


Orthostatic Hypotension Following Cervical Spine Surgery: Prevalence and Risk Factors

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Abstract

Study Design: Retrospective case series.

Objectives: This study aims to determine the prevalence and risk factors for orthostatic hypotension (OH) in patients undergoing cervical spine surgery.

Methods: Data was collected from records of 190 consecutive patients who underwent cervical spine procedures at our center over 24 months. Statistical comparison was made between patients who developed postoperative OH and those who did not by analyzing characteristics such as age, gender, premorbid medical comorbidities, functional status, mechanism of spinal cord injury, preoperative neurological function, surgical approach, estimated blood loss, and length of stay.

Results: Twenty-two of 190 patients (11.6%) developed OH postoperatively. No significant differences in age, gender, medical comorbidities, or premorbid functional status were observed. Based on univariate comparisons, traumatic mechanism of injury ($P = .002$), poor ASIA (American Spinal Injury Association) grades (A, B, or C) ($P < .001$), and posterior surgical approach ($P = .045$) were found to significantly influence occurrence of OH. Among the significant variables, after adjusting for mechanism of injury and surgical approach, only ASIA grade was found to be an independent predictor. Having an ASIA grade of A, B, or C increased the likelihood of developing OH by approximately 5.978 times ($P = .003$).

Conclusion: Our study highlights that OH is not an uncommon manifestation following cervical spine surgery. Patients with poorer ASIA grades A, B, or C were more likely to have OH when compared with those with ASIA grades D or E (43.5% vs 7.2%). Hence, we suggest that postural blood pressure should be routinely monitored in this group of patients so that early intervention can be initiated.

Keywords

neurologic manifestations, orthostatic hypotension, postoperative complication, spine, spinal cord injury

Introduction

Orthostatic hypotension (OH) is typically defined as a decrease in systolic blood pressure (BP) of greater than 20 mm Hg or diastolic BP of greater than 10 mm Hg, from the baseline BP, within 3 minutes of changing body position from supine to an upright posture.¹ It is a common postoperative phenomenon among various surgical disciplines.² Its etiology is multifactorial and can include pharmacological, metabolic, and endocrine causes. There also exists a strong association between OH and patients with cervical spinal cord injury (SCI),³ where injury to descending preganglionic neurons results in a disruption of

sympathetic tone, causing a variety of cardiovascular abnormalities.⁴ It is often characterized by symptoms of dizziness, light-headedness, and syncope; however, some patients can

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also present with weakness, fatigue, cognitive issues, visual blurring, headache, neck pain, orthostatic dyspnea, or chest pain.¹ Symptomatic OH can be distressing to the patient and limits participation in rehabilitation activities, potentially delaying recovery after surgery.

Aims and Objectives

The objective of this study is to determine the prevalence and risk factors for developing OH following cervical spine surgery. We intend to study multiple factors that may have influenced the occurrence of OH and identify the significance of each factor to determine what are the independent factors. In addition to the general factors that might influence OH such as age, functional status and comorbidities, we also intend to analyze if traumatic etiology, ASIA (American Spinal Injury Association) grade, and surgical approach could influence the occurrence of OH. Given that, patients with traumatic SCI are at a higher risk to develop OH than patients with atraumatic causes of cervical cord compression (such as degenerative myelopathy, infection, or metastatic disease) as described in previous studies, we wanted to analyze if this as well true for our selected population.⁵

Methods

After obtaining institutional review board approval, all patients who had undergone cervical spine surgery during the years 2016 and 2017 were shortlisted from our institutional database. Shortlisted patients were divided into 2 groups depending on the diagnosis of orthostatic hypotension following surgery. This diagnosis is made from the postural BP recording at the first physiotherapy or occupational therapy assessment, which is typically 2 to 3 days following surgery. Additionally, it is also noted from the postural BP recording that is done whenever the patient is moved to a different bed or ward as a part of falls risk assessment. Patients were excluded if they had undergone multiple or staged spine operations, or where OH data was not recorded.

Data Collection

Inpatient records were reviewed for patient characteristics such as age, gender, premorbid mobility status, level of independence in activities of daily living (ADLs), and presence of medical comorbidities (diabetes, hypertension, hyperlipidemia, ischemic heart disease, and stroke). Disease characteristics were also identified, such as mechanism of cord compression (traumatic vs atraumatic) and preoperative ASIA grade (assessed on the day of surgery).⁶ Operative notes were reviewed to identify factors such as surgical approach (anterior vs posterior), number of levels decompressed, and estimated blood loss. The postoperative length of hospital stay was also noted for each patient. Both groups were statistically compared to look for significant differences in the above parameters.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics (version 23.0), and significance tests were 2-sided at the 5% significance level. Data normality was checked using the Shapiro-Wilk normality test. For continuous variables, Student's *t* test (for normally distributed data) or Mann-Whitney *U* test (for skewed data) was used. For categorical variables, chi-square or Fisher's exact test was used to evaluate statistical significance. Appropriate adjustments were made for unequal sample sizes. ASIA grades were grouped into "A + B + C" and "D + E" for clarity of interpretation. Binomial logistic regression was used to evaluate predictors of developing OH. The model was finalized when limited data and multicollinearity threatened the stability of model. Model fit was evaluated using a goodness of fit test. The crude and adjusted odds ratios (ORs) are reported with their 95% confidence intervals (CIs).

