

Available online at www.sciencedirect.com

### **ScienceDirect**

journal homepage: http://www.elsevier.com/locate/pjnns

### Original research article

# Comparison of perioperative complications following staged versus one-day anterior and posterior cervical decompression and fusion crossing the cervico-thoracic junction





## Kris Siemionow<sup>a</sup>, Marcin Tyrakowski<sup>a,b,\*</sup>, Kushal Patel<sup>a</sup>, Sergey Neckrysh<sup>c</sup>

<sup>a</sup> Department of Orthopaedic Surgery, University of Illinois at Chicago, Chicago, United States

<sup>b</sup> Department of Orthopaedics, Pediatric Orthopaedics and Traumatology,

The Medical Centre of Postgraduate Education, Otwock, Poland

<sup>c</sup> Department of Neurosurgery, University of Illinois at Chicago, Chicago, United States

#### ARTICLE INFO

Article history: Received 26 February 2014 Accepted 9 October 2014 Available online 22 October 2014

#### Keywords:

Perioperative complication Cervical spine Instrumented fusion Decompression

#### ABSTRACT

Introduction: Multilevel cervical pathology may be treated via combined anterior cervical decompression and fusion (ACDF) followed by posterior spinal instrumented fusion (PSIF) crossing the cervico-thoracic junction.

The purpose of the study was to compare perioperative complication rates following staged versus same day ACDF combined with PSIF crossing the cervico-thoracic junction. *Material and methods*: A retrospective review of consecutive patients undergoing ACDF followed by PSIF crossing the cervico-thoracic junction at a single institution was performed.

Patients underwent either same day (group A) or staged with one week interval surgeries (group B). The minimum follow-up was 12 months.

Results: Thirty-five patients (14 females and 21 males) were analyzed. The average age was 60 years (37–82 years). There were 12 patients in group A and 23 in group B. Twenty-eight complications noted in 14 patients (40%) included: dysphagia in 13 (37%), dysphonia in 6 (17%), post-operative reintubation in 4 (11%), vocal cords paralysis, delirium, superficial incisional infection and cerebrospinal fluid leakage each in one case. Significant differences comparing group A vs. B were found in: the number of levels fused posteriorly (5 vs. 7; p = 0.002), total amount of intravenous fluids (3233 ml vs. 4683 ml; p = 0.03), length of hospital stay (10 vs. 18 days; p = 0.03) and transfusion of blood products (0 vs. 9 patients). Smoking and cervical myelopathy were the most important risk factors for perioperative complications regardless of the group.

Conclusions: Staging anterior cervical decompression and fusion with posterior cervical instrumented fusion 1 week apart does not decrease the incidence of perioperative complications.

© 2014 Polish Neurological Society. Published by Elsevier Urban & Partner Sp. z o.o. All rights reserved.

E-mail address: marcintyrak@gmail.com (M. Tyrakowski).

http://dx.doi.org/10.1016/j.pjnns.2014.10.001

<sup>\*</sup> Corresponding author at: Department of Orthopaedic Surgery, University of Illinois at Chicago, 835 South Wolcott Ave., Room E-270, Chicago, IL 60612, United States. Tel.: +1 312 996 7161; fax: +1 312 996 9025.

<sup>0028-3843/</sup> C 2014 Polish Neurological Society. Published by Elsevier Urban & Partner Sp. z o.o. All rights reserved.

### 1. Introduction

Combined anterior-posterior cervical decompression and fusion crossing the cervico-thoracic junction is performed in patients with cervical deformity and multilevel spinal cord compression. There is much debate about performing combined anterior-posterior cervical decompressions and fusions as well as whether to perform staged or same day surgery. Complications in cervical spine surgery increase proportionately to the number of levels operated and total operative time [1]. Complications associated with multilevel cervical spine surgery include, dysphagia, dysphonia, postoperative airway compromise, non-union, infection, and medical complications. Estimated rates of airway compromise after cervical spine surgery range from 1.7% to 6%, and include a spectrum from postextubation edema to life-threatening acute airway obstruction [2–5]. General complication rate following anterior cervical decompression and fusion (ACDF) is reported to be lower than posterior spinal instrumented fusion (PSIF) [6]. Patients undergoing combined ACDF and PSIF, especially extended to cervicothoracic junction are at greater risk of perioperative complications [7]. ACDF and PSIF may be staged (with several days interval) or performed on the same day, and the indication for staging these procedures is reported to be the patients general condition [8,9]. There is a paucity of data comparing the perioperative complication rate in patients undergoing staged versus same day combined anterior-posterior cervical decompression and fusion crossing the cervico-thoracic junction.

