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Research Article

High-sensitivity troponin T predicts perioperative adverse events in patients undergoing neurosurgical procedures

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Abstract

Objectives: Previous studies have shown that troponin is a valuable predictor of perioperative complications after non-cardiac surgery. However, the relationship of the preoperative troponin level with perioperative adverse events has not been well described in patients undergoing neurosurgical procedures. The aim of this study was to evaluate the impact of the preoperative high-sensitivity cardiac troponin T (hs-cTnT) level on the outcome of patients who underwent neurosurgery.

Methods: The records of 2519 patients who were over 18 years of age and underwent elective neurosurgery between December 2014 and December 2018 were retrospectively evaluated. Patient medical and demographic data and the results of routine preoperative laboratory tests, including the hs-cTnT level, were collected to assess a potential association between these factors and perioperative adverse events.

Results: Perioperative adverse events occurred in 251 (10.0%) patients. Older patients and those with more comorbid conditions tended to have a higher rate of perioperative adverse events. The preoperative hs-cTnT level was significantly higher in the individuals who experienced a complicated in-hospital course than in those who did not (21.6±8.2 ng/L vs 6.3±3.1 ng/L; p<0.001). Multivariate analysis indicated that age (odds ratio [OR]: 2.33, 95% confidence interval [CI]: 1.16-4.35; p<0.01), the presence of diabetes (OR: 3.13; 95% CI: 1.15-6.32; p=0.004), and a preoperative hs-cTnT level of >18.3 ng/L (OR: 4.51, 95% CI: 2.34–7.82; p<0.001) were significant and independent predictors of perioperative adverse events.

Conclusion: The results of this study indicated that a higher preoperative hs-cTnT level was associated with perioperative adverse events in adult patients undergoing elective neurosurgery.

Keywords: High-sensitivity troponin T, neurosurgery, prognosis

The early recognition of predictors of adverse outcomes in patients undergoing surgery is important for timely risk stratification and management [1]. Clinical risk stratification tools and preoperative laboratory tests have frequently been used as a component of the preoperative workup for patients undergoing various surgical procedures [1]. Several studies have reported that patient factors, comorbidities, and surgical characteristics are associated with a higher incidence of complications in neurosurgery [2, 3]. However, only a few studies have examined the association between preoperative biomarkers and perioperative complications following neurosurgical procedures.

Troponins are proteins that regulate the calcium-induced interaction between myosin and actin that results in muscle contraction [4]. Troponin I and troponin T are the most widely used and are the most specific biomarkers for myocyte injury. Elevated troponin levels are a predictor of major adverse events in multiple settings [5, 6]. Multiple studies have demonstrated that preoperative troponin I and T are valuable predictors of worse outcomes not only after cardiac or vascular surgery but also after noncardiac surgeries [7-10]. Although the predictive value of cardiac biomarkers, such as troponins and natriuretic peptides, has been evaluated in various noncardiac surgical

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procedures, including vascular, gynecological, urological, orthopedic, reconstructive, and abdominal surgeries [11-13], their ability to predict adverse events in patients undergoing neurosurgery is unknown. High-sensitivity troponin (hs-cTnT) assays have been introduced in recent years [14]. This retrospective cohort study was an examination of preoperative hs-cTnT test results and adverse events in patients who underwent neurosurgery.

Materials and Methods

Study design and selection of patients

This retrospective study was approved by the Mugla Sıtkı Kocman University Ethics Committee. The committee waived informed consent because the research only involved previously collected data. Patients who were at least 18 years old and had a hs-cTnT measurement from within 7 days before a neurosurgical procedure performed between December 2014 and December 2018 at the Mugla Sıtkı Kocman University Faculty of Medicine Hospital were consecutively included.

Clinical characteristics, demographic details, comorbidities, and medical history data, including age, sex, and the type and duration of surgery, were obtained retrospectively from medical records. Several laboratory values (hemoglobin, creatinine, electrolytes, hs-cTnT, etc.) were also noted. The selected neurosurgical procedures included intracranial (tumor debulking, evacuation of intracranial hemorrhage, surgery for aneurysms, etc.) and spinal surgeries (laminectomy, arthrodesis, discectomy, and/or laminectomy in any region of the spine).

Exclusion criteria were age below 18 years, pregnancy, acute coronary syndrome or acute heart failure in the previous month, insufficient preoperative clinical or laboratory data, or hemodialysis or peritoneal dialysis administration for renal failure. Emergent surgical procedures were also excluded. Patients who underwent a nonemergent, neurosurgical procedure and had their preoperative hs-cTnT level measured during the 7 days prior to the surgery were included in the analysis.

