overall perioperative complication rate of 8.4%, dysphagia was the most common among them, as is the case in the current study.

In our study, the incidence of dysphagia was 6.4%. Yee et al. (2020) showed in their literature review that the incidence of postoperative dysphagia was 5.3%. There are many possible causes of dysphagia such as excessive or prolonged retraction, esophageal injury, denervation of the esophagus or pharyngeal plexus, development of soft tissue edema, and hematoma formation. Also, improper placement of the graft or plate can cause dysphagia. Although this complication is the most common, fortunately, it completely improves within days to weeks in most cases (Mihaylova et al., 2020) (Park et al., 2020).ACDF+P surgery, ≥ 3 levels intervention and palate addition were all risk factors for the development of postoperative dysphagia in our study. Park et al. (2020) reported that the risk factors for this complication were DM, more than one level intervention, long duration of surgery and anesthesia, and increased size of the intubation tube.

The rate of RLN injury was 1.8%. It is relatively one of the common perioperative complications, usually presented as hoarseness, sometimes dysphagia, when it is unilaterally injured. Bilateral injuries may lead to respiratory insufficiency. In many cases, the injury is still subclinical with no symptoms. Yadav et al. (2017) reported a RLN injury rate of 3.9%. From an anatomical point of view, the

right RLN is more vulnerable due to its anatomical pathway, particularly at the levels below C4 (Miscusi et al., 2007). But in general, most of these injuries are transient and improve within weeks to months (Gokaslan et al., 2017).

Surgical site infection may be superficial or deep. This complication occurred in two patients in our study at a rate of 1.8%. Both were superficial infections treated with antibiotics. Tasiou et al. (2017) reported a superficial infection rate of 0.8%, but they reported no risk factors. Others have found that prolonged surgery and advanced age may increase the risk of infection (Yao et al., 2018) (Takenaka et al., 2021).

The dural tear is one of the relatively few complications, as it occurred in the current study at a rate of 0.9% in a patient who underwent ACCF surgery. Mihaylova et al. (2020) reported a dural tear rate of 2.7%, all of which occurred in patients who underwent ACCF surgery. Thickening or calcification of PLL significantly increases the risk of dural tear. Therefore, more caution must be paid in such cases and perhaps leave remnants of the ligament if it adheres to the dura to avoid its rupture. In some cases, it is recommended to choose the posterior approach to avoid this complication. The dural tear should be repaired if possible or covered to avoid CSF leak which increases the risk of infection.

The formation of a compressive hematoma, although rare, can be serious and life-threatening. In this study, hematoma occurred in one patient at a rate of 0.9% who underwent ACCF, which was managed surgically. The literature review showed that the incidence of hematoma is 0-12% (Yee et al. 2020). We believe that its low incidence in our study is due to the use of drainage in all patients. The only case that had hematoma showed blockage of the drainage which was replaced at the time of surgical hematoma evacuation. Therefore, we believe in the important role of drainage to avoid this complication. In addition, early recognition and early management are crucial in preventing irreversible sequelae.

In the current study, the rate of clinical deterioration was 0.9% in a patient with radiculopathy who suffered from C7 weakness after ACDF surgery. Clinical deterioration is more common in patients with myelopathy, with an incidence rate ranging between 0.2-3.3%. Whereas, its incidence rate in patients with radiculopathy is 1.3% (Epstein et al., 2019). Hasan et al. (2018) reported a rare case of Brown-Squared syndrome after ACDF surgery; which was improved within 3 months. The neurological injury occurs when removing osteophytes or dissecting the thickened or calcified PLL using Kerrison rongeur. But can also occur as a result of graft slippage or during the intubation in the presence of significant cervical degeneration in elderly patients. Careful microdissection, as well as good hemostasis, helps with avoiding these complications.

5. Conclusion

Peri-surgical complications related to anterior spine surgery rate is relatively low (12.8%); the majority of them are minor and can be managed conservatively with a good prognosis. However, although it is rare, some complications may be life-threatening. Dysphagia was the most common perioperative complication in the study (6.41%), however, it carries a good prognosis. Plate addition, ≥ 3 levels intervention and ACDF+P/ACCF surgery are risk factors for the development of perioperative dysphagia. The use of drainage may prevent compressive hematoma formation, so that, we recommend using drainage in all cases. Early recognition of these complications and appropriate management are all of paramount importance for improving the outcomes and avoiding irreversible sequelae, decreasing the rate of readmission or the length of hospital stay, thus overall health cost. This paper reports a relatively low complications rate in the short term and recommends prospective long-term studies. This study has certain limitations being retrospective in nature. Also, the limited sample size may affect the statistical study power.

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Conflicts of Interest: The authors declare no conflict of interest.
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Informed consent: No participant's informed consent was necessary for our retrospective study.

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