The aim of the study is to analyze and compare the perioperative complications following staged versus same day ACDF combined with PSIF crossing the cervico-thoracic junction.

#### 2. Material and methods

A retrospective review of medical data of all consecutive patients undergoing ACDF followed by PSIF crossing the cervico-thoracic junction treated between January 2010 and October 2012 at a single institution was performed. The patients underwent either same day (Group A) or staged (Group B) surgery. All staged procedures were performed one week apart. All of the patients were operated on by the same surgical team (first and senior author). Patients underwent either anterior cervical diskectomies and fusions, anterior cervical corpectomies and fusion (ACCF), or hybrid constructs. Anterior interbody fusions were performed by use of allograft, PEEK cages filled with either allograft or autograft, fibular allograft strut, titanium mesh cages or expandable cages depending on pathology, number of levels treated and patients' preference. All patients were stabilized anteriorly with semi-constrained cervical plates (DePuy or Medtronic) spanning the operated segments.

PSIF included placement of cervical lateral mass, pedicle or intralaminar screws, and thoracic pedicle screws connected with 3.5 mm rods. Posterior decortication of the instrumented vertebrae and frozen allograft chips mixed together with local



Fig. 1 – Upright neutral radiograph of the cervical spine demonstrating C3–C7 anterior cervical decompression and fusion and C3-Th2 posterior instrumented fusion: (a) antero-posterior view; (b) lateral view.



Fig. 2 – Upright neutral lateral radiograph demonstrating multilevel degenerative spondylosis with cervical kyphosis.



Fig. 3 – Sagittal view of the T2-weighted MRI scan demonstrating multilevel degenerative cervical spondylosis with myelopathy.

autograft were the base for spondylodesis. All PSIF constructs crossed the cervico-thoracic junction (the distal instrumented vertebra varied from T1 to T5) (Fig. 1).

Medical records provided the following data: age and sex of the patients, index diagnosis – indication for surgery, diabetes and smoking status, post-operative changes in neurological status, number of levels fused anteriorly and posteriorly, total time of surgery (from incision to closure of the wound for both ACDF and PSIF), total estimated blood loss (EBL), total transfusion of blood products, total amount of intravenous fluids (IVF) given to the patient perioperatively and length of hospital stay. All perioperative complications were reported. The minimum follow-up period was 12 months.

Unpaired interval data were compared with Student's t-test. A *p*-value of 0.05 was considered significant. Nominal data were compared with Fisher's exact test. The data was

analyzed using the JMP 10.0.2 (SAS Institute Inc., Cary, NC) statistical software.

#### 3. Results

Thirty-five of the 43 patients met the inclusion criteria. There were 14 women and 21 men. The average age was 60 years (range 37–82 years). There were 12 patients who underwent one-day (Group A) and 23 – staged (Group B) surgery. There were 27 patients with degenerative cervical spondylosis with myelopathy (Figs. 2 and 3). Five patients had unstable cervical vertebrae fracture, two had metastatic tumor in the cervical spine and one had osteomyelitis of the cervical vertebra (Table 1).