The Elecsys 2010 system (Roche Diagnostics GmbH, Risch-Rotkreuz, Switzerland) was used to analyze the hs-cTnT level [15].

Study outcomes

The outcome measure of the study was a perioperative adverse event during hospitalization, This included death, cardiopulmonary complications (acute coronary syndrome, pulmonary embolism, thromboembolic events, acute heart failure, arrhythmia requiring monitoring or treatment), deep wound infection, major bleeding requiring transfusion, acute renal failure, pneumonia, cerebrovascular accidents, sepsis, and return to the operating room.

Statistical analysis

The results of descriptive analyses are expressed as mean±SD for normally distributed variables, as medians and maximum-minimum values for non-normally distributed variables, and as percentages for categorical variables. In the evaluation of the differences between the categorical variables, Fisher's exact test was used in row and column tables and Pearson's chi-square test was used for 2x2 tables. In order to compare continuous variables in pati"ents with and without perioperative adverse events, independent t-tests were used for normally distributed data, and the Mann-Whitney U test was used for non-normally distributed data. Univariate and multivariable logistic regression analyses were performed to determine independent predictors of perioperative complications. Jamovi software (The jamovi project 2018, version 0.9.1.7, retrieved from https://www.jamovi.org) was used to perform the statistical analysis.

Results

A total of 2519 patients who underwent elective neurosurgical procedures (mean age: 69.3±8.4 years, 52% male) were included in this study. Of the study group patients, 2078 (82.5%) underwent spinal surgery and 441 (17.5%) underwent intracranial surgery.

Perioperative adverse events

Perioperative adverse events occurred in 251 (10.0%) patients. The in-hospital perioperative adverse events are presented in Table 1. Patients who had perioperative adverse events were older (mean age: 73.7±8.7 years vs 68.4±9.9 years; p<0.001), and were more likely to have underlying comorbid diseases, such as coronary artery disease (28.7% vs 11.0%; p<0.001), diabetes mellitus (29.9% vs 15.6%; p<0.001), and heart failure (15.1% vs 9.3%; p<0.001). The preoperative hs-cTnT level was significantly higher in the individuals who experienced a complicated in-hospital course than in those who did not (21.6±8.2 ng/L vs 6.3±3.1 ng/L; p<0.001).

Predictors of perioperative adverse events

A relationship between preoperative adverse events and the following variables was demonstrated via univariate analysis: age, coronary artery disease, diabetes, heart failure, and preoperative hs-cTnT level. Multivariate analysis showed that age (OR: 2.33, 95% CI: 1.16-4.35; p<0.01), presence of diabetes (OR: 3.13, 95% CI: 1.15-6.32; p=0.004), and preoperative hs-cTnT of >18.3 ng/L (OR: 4.51, 95% CI: 2.34–7.82; p<0.001) were significant and independent predictors of perioperative adverse events (Table 2).

Discussion

This was a single-center, retrospective, and observational study of 2519 consecutive patients over the age of 18 who

Table 1. Baseline characteristics of patients with and without perioperative adverse events

	No adverse event (n=2268)	Adverse event (n=251)	P
Male	1171 (51.6)	135 (53.8)	0.179
Age (years)	68.4±9.9	73.7±8.7	<0.001
Medical history			
Hypertension	1566 (69.0)	177 (70.5)	0.62
Hyperlipidemia	845 (37.3)	97 (38.6)	0.67
Diabetes mellitus	354 (15.6)	75 (29.9)	<0.001
Atrial fibrillation	246 (10.8)	33 (13.1)	0.27
Chronic obstructive pulmonary disease	346 (15.3)	40 (15.9)	0.77
Malignancy	221 (9.7)	25 (9.9)	0.91
Coronary artery disease	250 (11.0)	72 (28.7)	<0.001
Heart failure	213 (9.3)	38 (15.1)	<0.001
Laboratory results			
Hemoglobin (g/dL)	12.1±1.74	12.0±1.57	0.42
Mean platelet volume (fL)	9.6±1.54	9.7±1.58	0.12
Albumin (g/dL)	3.6±0.37	3.6±0.42	0.84
Creatinine (mg/dL)	1.0±0.35	1.0±0.41	0.52
C-reactive protein (mg/dL)	2.2±3.3	2.4±3.4	0.21
High-sensitivity troponin T (ng/L)	6.3±3.1	21.6±8.2	<0.001

Values are given as mean±SD or number (percentage).

