

The Role of Troponin-T Biomarker as an Indicator for Cardiac and Non-Cardiac Complications in Cardiac Patients Undergoing Non-Cardiac Surgery at Dr. Wahidin Sudirohusodo Hospital, Makassar, Indonesia

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ABSTRACT

Background: Non-cardiac surgery in patients with cardiovascular risk can lead to postoperative complications. Troponin T, a cardiac biomarker, is proposed as an indicator of cardiac risk in these patients. This study evaluates troponin T levels before and after non-cardiac surgery and their association with postoperative complications.

Methods: This prospective cohort study included 46 patients selected through consecutive sampling. Demographic data and troponin T levels were recorded before and 24 hours after surgery.

Results: Postoperative complications included cardiac events (15.21%), such as myocardial infarction (4.34%), heart failure (4.34%), and arrhythmia (6.52%), and non-cardiac events (17.39%), such as sepsis (4.34%), bleeding (4.34%), surgical site infection (6.52%), and respiratory insufficiency (2.17%). The average patient age was 50.15 ± 8.81 years, with 60.9% being male. There was a significant relationship between troponin T levels and the incidence of cardiac complications after surgery.

Conclusion: Elevated postoperative troponin T levels may serve as a prognostic indicator for cardiac complications in non-cardiac surgery patients. Routine monitoring could aid in early detection and improved postoperative management.

Introduction

Postoperative mortality is the leading cause of death globally [1–3]. Perioperative mortality rates are high, especially in patients with cardiac comorbidities such as heart failure and coronary artery disease. Studies of more than 600,000 patients show that heart failure patients undergoing complex surgery have a postoperative mortality rate of more than 10% [1–4]. Therefore, various strategies have been developed to risk stratify and optimize patient outcomes. One approach that

is increasingly used is cardiovascular biomarkers as perioperative risk indicators.

A biomarker-based approach is a solution, as the process of cardiac risk stratification with conventional screening is often complex and resource-intensive. The Canadian Cardiovascular Society proposes a biomarker-based algorithm by measuring brain natriuretic peptides (BNP/NT-proBNP) preoperatively as part of risk stratification [5]. If there is an increase in natriuretic peptides, postoperative troponin monitoring is recommended. Cardiac troponins are myocardial structural proteins that are released during myocardial

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injury. Therefore, troponin is one of the main biomarkers in the diagnosis and prognosis of cardiovascular disease.

Troponins have long been used in the evaluation of acute coronary syndromes and have been shown to have significant prognostic value [6-7]. Several studies have shown that elevated troponins before surgery are associated with a higher risk of postoperative cardiovascular complications [8-9]. A prospective study in 979 patients showed that 24% of patients had elevated troponin T preoperatively, which was associated with increased postoperative cardiovascular events [9]. Another study in 599 patients found that 41% of patients had hsTnT levels above the 99th percentile before non-cardiac surgery [8]. In contrast, another study found no significant association between preoperative troponin elevation and postoperative major cardiovascular events [10]. Therefore, further studies are needed to determine the benefits of preoperative troponin measurement as a risk indicator.

One method to evaluate postoperative outcomes is through the concept of major adverse cardiovascular events (MACE). Classic MACE includes stroke, myocardial infarction, and cardiovascular death [11]. However, some studies have also included heart failure and ischemic cardiovascular events in the definition of MACE [12]. Risk factors for MACE vary depending on individual patient characteristics, so biomarker-based approaches may aid in risk prediction. In addition to cardiovascular complications, non-cardiovascular complications are also common postoperatively and contribute to increased patient morbidity and mortality [13].

Elevated troponin levels are associated with worse prognosis in perioperative patients [14]. However, the optimal threshold of troponin in estimating cardiovascular surgery outcomes has not been clearly defined. The difference in results between studies suggests that the use of troponin as a perioperative biomarker still requires further validation. Therefore, this study aimed to explore the relationship between preoperative troponin T levels and the incidence of postoperative cardiovascular and non-cardiovascular complications, including MACE.

Methods

This study was an observational analytic study with a prospective cohort design conducted at Dr. Wahidin Sudirohusodo Hospital Makassar. The study lasted from May 2024 until the required sample size was met. The study population included patients undergoing non-cardiac surgery, with samples selected using the consecutive sampling method. Inclusion criteria included patients aged 18-60 years with a clear history of disease and agreed to participate in the study. Meanwhile, patients who did not meet these criteria, or who had

contraindications for blood sampling, were excluded from the study.