Results

A total of 190 consecutive patients met our inclusion criteria, of whom 22 (11.6%) developed OH postoperatively. The patients had a mean age of 61.2 years (range 17-86 years, SD 12.1) and 142 of them (74.7%) were male. Majority of the operations were performed for atraumatic (degenerative, neoplastic or infective) cervical spine disease (81.1%).

Univariate comparisons between patients with and without postoperative OH were done and tabulated (Table 1). No statistically significant differences in age, gender, medical comorbidity, premorbid function, or mobility were observed. The number of levels decompressed, and estimated blood loss were not found to be significant predictors of OH. Patients with postoperative postural hypotension were more likely to have a traumatic mechanism of injury as opposed to atraumatic cord injury (OR 4.55, $P = .002$). Also, patients with poorer ASIA grades A, B, or C were more likely to have OH when compared with those with ASIA grades D or E (43.5% vs 7.2%; OR 9.94, $P < .001$). A posterior surgical approach may also be associated with postural hypotension (OR 2.67, $P = .045$). In addition, we found that the patients with OH had a longer mean postoperative hospitalization compared with those without (63.9 vs 24.2 days, $P < .001$).

Binomial logistic regression was used to evaluate predictors of OH that had been identified with univariate comparison (ASIA grade, traumatic injury, and surgical approach). The model was statistically significant, $\chi^2(3) = 21.248$, $P < .0005$, and correctly classified 86.3% of cases. The crude and adjusted ORs with the 95% CIs are presented (Table 2). After adjusting for mechanism of injury and surgical approach, only ASIA grade was found to be an independent predictor of postoperative OH. Having an ASIA grade of A, B, or C increased the likelihood of developing OH by approximately 5.978 times (adjusted OR, 95% CI 1.83-19.52; $P = .003$).

Table 1. Baseline Characteristics and Clinical Profile of Patients.

Parameters	Total (n = 190), n (%)	Without Postural Hypotension (n = 168), n	With Postural Hypotension (n = 22), n	P ^a
Age, years, mean (SD)	61.2 (12)	61.6 (12)	58.4 (12)	.251
Gender				.602
Female	48 (25.3)	44	4	
Male	142 (74.7)	124	18	
Mobility				.419
Ambulant without aid	161 (85.3)	143	19	
Wheelchair	9 (4.7)	7	2	
Walking stick or frame	19 (10.0)	18	1	
ADL status				.280
Independent	181 (95.3)	161	20	
Assisted	9 (4.7)	7	2	
Comorbidities				
DM	65 (34.2)	54	11	.097
HTN	99 (52.1)	89	10	.507
HLD	94 (49.5)	83	11	.958
IHD	24 (12.6)	22	2	.595
CVA	7 (3.7)	5	2	.152
Etiology				.002
Traumatic	36 (18.9)	26	10	
Nontraumatic	154 (81.1)	142	12	
ASIA grade				<.001
ASIA A	3 (1.6)	1	8	
ASIA B	3 (1.6)	1	8	
ASIA C	17 (8.9)	11	6	
ASIA D	123 (64.7)	113	10	
ASIA E	44 (23.2)	42	2	
ASIA grade (grouped)				<.001
ASIA A + B + C	23 (12.1)	13	10	
ASIA D + E	167 (87.9)	155	12	
Approach				.045
Anterior	90 (47.4)	84	6	
Posterior	100 (52.6)	84	16	
No. of levels decompressed (mean)		2.26	2.27	.958
Blood loss				.314
Minor (<500 mL)	167 (87.9)	149	18	
Major (≥500 mL)	23 (12.1)	19	4	
Length of postoperative stay, days, mean		24.2	63.9	<.001

Abbreviations: SD, standard deviation; ADL, activities of daily living; DM, diabetes mellitus; HTN, hypertension; HLD, hyperlipidemia; IHD, ischemic heart disease; CVA, cerebrovascular accident; ASIA, American Spinal Injury Association.

^aP values in boldface are statistically significant ($P < .05$).

