30-Day unplanned surgery in cervical spondylotic myelopathy surgically treated: a single-center experience

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ORIGINAL ARTICLE

30-Day unplanned surgery in cervical spondylotic myelopathy surgically treated: a single-center experience

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Abstract

Study design Retrospective cohort study.

Objective Analyze the rate and risk factors associated with Unplanned Surgeries (US) during the first 30 days in patients treated for cervical spondylotic myelopathy.

Background US are often regarded as a potentially useful quality of care indicator.

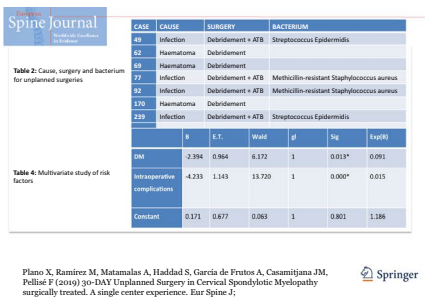
Methods We defined US as any, non-planned, surgical procedure as a complication after "index" surgery. Demographic data, comorbidities, ASA, smoking status, surgical details and postoperative complications were collected. We conducted a subjective outcome test using the Global Outcome Score (GOS). To assess risk factors, a bivariate analysis was performed using T Student or Chi-square. Risk is shown as odds ratio (OR) with 95% confidence interval (CI). Multivariable logistic regression models with bootstrap resampling procedure were performed.

Results The study included 303 patients (200 men) with mean age of 57.7 years (27–86) and mean follow-up of 75.35 months (16–126 m). 63.3% patients were ASA 1 or 2 and 41.9% were smokers. 77.9% of patients had some comorbidity. Anterior approach surgeries were 65.7%. Perioperative complications: 29% medical, 8.9% intraoperative and 3% implant related. US rate was 2.6%. Causes for revision were postoperative infection or deep hematomas. After bivariate analysis, the risk factors associated were diabetes mellitus (OR 2.6; 95% CI 1–5.5) and intraoperative complications (OR 6.5, 95% CI 1–40). The presence of US does not have influence in satisfaction using GOS score.

Conclusions Our US rate was 2.6%, similar to the literature. Diabetics and patients suffering an intraoperative complication are more likely to need an early reinterventions (OR 2.2 and 6.5, respectively). US did not alter the patient's outcomes.

Graphical abstract

These slides can be retrieved under Electronic Supplementary Material.



Keywords Unplanned surgery · Cervical spondylotic myelopathy · Surgical treatment

Extended author information available on the last page of the article

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Introduction

Cervical spondylotic myelopathy (CSM) is the single most common cause of spinal cord dysfunction in the adult population [1].

Several predictable risk factors for the development of myelopathy have been proposed in CSM or OPLL studies, but they were not definitive [2].

Through an epidemiological review on patients with non-traumatic spinal cord injury (NTS), New et al. estimated that nearly 30–59% of all NTS were due to CSM in the Western world, and they estimate the prevalence of CSM between 26 and 76 per million people in Europe and the USA and 1120/million population in Canada [1]. These figures might be infra-estimating the real burden of CSM due to limitations with data collection and labeling. For example, in the Canadian registry only paraplegia and quadriplegia were considered, and less severe cases were not analyzed. In addition, milder forms of myelopathy—which represent an important segment of the CSM population—are often under diagnosis clinically missed or mislabeled [3].

The number of cervical surgeries performed for CSM has exponentially increased in recent years. Lad et al. [4] identified a sevenfold increase in the number of surgeries between 1993 and 2002 in the USA. The increase is more noticeable in the elderly age segment [5]. This can be explained by the increase in life expectancy and the improvement in general health with a more active and demanding population, with better access to healthcare services. The number of surgeries for CSM is expected to increase even further in the near future due to the prevalence of cervical spondylosis in the elderly population and the high incidence of myelopathy within this group (8% at 1 year and 23% at 44 months) [6].

Recent studies show that the number of cervical surgeries between 1990 and 2000 has increased, with cervical fusion surgeries increased by 206% from 14.7 to 45/100,000) in people over 65 years [5].

In surgically treated patients, readmissions and reoperations have the intrinsic advantage of being well documented and coded even in administrative databases. They can serve as a reliable measure of quality of care [7].

Unplanned Surgeries (US) are often regarded as a potentially useful indicator especially that it is more frequent than mortality. There are advantages in reporting US as an indicator of quality of care. First, it is assumed that US are only performed when there is a real emergency. In addition, they are reported immediately and they can be easily collected from administrative databases [8]. Besides their interest as a measure of quality of care, US negatively impact the rate of subsequent complications and readmissions; increase costs; and might worsen the final result [9].