Total number of 28 complications occurred in 14 patients (40%; 14/35). Seven of these patients had one complication (20%; 7/35), one patient had two complications (3%; 1/35) and

Table 1 – Demographic data of the study group.										
	Number of patients	Females	Males	Age [years]	Cervical spondylosis	Fracture	Tumor	Osteomyelitis	Diabetes	Smoking
Group A	12	6	6	62 (48–82)	9	3	0	0	3	3
Group B	23	8	15	59 (37–73)	18	2	2	1	4	13
Total	35	14	21	60 (37–82)	27	5	2	1	7	16

spinal inst	rumented fusion Number of patients	Dysphagia	PEG <sup>a</sup> tube	Dysphonia	Reintubation	Tracheostomy	Pneumonia	Postoperative delirium	SSI <sup>b</sup> (superficial incisional)	CSF <sup>c</sup> leakage
Group A	12	4 (33%)	1	2 (17%)	2	0	0	0	0	0
Group B	23	9 (39%)	۲٦	4 (17%)	2	2	2	4	4	1
Total	35	13 (37%)	2 (6%)	6 (17%)	4 (12%)	2 (6%)	2 (6%)	1 (3%)	1 (3%)	1 (3%)
Probability	х	0.76	0.57	0.69	0.42	1.0	1.0	1.0	1.0	1.0
<sup>a</sup> PEG – perci	itaneous endoscop	ic gastrostomy.								
- Sol - surgi	cal site infection.									
c CSF – cereb	ro-spinal fluid: pro	bability - Fisher's	exact probab	vility (exact probab	vility that the differe	nce between the obse	rved and expected	frequencies occurred	bv chance).	

Table 3 – Perioperative complications rate according to the age of the patients.					
	≤60 years of age	>60 years of age			
Group A	2/6 (33%)	3/6 (50%)			
Group B	4/13 (31%)	5/10 (50%)			
Total	6/19 (32%)	8/16 (50%)			

six patients had three or more complications (17%; 6/35). The most common complication was dysphagia that occurred in 13 patients (37%; 13/35) and two of them required PEG tube implantation. Six patients had dysphonia (17%; 6/35) and one of them had vocal cord paralysis (3%; 1/35). Four patients (11%; 4/35) required post-operative re-intubation because of airway edema or vocal cord paralysis; two of these patients required tracheostomy. Each of the following: postoperative delirium, superficial incisional infection and leakage of the cerebrospinal fluid occurred once in the study group. Comparison of perioperative complications between Group A and Group B is presented in Table 2. Complications were noticed in 50% (8/16) of patients aged over 60 years and in 32% (6/19) of patients younger than 60 years (Table 3).

Comparing clinical data of Group A versus Group B there were no significant differences in the number of levels fused anteriorly, total surgical time, and total EBL, Table 4. Statistically significant differences were noted for the number of levels fused posteriorly, total amount of intravenous fluids (IVF) given to the patients and length of hospital stay (Table 4). There was no need for transfusion of blood products in the group A, while nine patients in the group B required transfusion (27 units of red blood cells, seven units of platelets and four units of fresh frozen plasma).

The neurological status improved after the surgery in 31 patients, was the same as before the operation in two patients (one had no neurological deficits before and after the surgery; the other had still tenderness in deltoid area, tingling in the fingers and weakness of deltoid – 4/5 as before operation) and was worse in two patients (weakness of the left deltoid worsened from 4/5 to 3/5 in one patient; subjective worsening of tingling in the fingers of the left hand in addition in the other patient), Table 5. Both patients with worsening of neurological status had changes noted in intra-operative monitoring (MEPs and SSEPs). There were six patients who had changes in intraoperatively recorded SSEPs and MEPs, but had improvement in their neurological status on last follow up.

Eight of the 16 smokers (50%; 8/16) had at least one complication among the total of 14 complicated patients (57%; 8/14). All four patients who needed postoperative re-intubation were smokers as well as the two patients that had postoperative pneumonia and one with SSI. Complications occurred in two of three smokers in group A (66%; 2/3) and in 6 of 13 smokers in group B (46%; 6/13).

Three of the seven patients with diabetes (43%; 3/7) had perioperative complications. All of them were smokers. All three patients had dysphagia and dysphonia, and two of them required re-intubation. Complications occurred in one of three diabetic patients in group A (33%; 1/3) and in two of four diabetic patients in group B (50%; 2/4).