Discussion

Postoperative OH is a well-documented phenomenon; a retrospective study of 495 patients by Hanada et al found that approximately 40% experience OH during early mobilization following cardiothoracic and abdominal surgery.⁷ Jans et al⁸ found that following hip arthroplasty, 19% of patients without previously documented OH experienced a significant postural drop 24 hours after surgery ($n = 26$).⁸ There is also a well-established link between SCI and the development of OH.³ Postural changes during physiotherapy and mobilization have been shown to induce clinically significant hypotensive episodes in 74% of SCI patients, being symptomatic in 59% of patients with SCI.³ Indeed, our institution limits patient participation in rehabilitation activities when OH is present for safety

reasons. Other well-established risk factors for OH include age, cardiovascular disease, and neurodegenerative diseases such as diabetic autonomic neuropathy, multisystem atrophy, and Parkinson's disease.^{9,10}

The mechanisms underlying OH in patients with SCI are multifactorial.¹¹ Physiological abnormalities in SCI patients that are thought to contribute to OH include sympathetic nervous system dysfunction, impaired baroreceptor sensitivity, inactive skeletal muscle pumps, cardiovascular deconditioning, and deranged salt and water balance.¹²⁻¹⁵ The severity of OH is correlated to the degree of neurological deficit following SCI. To wit, higher level injuries are associated with greater damage to efferent sympathetic nerves.¹⁶ For example, lesions above T6 disrupt sympathetic innervation to major vessels in the splanchnic bed, impairing the vasoconstrictive effects of the

Table 2. Binomial Regression With Adjusted Odds Ratios.

Variable	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	<i>P</i> ^a
ASIA grade			.003
ASIA D + E	I	I	
ASIA A + B + C	9.936 (3.61-27.34)	5.978 (1.83-19.52)	
Mechanism			.219
Nontraumatic	I	I	
Traumatic	4.55 (1.78-11.62)	2.045	
Approach			.246
Anterior	I	I	
Posterior	2.667 (0.995-7.15)	1.868 (0.649-5.37)	

Abbreviations: OR, odds ratio; CI, confidence interval; ASIA, American Spinal Injury Association.

^a*P* value in boldface are statistically significant (*P* < .05).

baroreflex. OH is thus more commonly found in patients with tetraplegia than in those with diplegia. While OH in SCI patients has been extensively studied, its prevalence and severity in nontraumatic SCI such as compressive cervical myelopathy remains less well-researched. One study of 29 patients found significant differences in OH between patients with compressive cervical myelopathy and healthy controls.¹⁷ McKinley et al⁵ followed 117 SCI patients and found that traumatic SCI patients had a significantly higher incidence of OH compared to nontraumatic SCI patients (36.7% vs 5.3%).

In our study, we found that OH is a common complication in patients who undergo cervical spine surgery (overall incidence of 11.6%) and it is associated with prolonged hospitalization. Our findings indicate that preoperative ASIA grade is a statistically significant predictor of OH. These findings are consistent with our understanding of the pathophysiology of OH in patients with SCI. Our study found that age was not significantly associated with the development of OH. This is notable considering the higher incidence of OH normally seen in older populations. Claydon et al¹¹ also noted a paucity of reported OH in elderly SCI patients, the cause of which is uncertain. The significance and implications of this should be further explored given the global trend in SCI patient demographics toward older individuals in recent decades.¹⁸

Comprehensive reviews on management principles of OH is available in literature.^{19,20} Treatment options include pharmacological therapy (midodrine, fludrocortisone, etc) and non-pharmacological measures (such as salt and fluid management, abdominal binders, and upper limb exercises).

Validity and Limitations

Regarding the external validity of our results, we believe that our sample is generally representative of postoperative patient populations encountered in our local clinical setting. However, our mean patient age at surgery (61.2 years) is significantly higher than data from other countries.

Our study had several limitations because of its retrospective nature. Majority of the patients with degenerative cervical

spine disease were admitted electively for surgery and could be reviewed for preoperative optimization by the anesthetist. In contrast, most of the patients with traumatic SCI would have been admitted via the emergency department and the surgery performed as an emergency procedure; this may have caused poorer optimization of preexisting hypertensive or cardiac conditions, thus influencing the occurrence of postoperative OH.

At our institution, postural BP is only measured at specific junctures during the patient's hospitalization. Specifically, it is measured once at the initiation of rehabilitation and once whenever the patient is moved to a different ward (as part of a falls risk assessment). Patients diagnosed with OH were not categorized into true positives or false positives. Routine regular monitoring was only performed if severe or symptomatic OH was detected. The low frequency and delay in measurement following surgery would mean that our study probably underdetects the incidence of OH, particularly in patients with transient or intermittent OH. Additionally, patients who were too frail or weak to tolerate a measurement of postural BP were excluded from the study if OH was not subsequently detected during the same admission. Since these patients are likely at higher risk of OH, there is probably an element of selection bias that under-samples patients with OH.

Last, while our results showed that OH patients had a longer hospitalization, we also found that those with OH had poorer ASIA score. It could be possible that OH and ASIA grade both attributed to this longer hospital stay, rather than OH affecting it independently. This is another limitation that we could not address in this current study and may require further prospective studies.

Conclusion

Our study highlights the importance of being familiar with the potential complications of OH as it can impede recovery and rehabilitation. We found that OH occurred in 11.6% of our patients following cervical spine surgery. The most pertinent risk factor is having a poor preoperative ASIA grade. In addition, patients with OH experienced a significantly longer length of hospital stay. Given the deleterious effects associated with OH, we suggest that postural BP should be routinely and actively monitored in all patients with poor ASIA grades so that early intervention can be initiated; thus, improving participation in rehabilitation activities and potentially reducing the duration of hospitalization.


Declaration of Conflicting Interests

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