Journal of
Babol University of Medical Sciences
JBUMS
e-ISSN: 2251-7170 p-ISSN: 1561-4107

Myocardial Injury in Mechanically Ventilated Cases in Intensive Care Unit

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Article Type

Research Paper

Received:
Mar 3rd 2023
Revised:
Apr 29th 2023
Accepted:
May 31st 2023

ABSTRACT

Background and Objective: General anesthesia and tracheal intubation activate the sympathetic nervous system that might affect the innervation of the heart. The aim of study is to look for the incidence of myocardial injury (MI) in intubated adult patients in the Intensive Care Unit (ICU).

Methods: This cross-sectional study was conducted on all intubated patients during four months in Imam AL Sadeq Teaching Hospital's ICU, from January 2022 to May 2022. Patients were selected by the census sampling method. Electrocardiograms (ECG), echocardiograms (echo), blood pressure monitoring, other vital signs, and high-sensitivity serum troponin I testing were used to detect myocardial damage. Patients were divided to normal and high troponin groups. Primary diagnosis of admission to ICU was recorded. Patients were followed after 60 days by visits or phone call.

Findings: This study included 40 patients with a mean age of 56.6±7.3 years. There were 17 (42.5%) cases of new MI in the ICU. Troponin levels were found to be significantly associated with age, hypertension, and atrial fibrillation ($p<0.05$), but not with gender or the type of illness. Patients with elevated troponin levels were three times more likely to experience mortality within 60 days compared to those with normal levels (0.0247). Logistic regression analysis confirmed a significant positive association between troponin levels and mortality, controlling for age, hypertension, and atrial fibrillation (odds ratio=5.49, 95% CI= 1.15-27.15, p=0.033). Age, hypertension, and atrial fibrillation were not significant predictors of mortality.

Conclusion: In conclusion, our study showed a high rate of MI in non-cardiac ICU patients and also a significant association between elevated troponin levels and increased mortality within 60 days in ICU patients. The findings of this study show the importance of monitoring troponin levels as a prognostic indicator in critically ill patients.

Keywords: *Myocardial Infarction, Troponin, Intensive Care Units, Mortality*.

Cite this article: ALjubawii AA, Radhi AK, Abdulameer Almustafa H. Myocardial Injury in Mechanically Ventilated Cases in Intensive Care Unit. *Journal of Babol University of Medical Sciences*. 2023; 25(1): 372-8.

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Publisher: Babol University of Medical Sciences

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[DOI: 10.22088/jbums.25.1.372]

Introduction

General anesthesia and tracheal intubation have significant hemodynamic effects, activating the sympathetic nervous system. Catecholamine increases arrhythmias and platelet aggregation (1-3). Myocardial damage is defined as a cardiac troponin (cTn) reading over the 99th percentile. cTn rises and/or falls indicate an acute injury (4-6). Myocardial damage was defined as troponin I levels>30 ng/L without overt ischemia. Patients with peak values 30 ng/L were considered non-elevated. Myocardial Infarction is acute myocardial injury recognized by aberrant cardiac biomarkers in the setting of ischemia evidence comprising symptoms, ECG, and imaging such as echocardiography, C.T. angiography and catheterization. Myocardial ischemia carries a high risk of morbidity and mortality, prompting clinical investigation (7-9). High-sensitivity cTn assays have transformed cardiology. Troponin is a complex of three regulatory proteins (troponin C, troponin I, and troponin T) that regulate skeletal and cardiac muscle contraction (10, 11). Only one tissue-specific isoform of Tn I is described for cardiac muscle tissue (cTnI), whereas TnT has numerous. Human Tn C lacks cardiac-specific isoforms (12). Troponins I and cardiac-specific T are diagnostic and predictive indications for myocardial damage. Troponin is normally undetectable in the blood. Troponin is released when cardiac muscle cells are damaged. Troponin blood levels rise with injury (13, 14). In critically unwell patients, diagnosing myocardial infarction is difficult. Analgesic usage rarely causes ischemic chest discomfort. These patients are often endotracheal intubated, sedated, or comatose, which hinders ischemic symptom manifestation. cTn levels are only assessed in critically sick individuals with documented coronary artery disease or when MI is considered an explanation for hypotension or arrhythmia. Thus, increased cTn levels may not be recognized, and MI in the ICU may be ignored (15-17). Cardiac troponins are used to diagnose myocardial infarction (AMI), however they can also be linked to other illnesses and disorders. Multiple causes raise cardiac troponins, not just ischemia myocyte necrosis. It is crucial that we be aware of the numerous pathological or physiological circumstances that might contribute to elevated troponins to avoid differential diagnostic errors. These errors can considerably increase if physicians rely simply on laboratory data without considering clinical history and examination (18, 19). Understanding the relationship between troponin levels and mortality in this population can help clinicians make more informed decisions about patient care and management. Identifying predictors of mortality in ICU patients can aid in the development of risk stratification models and treatment guidelines. Given the high prevalence of cardiovascular disease in ICU patients, investigating troponin levels as a potential biomarker for adverse outcomes could have significant implications for patient outcomes and healthcare resource utilization. The aim of study is to look for the incidence of myocardial injury in adult intubated patients in the RCU.