Kelly et al. [10] show a rate of complications inferior to 1.2%, but a reoperation rate the first 90 days superior to 2% (ACDF 3.35% vs. ACDA 2.04%, OR 0.63, 95% CI 0.44–0.92, $p=0.015$) [10].

The purpose of this study was to analyze the US during the first 30 days after index surgery in patients surgically treated for CSM in our center. We defined US as any surgical procedure following a direct or indirect complication after the index surgery in the first 30 days.

Our objective was to determine the rate of US as well as the associated risk factors. We would use this information to compare our results to the published literature and offer a comparison point to others, in the hope of improving quality of care for CSM both locally and globally.

Materials and methods

This was a single-center retrospective analysis of data of patients undergoing surgery for CSM Prior Informed consent from the patients and after being approved by Clinical Research Ethics Committee of our hospital.

We collected all patients operated for CSM between January 2005 and December 2013. Patients with previous cervical surgeries or operated by a combined anterior and posterior approach, as well as patients with language barrier, were excluded.

The patients were contacted by phone or after personal interview.

Demographics, comorbidities before surgery including preoperative American Society of Anesthesiologists (ASA) score [11], smoking status, surgery related-data and postoperative complications were collected and analyzed.

Patient satisfaction with the surgical outcome was assessed by means of a subjective evaluation—the Global Outcome Score (GOS) [12]—test.

We grouped the test values in three groups: dissatisfied, indifferent and satisfied.

Continuous variables were reproduced using the mean value and confidence interval and categorical variables as percentage of occurrence. To assess risk factors for US, a bivariate analysis was performed using Student *t* test to compare continuous variables with a normal distribution. The Chi-square test was used to compare categorical variables. Risk is shown as odds ratio (OR) with 95% confidence interval (CI).

Finally, a multivariate logistic regression was performed. We used resampling techniques to be able to calculate the 95% confidence interval. Statistical analysis was carried out using SPSS v.20 (South Melbourne, Victoria: Cengage Learning Australia, in 2012, SPSS Inc.) [13].

Results

303 patients met the study criteria, and nearly two-thirds were males (M = 200/F = 103). The average age at surgery was 57.7 years (SD 12.6, range 27–86 y), and the mean follow-up was 75.35 months (SD 27.1, range 16–126 m). All patients included were controlled at least during the first 16 months. Also, 63.3% had an ASA score between 1 and 2. 41.9% patients (127/303) were smokers and 77.9% (236/303) had one or more comorbidities. 65.7% had an anterior surgery. Only 20% had surgery over 3 levels. All procedures were instrumented surgeries.

Postoperative complications were divided into medical, perioperative and implant-related complications resulting and accounted for 29% (88/303), 8.9% (27/303) and 3% (10/303), respectively. Full demographic and surgical details are given in Table 1.

In the present series, only eight patients had an US. The most common cause for revision was a deep surgical site infection. Five patients needed a surgical debridement and a course of antibiotic treatment adjusted surgically. The remaining three had an acute deep hematoma after their anterior surgery (Table 2). Intraoperative cultures grew *Methicillin-resistant Staphylococcus aureus (MRSA)* in three patients with deep infection and the remaining two had a *Streptococcus epidermidis*. The rate of unplanned surgeries in our series was 2.6% (1–4. 6%, 95% CI).

Comparing patients who underwent US to those that did not, we noted that the US cohort is 9 years older on average (56.41 years; SD 12. 95 vs. 65.14 years SD 13.40). This difference was not statistically significant ($p = 0.079$). On the other hand, and as would be expected, patients with US had a longer hospital stay ($p = 0.0001$). The mean hospital stay was 8.6 days, rising up to 23.5 days in the re-intervened cases (Tables 1, 3).

In the bivariate analysis of risk factors for US, only diabetes mellitus (DM) was shown to increase the risk reintervention within the first 30 days (OR 2.6 95% CI 1–5.5. $p = 0.004$). Also, having an intraoperative complication significantly increased the chances of US (OR 6.5, 95% CI 1–40. $p = 0.001$). The rest of the studied variables did not reach significance (Table 3).

The multivariate regression confirmed that DM and perioperative complications were independent risk factors for US, with intraoperative complications having a greater impact on reinterventions (Table 4).