Troponin-T levels were measured in all study subjects as a baseline before surgery. After surgery, repeat measurements were performed at 24 hours postoperatively and six months postoperatively. Data related to cardiovascular and non-cardiovascular complications, including MACE (myocardial infarction, heart failure, stroke, and death), were collected through medical records and direct interviews. Patients who experienced loss to follow-up or died during the perioperative period were categorized as dropouts.

The data obtained were analyzed using statistical software. A normality test was conducted using the Shapiro-Wilk test. For data following a normal distribution, group comparisons were performed using the unpaired t-test, while non-normally distributed data were analyzed using the Mann-Whitney U test. All statistical analyses were interpreted at a 95% confidence interval ($p < 0.05$). This study received ethical approval from the Faculty of Medicine, Hasanuddin University, and all participants provided informed consent before participation.

Results

Based on (Table 1), it is obtained information that the participants in this study had an average age of 50.15 ± 8.81 years. Most of the participants of this study were men with ASA PS 3.

Table 1- Characteristics of participants

Characteristics	n (%) / Mean \pm SD
Age (year)	50.15 \pm 8.81
Sex	Male 28 (60.9) Female 18 (39.1)
ASA PS	2 21 (45.7) 3 25 (54.3)

Note: Numerical data are presented as mean \pm standard deviation, categorical data as n (%).

(Table 2) shows that troponin T levels increased before 24 hours after surgery and 6 months after non-cardiac surgery. Statistical test results showed that there were differences in troponin T levels based on the study time ($p < 0.05$).

(Table 3) shows that there are differences in changes in troponin T levels based on the study time ($p < 0.05$). (Table 3).

In this study, non-cardiac postoperative complications were cardiac complications of 15.21% consisting of myocardial infarction (4.35%), heart failure (4.35%), and arrhythmia (6.52%). Non-cardiac complications amounted to 17.39% which consisted of sepsis (4.35%), bleeding (4.35%), wound infection (6.52%) and respiratory insufficiency (2.17) (Table 4).

Table 3- Comparison of changes in troponin T levels in non-cardiac surgery

Measurement time	Changes in Troponin-T Levels	P value
	Mean±SD	
Before - 24 hours after surgery	0.24 ± 0.42	0.001*
24 hours - 6 months after surgery	0.26 ± 0.08	
Before - 24 hours after surgery	0.24 ± 0.42	0.001*
Before - 6 months after surgery	0.26 ± 0.43	
24 hours - 6 months after surgery	0.26 ± 0.08	0.001*
Before - 6 months after surgery	0.26 ± 0.43	

Note: Wilcoxon test, ns: not significant, *significant

Table 4- Frequency Distribution of Cardiac and Non-cardiac Complications

Variable	Complications	n (%)
Cardiac	Myocardial infarction	2 (4.35)
	Heart failure	2 (4.35)
	Arrhythmia	3 (6.52)
	None	39 (84.78)
Non-cardiac	Sepsis	2 (4.35)
	Bleeding	2 (4.35)
	Wound infection	3 (6.52)
	Respiratory insufficiency	1 (2.17)
	None	38 (82.61)

These results showed that troponin T levels before surgery, 24 hours after surgery and 6 months after non-cardiac surgery in patients who had cardiac complications were greater than in patients who did not have cardiac complications. Statistical test results showed that there was a significant association of troponin T levels before surgery, 24 hours after surgery and 6 months after non-cardiac surgery with cardiac complications ($p < 0.05$) (Table 5).

These results showed that troponin T levels before surgery, 24 hours after surgery and 6 months after non-cardiac surgery in patients who experienced non-cardiac complications were greater than in patients who did not experience non-cardiac complications. Statistical test results showed that there was no significant association of troponin T levels before surgery, 24 hours after surgery and 6 months after non-cardiac surgery with non-cardiac complications (Table 5).

These results showed that changes in troponin T levels at 24 hours after surgery and 6 months after non-cardiac surgery were significantly associated with non-cardiac complications ($p < 0.05$). Changes in troponin T levels in patients with non-cardiac complications were greater than patients without non-cardiac complications (Table 6).