Methods

This is a prospective observational study on patients with recent myocardial injury after being intubated in Intensive Care Unit. The study started from January 2022 to May 2022, in Imam AL Sadeq Teaching Hospital's ICU. The research was approved by the ethical committee of the Faculty of Medicine, University of Babylon (1022, January 12th, 2022).

All patients hospitalized in ICU were selected by census sampling. Inclusion criteria were being adult (above 18 years old) and being intubated. Exclusion criteria were high troponin I levels before admission to ICU in the same hospitalization or in last one month, history of pulmonary embolism, myocarditis, sepsis, renal failure, being transferred from cardiac care unit to ICU, postoperative ICU patients, and traumatic reasons of ICU admission.

[DOI: 10.22088/jbums.25.1.372]

Measurement of serum cardiac troponin I, along with serial ECGs, echocardiography, blood pressure assessment and other vital signs were all used together to detect myocardial injury in ICU patients. ECGs were interpreted independently for the presence of ischemic changes. ST-segment elevation, T-wave inversion, Q waves, and ST-segment depression were considered for the diagnosis of MI in accordance to troponin levels. The high sensitivity serum troponin I measurement kit is ELISA type detected with VIDUS machine.

Eligible patients were divided into two groups for comparison:

1. Elevated serum cardiac troponin I (cTn I≥30 ng/L)
2. Normal troponin I (cTn I<30 ng/L)

Our main objective was to estimate the prevalence of MI during ICU stay and determine its risk factors. ,In case of prospethive evaluation of patientsstudy exposure was defined as diagnosis of new MI based on the physician report of serial ECGs and a positive troponin I (cTn I≥30 ng/L) serum test. Primary outcome was 60-day mortality rate. To assess the primary outcome, patients who were discharged were followed by phone call by the lead researcher. No cases of follow up failure happened due to not answering the phone.

Moderator variables of age, gender, previous diseases, and reason of being admitted to ICU were recorded.

Bivariable analyses were performed by chi-square for categorical data with higher than 2 categories, or fisher exact test for binominal data. Results were expressed as n (%). We performed a logistic regression analysis to determine the association between mortality and troponin levels while controlling other potential confounding variables that had significant associations with troponin levels in bivariable analysis. Statistics were performed in SPSS version 21 and $p<0.05$ was considered as significant.

Results

Forty patients were included in this prospective study and all were followed up. The mean age of participants was 56.6±7.3 years and there were 28 male cases (70%). There were 17 (42.5%) cases with MI diagnosis during the ICU stay (Table 1). In the group of individuals over the age of 65, only 26.6% had normal troponin levels while 73.3% had elevated levels. In contrast, in the group of individuals under the age of 65, 76% had normal troponin levels while only 24% had elevated levels, showing a statistically significant relationship ($p<0.001$). There was no significant association between gender and troponin levels. The type of illness, including Ischemic CVA (20 patients, 50% of all patients), Intracranial hemorrhage (10 patients, 25%) and other causes (10 patients, 25%) showed non-significant correlation. There was a statistically significant association between hypertension and high troponin levels ($p=0.0025$). In other words, individuals with hypertension are more likely to have elevated cTr levels compared to those without hypertension. There was evidence of an association between atrial fibrillation and high troponin levels ($p=0.039$) showing higher rates of elevated troponin levels in patients with atrial fibrillation; but there were no association between Diabetes Mellitus and Left Ventricular Hypertrophywith troponin levels.