Finally, 232 patients answered the GOS questionnaire. Bivariate analysis showed no association between patients satisfaction (or dissatisfaction) and having had a reintervention ($p = 0.243$) (Table 5).

Table 1 Descriptive results data

	X medium	Range
Years	57.7 years	27–86 years
Sex		
Men	200 (66%)	
Women	103 (34%)	
Follow-up	75.35 months	16–126 months
ASA		
I	31 (10.2%)	
II	161 (53.1%)	
III	105 (34.7%)	
IV	4 (1.3%)	
Loss	2 (0.7%)	
Smoker		
Yes	127 (41.9%)	
No	176 (58.1%)	
Comorbidity		
Yes	236 (77.9%)	
No	67 (22.1%)	
Approach		
Anterior	199 (65.7%)	
Posterior	100 (33.0%)	
Combined	3 (1.0%)	
Nº levels		
I	40 (13.2%)	
II	99 (32.7%)	
III	103 (34.0%)	
> III	57 (18.7%)	
Loss	4 (1.3%)	
Nº complications		
Medical	29% (88/303)	
Peroperative	8,9% (27/303)	
Implant related	3% (10/303)	

ASA American Society of Anesthesiologists score, *Nº* Number

Discussion

We have witnessed a steady increase in the number of cervical spine surgeries, especially in the elderly subgroup. Specifically, the rate of cervical spine surgeries performed in the general adult US population has increased by 90% between 1990 and 2000 (29 to 55/100,000 adults) [14]. During the same time interval, cervical fusion surgeries increased by 206% (from 14.7 to 45/100,000 adult) in people over 65 years [5]. At the same time, the proportion of patients having myelopathy has increased within the same population [15]. Hence, surgeons are more likely to be operating on an elder and more complex population at risk of having more complications [17]. The quality of procedural care has been the object of increased scrutiny over the past years. One of the parameters used to

Table 2 Cause, surgery and bacterium for unplanned surgeries

Case	Cause	Surgery	Bacterium
49	Infection	Debridement + ATB	*Streptococcus Epidermidis*
62	Hematoma	Debridement	
69	Hematoma	Debridement	
77	Infection	Debridement + ATB	*Methicillin-resistant Staphylococcus aureus*
92	Infection	Debridement + ATB	*Methicillin-resistant Staphylococcus aureus*
170	Hematoma	Debridement	
239	Infection	Debridement + ATB	*Streptococcus Epidermidis*
270	Infection	Debridement + ATB	*Methicillin-resistant Staphylococcus aureus*

ATB antibiotics

Table 3 Unplanned surgery risk factors

Reintervention	Yes	No	*p*	CI
	8 (2.6%)	295 (97.4%)		1–4.6%
Years	65.14 years	56.4 years	0.079	1–(− 18.4) years
Hospitalization days	23.5 days	8.6 days	**0.001***	**5–24.15** days
DM			O.R. 2.2	
Yes	5	46	**0.004***	
No	3	249		**1–5.5**
Perioperative complications			O.R. 6.5	
Yes	6	19	**0.000***	**1–40.0**
No	2	255		
Loss	22			
Approach				
Anterior	4	183	0.176	
Posterior	4	89		
Combined	0	4		
ASA				
I	0	30	0.679	
II	4	149		
III	3	90		
IV	0	3		
Loss	25			
Smoker				
Yes	5	123	0.23	
No	3	172		
Comorbidity				
Yes	8	229	0.128	
No	0	66		
Loss				

Bold values are the risk factors which show significant differences

ASA American Society of Anesthesiologists score, *CI* confidence interval, *d* days, *DM* diabetes mellitus, *OR* odds ratio, *y* years

measure quality of care, hospital efficiency and healthcare resource utilization is readmission within 30 days of index surgery, as advocated by Jencks et al. [16]. Readmissions and reoperations have the intrinsic advantage of being well documented and coded even in administrative databases. They can serve as a reliable measure of quality of care that can be used to compare different procedures or same procedures in different settings. This is unfortunately not possible when assessing "adverse effects" or complications as they are non-uniformly reported and often missed. Therefore, they cannot be used to compare between daily recorded hospital databases and studies.