Among four patients that needed re-intubation two (50%; 2/4) had staged procedures. Three of these patients (75%; 3/4)

and fusion followed by posterior spinal instrumented fusion.				
	Group A	Group B	pc	
Number of levels fused anteriorly	3 (1–5)	3 (1–5)	0.8	
Number of levels fused posteriorly	5 (2–7)	7 (4–12)	0.002 <sup>*d</sup>	
Total surgical time (minutes)	434 (219–585)	457 (137–820)	0.7	
EBL <sup>a</sup> [ml]	413 (30–1000)	556 (80–2000)	0.3	
IVF <sup>b</sup> [ml]	3233 (1700–5100)	4683 (2300–9500)	0.03*	
Length of hospital stay [days]	10 (2–28)	18 (4–45)	0.03*	
<sup>a</sup> EBL – estimated blood loss.				

Table 4 - Comparison of clinical data between same day (Group A) versus staged (Group B) anterior cervical diskectomies

<sup>b</sup> IVF – intravenous fluids.

<sup>c</sup> *p* – significance of t-test.

<sup>d</sup> \*Indicates significant difference.

Table 5 – Postoperative neurological status in the study group.						
	Postoperat	ive neurological	status			
	Improvement	No change	Worsening			
Group A	11	1	0			
Group B	20	1	2			
Total	31	2	2			

suffered from cervical spondylosis with myelopathy, one had osteomyelitis. Three of these patients that needed re-intubation (75%; 3/4) had ACDF on four levels (more than average) and all of them had PSIF on more levels than average (three patients: seven levels; one patient: eight levels). Total surgical time was longer than average in two (50%; 2/4), EBL was higher than average in three (75%; 3/4) and IVF was more than average in two (50%; 2/4) of them. All that needed re-intubation had neurological improvement although two of them (50%; 2/4) had changes in intraoperative neuromonitoring. None of these patients had SSI, dural tear or CSF leakage.

#### 4. Discussion

Complications following combined anterior-posterior cervical spine surgery may lead to prolonged hospital stay, increased morbidity and mortality, and worse clinical outcomes [6,7]. This is the first series to report on the difference in complication rates in patients undergoing same day versus staged anterior-posterior decompression and fusion crossing the cervico-thoracic junction. The complication rate following combined ACDF and PSIF crossing the cervico-thoracic junction is reported to be as high as 69% [7]. In our series, 40% of patients had a complication in the perioperative period. This is in-line with data reported by Fehlings et al. [10]. Our series does not take into consideration non-union, instrumentation related problems and other complications that could occur with longer follow-up.

The most frequent perioperative complication in our patients was dysphagia. This is consistent with data published by other authors [7,10-17]. The incidence of perioperative complications was similar for the patients undergoing sameday and staged anterior-posterior decompression and fusion even though staging the procedures is sometimes considered as safer for the patient. We found no statistically important differences in total number of levels fused anteriorly, total estimated blood loss and total surgical time. Patients treated via staged surgical procedures required more intravenous fluids and more blood product transfusions. Both are likely to be caused by syndrome of inappropriate antidiuretic hormone (SIADH) that has been reported in association with a variety of surgical procedures and anesthetic agents [18-23]. The incidence of SIADH in patients undergoing spinal fusion was reported to be 5-100% and is considered as self-limiting phenomenon that resolves within two or three weeks [21-23]. However an additional stress (e.g. the second surgery within seven days as in our study) might enhance the vicious circle of SIADH.

Staging resulted in longer lengths of stay. Without seeing a clear benefit in terms of complication reduction, the cost associated with longer lengths of stay may not be justified. Age of the patients is reported to be the risk factor for perioperative complications following cervical spine surgery [24,25]. In this series patients older than 60 years of age had relatively more perioperative complications in comparison to the younger individuals (50% versus 32%, respectively). There were no differences between staged and one-day surgery in these age groups.

The incidence of C5 palsy in this series was 6% (2/35) and was similar to that reported by other authors (0-30%) [26,27]. For the six patients who had changes in intraoperative neuromonitoring, an action plan was implemented which involved trouble shooting the equipment, raising mean systolic blood pressure to >90 mmHg, removing instrumentation and/or deformity correction when applicable. All of these patients demonstrated improvement in neurological function after the surgery.