Table 2. Multivariate analysis for the prediction of perioperative adverse events

	OR	95% CI	P
Age (per year)	2.332	1.161-4.353	<0.01
Heart failure (presence vs absence)	1.034	0.341-3.132	0.632
Diabetes mellitus (presence vs absence)	3.131	1.153-6.321	0.004
High-sensitivity troponin T >18.3 ng/L	4.512	2.344–7.822	<0.01
Coronary artery disease (presence vs absence)	1.132	1.056-1.721	0.344

underwent elective intracranial and spinal surgery. The incidence of perioperative adverse events was 10%. Multivariate analysis revealed that older age and a high preoperative hs-cTnT level were independent prognostic factors for perioperative adverse events.

Morbidity and mortality can occur in cardiac or non-cardiac surgery as a result of significant perioperative complications [1]. Although neurosurgical procedures have been thought to present an intermediate risk of death and cardiovascular complications, perioperative adverse events are not uncommon [16]. Current data show that preoperative measurements of the biomarkers of cardiovascular dysfunction provide additive prognostic information of major adverse events and mortality after various noncardiac surgical procedures, such as vascular [17], gastrointestinal [18], and orthopedic [19] procedures. Previous studies have established several clinical and laboratory predictors of perioperative complications in patients undergoing spinal and intracranial surgery [2, 3], but the prognostic value of cardiac biomarkers, especially troponins, have not been comprehensively evaluated in these patients.

Ruggieri et al. [20] analyzed N-terminal pro-brain natriuretic peptide and the prognostic value of serum cardiac troponin T in patients with no history of cardiac anomalies before and after elective surgery for intracranial tumor resection. Serum troponin T and N-terminal pro-brain natriuretic peptide levels were measured in 108 patients. High N-terminal pro-brain natriuretic peptide serum levels were associated with the occurrence of intracranial mass effect (midline shift or deleted perimesencephalic cisterns). In another study, McClendon et al. [21] examined the effect of renin-angiotensin system inhibitors on postoperative troponin elevation in spinal fusions and analyzed the correlation with hospital stay. They examined 208 patients retrospectively, and found that the preoperative use of renin-angiotensin system inhibitors was independently associated with postoperative troponin elevation and a longer hospital stay. However, they did not evaluate the prognostic value of troponin in their study population.

In a study conducted by Macfarlane et al. [22] to investigate the predictive features of troponin I level, it was concluded that it was insufficient to measure consecutive postoperative troponin 1 levels in routine elective spine surgery as a predictor of increased 30-day mortality. This cohort study of 92 patients (39 supine, 53 prone) revealed that no validated troponin I elevation was observed for 24 hours in any group. A false high level was recorded as "prone <2 hours" and 1 as "prone >2 hours." On day 7, 1 non-ST segment myocardial infarction occurred without troponin I elevation in 24 hours (prone >2 hours). There was no 30-day mortality.

In a retrospective study of 100 patients with intracerebral hemorrhage, Garret et al. [23] examined whether troponin level is independent of all factors. The results of this study revealed that admission troponin levels were a significant risk factor for in-hospital mortality even after controlling for hemorrhage volume, gender, and age.

According to the current literature, hs-cTnT is more sensitive than conventional troponin measures to detect acute coronary syndromes [24]. In addition, several studies have shown that hs-cTnT values can improve diagnostic accuracy as well as prognostic accuracy, which can identify high-risk patients in the conventional troponin-negative group in a variety of diseases [25, 26]. However, the prognostic value of hs-cTnT has not previously been evaluated in spinal or intracranial surgery patients.

Limitations

This study has several limitations. First, given the retrospective nature of this research, measurement of preoperative hs-cTnT concentration was at the discretion of the managing service and was based on clinical reasons. Second, this study included only patients aged ≥18 years undergoing nonemergent spinal and intracranial surgery. Our hospital is a referral hospital, which may have affected our results Therefore, caution should be taken in extrapolating these results to other surgical populations.

Conclusion

Older age, the presence of diabetes, and a preoperative hs-cTnT of >18.3 ng/L were significant and independent predictors of perioperative adverse events in adult patients undergoing elective spinal and intracranial surgery. To the best of our knowledge, this is the first study to examine the prognosis value of hs-cTnT in neurological surgery. Routine measurement of the hs-cTnT before surgery could be a useful predictor in adult patients undergoing elective neurosurgical procedures.

Conflict of interest: None declared.

Ethics Committee Approval: This retrospective study was approved by the Mugla Sıtkı Kocman University Ethics Committee (02/05/2019 - 08/IX).

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