Table 5- Association of Troponin-T Level with Cardiac Complications

Troponin-T levels	Cardiac Complications		P value
	Yes	No.	
	Mean±SD	Mean±SD	
Before	1.41±0.43	0.77± 0.38	0.001*
24 hours after surgery	1.90±0.69	0.97±0.37	0.001*
6 months after surgery	1.98±0.74	0.99±0.39	0.001*
Non-Cardiac Complications			
Troponin-T levels	Yes	Yes	P value
	Mean± SD	Mean± SD	
Before	0.66 ± 0.48	0.91 ± 0.43	0.057 ^{ns}
24 hours after surgery	1.34 ± 0.92	1.06 ± 0.43	0.579 ^{ns}
6 months after surgery	1.38 ± 0.97	1.09 ± 0.46	0.522 ^{ns}

Note: Mann-Whitney U test, ns: not significant, *significant

Table 6- Comparison of Changes in Troponin-T Levels with Non-cardiac Complications

Changes in Troponin-T Levels	Non-Cardiac Complications		P value
	Yes	No.	
	Mean± SD	Mean± SD	
Before and 24 hours after surgery	0.68± 0.48	0.15±0.34	0.006*
Before and 6 months after surgery	0.72± 0.53	0.17±0.35	0.010*

Note: Mann-Whitney U test, ns: not significant, *significant

Discussion

This study involved 46 patients who underwent non-cardiac surgery at Dr. Wahidin Sudirohusodo Hospital Makassar. The basic characteristics of the study sample showed that the average age of patients was 50.15 ± 8.81 years, with a sex composition dominated by men as much as 60.9%. Most patients had an ASA PS 3 status of 54.3%, indicating a health condition that requires more attention in the context of surgery.

The results showed that troponin T levels increased in patients undergoing non-cardiac surgery, both before, 24 hours, and 6 months postoperatively. This increase indicates a worsening of myocardial necrosis that occurs as a result of the stress caused by non-cardiac surgical procedures. These results are in line with the study by Indrawijaya et al., who found that changes in troponin T levels are associated with worsening myocardial necrosis [15]. The study by Horr et al. also revealed that approximately 5% to 25% of non-cardiac postoperative patients have elevated troponins, which may increase the

risk of morbidity and mortality both short- and long-term [16].

Meanwhile, changes in troponin T levels also showed significant differences. Postoperative elevated troponin T levels may reflect nonspecific cardiomyocyte stress and serve as a diagnostic and prognostic indicator for cardiovascular events in patients with ischemic heart disease or stable coronary artery disease. This increase is influenced by patient age, type of surgery, and disease and may be a marker for myocardial ischemia or other adverse cardiovascular events after non-cardiac surgery [17].

In addition to measuring troponin T levels, the study also recorded the incidence of cardiac and non-cardiac complications that occurred in patients after non-cardiac surgery. Cardiac complications, such as myocardial infarction, heart failure, and arrhythmia, occurred in approximately 15.22% of patients, while non-cardiac complications, including sepsis, bleeding, wound infection, and respiratory insufficiency, occurred in 17.39% of patients. These results are in line with previous studies that showed postoperative non-cardiac complication rates ranging from 11% to 28%, with 26% of patients experiencing complications within 30 days after non-cardiac surgery [18]. Cardiac complications often arise after major surgery, with a higher risk in patients with ischemic heart disease.

The association between troponin T levels and cardiac complications showed that patients with cardiac complications had higher troponin T levels than patients without cardiac complications. High troponin T levels may be a predictor of cardiac complications in patients undergoing non-cardiac surgery. A study by Chew et al. also found that elevated troponin T levels were independently associated with the incidence of cardiovascular complications [19]. Elevated troponin T in patients with cardiac complications indicates greater myocardial injury and is often associated with a long-term risk of cardiac disease progression.

However, in this study, there was no significant association between troponin T levels and non-cardiac complications, although there were greater changes in troponin T levels in patients with non-cardiac complications than those without such complications. Studies by Chew et al. and Ackland et al. showed that elevated troponin T levels can be a predictor of non-cardiac complications, such as sepsis, bleeding, or wound infection [19-20]. An increase in troponin T levels of more than 100% compared to baseline values may indicate myocardial injury associated with the non-cardiac complication.

This study has several limitations, including a relatively small sample size and a follow-up duration of only 6 months. Further research with a larger sample size and longer duration is needed to support these findings.

Conclusion

Troponin T levels increase before surgery and at 24 hours postoperatively and remain elevated up to 6 months after non-cardiac surgery and can be used as an indicator of cardiac postoperative complications in cardiac and non-cardiac patients during this period, indicating potential challenges of prolonged recovery. Additionally, higher troponin T levels are associated with an increased risk of developing cardiac complications, emphasizing the importance of continuous monitoring and appropriate postoperative management.

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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