Table 4 Multivariate study of risk factors

	B	ET	Wald	*gl*	Sig	Exp(B)
DM	− 2.394	0.964	6.172	1	**0.013***	0.091
Intraoperative complications	− 4.233	1.143	13.720	1	**0.000***	0.015
Constant	0.171	0.677	0.063	1	0.801	1.186

Bold values are the risk factors which show significant differences

B estimated parameter, *DM* diabetes mellitus, *ET* standard error, *Wald* Wald test, *gl* degree of freedom, *Sig* significance, *Exp(B)* odds ratio estimation

Table 5 Comparative GOS results between reintervention or no reintervention groups

Reintervention	Yes	No
GOS		
Disgusted	0	27
Indifferent	2	49
Satisfied	3	151
Loss 71		
		$P=0.243$
GOS		
Medium	11.8 (SD 3.0)	11.37 (SD 3.2)
CI 95%	9.0–15	10.8–11.79
		$P=0.769$

CI confidence interval, *GOS* global outcome score, *SD* standard deviations

Park et al. [17] recently published a review of 13,191 patients undergoing cervical spine surgery in South Korea in 2009. The reoperation rate in the first month was 0.76% and increased to 1.03% by 3 months after index surgery. Female gender, the presence of DM and associated comorbidities in this series were found to be risk factors for reoperations. DM had the greater effect size ($p<0.0001$, hazard ratio = 3.267, 95% CI 2137–4995).

Goel et al. published a rate of UP of 2.3, he analyzed the influence of liver disease in the outcome following surgery for degenerative disease of the cervical spine and concluded that liver disease independently predicts poor perioperative outcome. Based on these findings, careful consideration of a patient's underlying liver function before surgery may prove valuable in surgical decision-making, preoperative patient counseling and postoperative patient care [18].

In our study, the percentage of US was higher (2.6%): In our series, neither gender nor comorbidities were found to be significant risk factors for US. Only DM and perioperative complications were risk factors for US. Park et al. [17] used a national database for their study and lacked a detailed report of postoperative complications and therefore, did not analyze them. They also showed that patients with posterior cervical surgeries (laminoplasty, laminectomies with or without fusion) had an increased risk of early revision surgery. They, however, included all cervical surgeries and did not specify the specific different diagnostics. We on the other hand considered solely patients operated for DCM, which might explain the observed differences in rate of US. Another difference might be a higher percentage of ossification of the posterior longitudinal ligament (OPLL) in their series.

Tsai et al. analyzed the rate of US during the first 7 days. They reviewed 10,350 patients from a regional registry. Their US rate was 1.12%, with malposition of the instrumentation, epidural hematoma or inadequate decompression being the most frequent causes of reinterventions [19]. However, and likewise Park et al. reviewed all spinal surgeries and not only cervical myelopathy, and they did not reported the diagnosis.

In a paper by McCormack et al., readmissions after spinal surgery were dependent on age and preoperative comorbidity. They found that 4% of patients having an elective spinal surgery are readmitted within the first 30 days and 57% of readmitted patients need new surgery. Their rate of US is around 2.6%, similar to our data. They, however, do show differences depending on the surgical approach. Thus, they show a readmission rate of 4.3% (95% CI 2.6–6.0) in anterior surgery versus 5.9% (95% CI 0.7–11.0) in posterior approaches. Infection was the most frequent cause of readmission in the posterior group versus implant revision in the anterior approach [20]. They did not analyze risk factors. We do not found differences related to approach used.

Haddad et al. [15] conducted a review of cervical surgeries in the National Inpatient Sample and compared it to their institutional database. They documented an increasing number of surgeries done in the US for degenerative conditions as well as an increasing proportion of surgeries done for myelopathy. In their review age, gender, number of levels, ethnicity, hospital setting, payer and posterior approaches were predictive of complications. Also a higher preoperative Elixhauser comorbidity index was associated to a higher rate of infections. Their institutional infection rate for DCM surgeries was similar to ours (1.6%).

Our US rate is therefore comparable to the one reported by these series (2,6 IN OUR WORK in from of 1–4.6%

PUBLISHED). All the patients were controlled during the first month (minimum follow-up of 16 months); then we can conclude that the % of US during the first 30 days in our series was realistic

A recent systematic review on rates of readmissions in the first 30 days after orthopedic surgeries shows an overall rate of 5.4% (95% CI 4.8–6.0) and a 5.5% when considering spinal surgery alone (CI 3.7–6.6) [21].

A study of 750 patients published in 2015 analyzed the rate of unplanned readmissions in early postoperative patients of degenerative cervical surgery in a single hospital. According to their administrative record, 1.04% of patients operated for cervical spondylosis were readmitted within 90 days since the intervention. Unlike in our series, posterior approaches had a significantly higher readmission rate than anterior surgeries (3.13% vs. 0.63%). Most common causes for readmissions were persistent neurological symptoms and infection [22]. All these readmissions needed a surgical revision; therefore, their US rate was similar to ours with the exception that none of our patients needed revision for non-improving symptoms. This paper nevertheless does not analyze risk factors associated with US.