Smoking is an important risk factor in spinal procedures. However Fehlings et al. did not find smoking to increase the incidence of complications [10]. In our series smoking seemed to be the most important factor related to perioperative complications. Eight smokers (50%; 8/16) had at least one perioperative complication. Sixty two percent of patients with complications were smokers. All of the patients requiring postoperative reintubation, as well as those that developed pneumonia and SSI were also smokers. Because of the small number of patients statistical analysis between the two study groups was not possible, but the data indicates smoking as an important risk factor for perioperative complications in both staged and same day procedures. Seventy-five percent of the patients that needed re-intubation suffered from cervical myelopathy, most had multilevel ACDF or ACCF and multilevel PSIF, and 50% needed IVF more than average. This is in-line with previously reported risk factors for airway complications: cervical myelopathy, multi-level anterior procedures, smoking history, previous pulmonary disease, operative times over 10 h, and intraoperative fluid replacement volumes of over 6200 ml [3–5].

The limitations of this study include its retrospective nature, lack of randomization, and small sample size. In this series there appeared to be no benefit to staging surgeries 1 week apart, and in fact staged patients required more blood transfusions. Whether waiting a longer period in-between stages would result in more favorable complication profile warrants further investigation.

### 5. Conclusions

Anterior cervical decompression and fusion followed by posterior spinal instrumentation and fusion are highly demanding procedures for the surgeon and for the patient. Perioperative complications following these procedures are relatively frequent, but most of them resolve without further sequelae. There is no statistically significant difference between the rates of complications after staged and nonstaged anterior-posterior cervical decompression and fusion crossing the cervico-thoracic junction. Staging ACDF and PSIF crossing the cervico-thoracic junction 1 week apart leads to longer hospital stay and blood transfusions.

#### **Conflict of interest**

None declared.

#### Acknowledgement and financial support

None declared.

#### Ethics

The work described in this article has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans; Uniform Requirements for manuscripts submitted to Biomedical journals.

#### REFERENCES

- [1] Liu ZZ, Zhang J, Guo YX, Tian WM, Wang Y. Combined posterior and anterior approaches for the treatment of cervical spondylotic myelopathy. Zhongguo Gu Shang 2010;23(7):507–10.
- [2] Graham JJ. Complications of cervical spine surgery. A fiveyear report on a survey of the membership of the Cervical Spine Research Society by the Morbidity and Mortality Committee. Spine 1989;14:1046–50.