King et al. [23] analyzed readmission rate, both early and late, and the costs associated with surgical approach including the complications after initial surgery for degenerative cervical spine diseases. Out of a total of 12,000 patients who underwent surgery between 1998 and 2002, 2.5% were readmitted. Posterior cervical fusion was associated with higher hospital costs. On the other hand, patients having an anterior approach had a lower risk of reinterventions.

Similarly, Shamji et al. [24] concluded that a multiple-level posterior cervical fusion is associated with a higher rate of respiratory complications, postoperative infections, symptomatic hematomas and transfusions compared to an anterior approach. In the same line, Radcliff et al. [25] analyzed the relationship between the posterior approach and the C5 palsy in multilevel laminoplasty. MRI measurements revealed increase in C5 laminectomy trough width among patients with postoperative C5 palsy (17.9 vs. 15.2 mm, $p = 0.032$).

Luo et al. [26] presented opposing results, indicating that anterior multilevel surgery was linked to more major postoperative complications and reoperations.

Shamji et al. [24] also analyzed cost and hospital stay. The overall cost was almost double in the posterior approach, mainly due to longer hospital stay and higher probability of being discharge to a nursing or rehabilitation facility. In our series, reoperated patients had significant longer hospital stays, nearly 2 weeks more than non-complicated patients. This factor on its own represents a higher economic and social burden on patients and health care systems alike.

One of the items to be considered after DCM surgery is whether the patient's perceived outcome correlated to the final clinical outcome or if it is altered by the occurrence of complications. Multiple questionnaires have been devised to assess the final surgery outcome measuring different aspects with no clear superiority of one over the others. For this reason, Dalitz K and Vitzthum HE assessed and compared five specific DSM tests [*Nurick score, the Japanese Orthopedic Association* (*JOA) score, the Cooper myelopathy scale* (*CMS*), *the Prolo score and the European myelopathy score* (*EMS*)] [27]. There was a large quantitative difference among the scores as a result of the different criteria used to produce each score. Qualitatively, all five scores allowed evaluation of cervical myelopathy. In particular, the recovery rates as a measure of cumulative improvement showed less variation among most of the scores and allowed for statistical comparison. To this end, the Global Outcomes Score (GOS) was created so as to be able to capture the opinion of patients in the final phase of their surgical process. Patel et al. [28] similarly analyzed different DCM tests and concluded that the GOS is the one that best reflects improvement in minimal clinical important difference. These data justify the use of GOS in this study as a tool for subjective assessment of general health after surgery, especially since it was validated in retrospectively conducted studies.

To our knowledge no previous study has tried to analyze the impact of an US on the final clinical outcome after the resolution of the complication in DCM. The only similar work in spine surgery was the one conducted in the adult spinal deformity population. In this study by the European Spine Study Group, the authors showed that US occur more frequently in the elderly population, but they have no impact on the final result [29]. In our study, the age was higher in the US group, but this difference did not reach statistical significance. Also, the GOS result, as a measure of the final outcome, was not altered by the presence of US. Particularly, patients who had reinterventions did not have a worse perception of their general health when compared to those that did not have any reinterventions.

Limitations

This study has the inherent limitations to any retrospective study, mainly the lack of data homogeneity or poor data recording. However, the missing data did not exceed in any given variable in more than 10% of the sample. The total sample was 303 patients, and the incidence of US was low. This on the other hand, combined with some missing data might have limited our regression analysis power. This might explain why the surgical approach or age was not found to be significant factors in US.

Conclusions

Unplanned surgery rate can be used to assess quality of care after a surgical procedure. In our single-center series, our US rate after a CSM surgery was 2.6%, similar to the published literature. Patients with DM as well as patients suffering an intraoperative complication are more likely to need an early reinterventions (OR 2.2 and 6.5, respectively). Neither age nor surgical approach was found to be predictors of US. Complications needing an US occur most likely during admission and significantly lengthen hospital stay by 14 days ($p = 0.001$; 95% CI 5.0–24.15 OR). Finally, in our series, postoperative hematomas and infections needing US did not significantly alter the patient's perception of the final postoperative outcome.

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Compliance with ethical standards

Conflict of interest The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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