- [3] Emery S, Smith MD, Bohlman HE. Upper airwary obstruction after multilevel cervical corpectomy for myelopathy. Spine 1991;544–50.
- [4] Kwon BYJ, Furey C. Postoperative airway management after singlestage, multi-level anterior cervical decompression and posterior fusion: risk factors for delayed extubation. Proceedings of the NASS 18th Annual Meeting. Spine J 2003;3:67S–171S.
- [5] Kwon B, Yoo JU, Furey CG, Rowbottom J, Emery SE. Risk factors for delayed extubation after single-stage, multi-level anterior cervical decompression and posterior fusion. J Spinal Disord Tech 2006;19:389–93.
- [6] Boakye M, Patil CG, Santarelli J, Ho C, Tian W, Lad SP. Cervical spondylotic myelopathy: complications and outcomed after spinal fusion. Neurosurgery 2008;62(2):455–61.
- [7] Hart RA, Tatsumi RL, Hiratzka JR, Yoo JU. Perioperative complications of combined anterior and posterior cervical decompression and fusion crossing the cervico-thoracic junction. Spine 2008;33(26):2887–91.
- [8] Colak A, Kutlay M, Kibici K, Demircan MN, Akin ON. Two-staged operation on C2 neoplastic lesions: anterior excision and posterior stabilization. Neurosurg Rev 2004; 27(3):189–93.
- [9] Mehdian H, Weatherley C. Combined anterior and posterior resection and spinal stabilization for aneurysmal bone cyst. Eur Spine J 1995;4(2):123–5.
- [10] Fehlings MG, Smith JS, Kopjar B, Arnold PM, Yoon ST, Vaccaro AR, et al. Perioperative and delayed complications associated with the surgical treatment of cervical spondylotic myelopathy based on 302 patients from the AOSpine North America Cervical Spondylotic Myelopathy Study. J Neurosurg Spine 2012;16(5):425–32.
- [11] Skeppholm M, Ingebro C, Engström T, Olerud C. The Dysphagia Short Questionnaire: an instrument for evaluation of dysphagia: a validation study with 12 months' follow-up after anterior cervical spine surgery. Spine 2012;37(11):996–1002.
- [12] Cho SK, Lu Y, Lee DH. Dysphagia following anterior cervical spinal surgery: a systematic review. Bone Joint J 2013; 95-B(7):868–73.
- [13] Martin RE, Neary MA, Diamant NE. Dysphagia following anterior cervical spine surgery. Dysphagia 1997;12(1):2–8. discussion 9-10.
- [14] Smith-Hammond CA, New KC, Pietrobon R, Curtis DJ, Scharver CH, Turner DA. Prospective analysis of incidence and risk factors of dysphagia in spine surgery patients: comparison of anterior cervical, posterior cervical, and lumbar procedures. Spine 2004;29(13):1441–6.
- [15] Frempong-Boadu A, Houten JK, Osborn B, Opulencia J, Kells L, Guida DD, et al. Swallowing and speech dysfunction in patients undergoing anterior cervical discectomy and fusion: a prospective, objective preoperative and postoperative assessment. J Spinal Disord Tech 2002; 15(5):362–8.
- [16] Bazaz R, Lee MJ, Yoo JU. Incidence of dysphagia after anterior cervical spine surgery: a prospective study. Spine 2002;27(22):2453–8.
- [17] Tervonen H, Niemelä M, Lauri ER, Back L, Juvas A, Räsänen P, et al. Dysphonia and dysphagia after anterior cervical decompression. J Neurosurg Spine 2007;7(2):124–30.
- [18] Shapiro G, Green DW, Fatica NS, Boachie-Adjei O. Medical complications in scoliosis surgery. Curr Opin Pediatr 2001;13(1):36–41.
- [19] Mason RJ, Betz RR, Orlowski JP, Bell GR. The syndrome of inappropriate antidiuretic hormone secretion and its effect on blood indices following spinal fusion. Spine 1989;14(7):722–6.
- [20] Amini A, Schmidt MH. Syndrome of inappropriate secretion of antidiuretic hormone and hyponatremia after spinal surgery. Neurosurg Focus 2004;16(4):E10.

- [21] Callewart CC, Minchew JT, Kanim LE, Tsai YC, Salehmoghaddam S, Dawson EG, et al. Hyponatremia and syndrome of inappropriate antidiuretic hormone secretion in adult spinal surgery. Spine 1994;19(15):1674–9.
- [22] Elster AD. Hyponatremia after spinal fusion caused by inappropriate secretion of antidiuretic hormone (SIADH). Clin Orthop Relat Res 1985;194:136–41.
- [23] Bell GR, Gurd AR, Orlowski JP, Andrish JT. The syndrome of inappropriate antidiuretic-hormone secretion following spinal fusion. J Bone Joint Surg Am 1986;68:720–4.
- [24] Currier BL. Neurological complications of cervical spine surgery: C5 palsy and intraoperative monitoring. Spine 2012;37(5):E328–34.
- [25] Saunders RL. On the pathogenesis of the radiculopathy complicating multilevel corpectomy. Neurosurgery 1995; 37(3):408–12.
- [26] Imagama S, Matsuyama Y, Yukawa Y, Kawakami N, Kamiya M, Kanemura T, et al. C5 palsy after cervical laminoplasty: a multicentre study. J Bone Joint Surg Br 2010;92(3):393–400.
- [27] Nassr A, Eck JC, Ponnappan RK, Zanoun RR, Donaldson 3rd WF, Kang JD. The incidence of C5 palsy after multilevel cervical decompression procedures: a review of 750 consecutive cases. Spine 2012;37(3):174–8.