There were 3 deaths in normal troponin level group versus 7 in patients with elevated troponins. Individuals with elevated troponin levels are three times more likely to experience mortality within 60 days compared to those with normal troponin levels ($p=0.0247$).

[DOI: 10.22088/jbums.25.1.372]

Table 1. Demographic and clinical characteristics, and mortality rates

Characteristics	Normal cTr. (n=23) Number(%)	Elevated cTr (n=17) Number(%)	p-value
Age			
>65 (year)	4(17.4)	11(64.7)	<0.001
<65 (year)	19(82.6)	6(35.3)	
Gender			
Males	17(73.9)	11(64.7)	0.386
Female	6(26.1)	6(35.3)	
Admission diagnosis			
Ischemic CVA	11(47.8)	9(52.9)	
Intracerebral hemorrhage	5(21.7)	5(29.4)	0.434
Others*	7(30.4)	3(17.6)	
Pre-existing conditions			
Hypertension	8(34.8)	6(35.3)	0.0025
Diabetes Mellitus	6(26.1)	4(23.5)	0.618
Left Ventricular Hypertrophy	7(30.4)	5(29.4)	0.538
Atrial fibrillation	1(4.4)	6(35.3)	0.039
60 days mortality rate	3(13.1)	7(41.2)	0.0247

***Epilepsy and Chronic Obstructive Airway Disease, and Cancer, CVA, cerebrovascular accident.**

Our logistic regression analysis examined the association between troponin levels, age, hypertension, atrial fibrillation, and 60-day mortality in our cohort. The analysis revealed a significant positive association between troponin levels and mortality (odds ratio=5.49, 95% CI=1.15-27.15, p=0.033), controlling for age, hypertension, and atrial fibrillation. Age, hypertension and atrial fibrillation were not significant predictors of mortality (Table 2).

Table 2. Logistic regression of predictors of 60-day mortality

	p-value	Odds Ratio	95% CI lower	95% CI upper
Intercept	0.16			
Elevated cTr	0.03	5.49	1.15	27.15
Age>65 (year)	0.11	4.73	0.74	36.9
Hypertension	0.97	1.04	0.12	9.32
Atrial fibrillation	0.2	4.45	0.31	63.82

Discussion

Our study showed that rate of MI in non-cardiac ICU patients is about half of patients (42.5%) and this is so concerning. Atrial fibrillation (AF), hypertension, and old age were risk factors of in hospital MI. This was also associated with a poor prognosis in 60 days.

Similar to the work of Sarkisian et al. (13) who found that patients with myocardial injury are older and have more comorbidities than younger age groups, the results of this study show that patients with advanced age have a significant correlation with serum troponin elevation in the absence of any clinical evidence of cardiac ischemia, making them liable for the stressful effect of their intubation. Both subsets have a worse

[DOI: 10.22088/jbums.25.1.372]

prognosis compared to those whose cardiac troponin I levels are normal. Patients with type 2 myocardial infarction (non-obstructive ischemia) and myocardial injury have a very high long-term mortality (20, 21). There is a clear link between serum cTn elevation and age and the co-morbid status of a patient (cardiovascular (CV) risk factors, past CV disease, and chronic renal disease), as found by Hinton et al. in a review article (21). Similar to the evaluation by Hinton et al. based on a meta-analysis of some major studies (22-24), we found that a higher serum troponin level was substantially linked with the prognosis of patients. Increased focuses of cardiac troponins in PE provide the signs of individuals with a high risk of short-term death and adverse outcomes, as was demonstrated in our study. These findings are consistent with those of other meta-analyses. In (25, 26) using a high-sensitivity testing system, they discovered the correlation with neurosis (cortisol concentration) and elevated levels of troponin T in 508 people with no known coronary artery disease. The precise involvement of stress in the pathophysiology of cardiomyocyte damage has yet to be established, but researchers say it's crucial that it be done quickly.

Similar to our study, Wang et al. (27) focused on the incidence and outcomes of myocardial injury in critically ill patients. While our study included patients of all ages, Wang et al. specifically focused on elderly patients. The incidence of MI was higher in our study (42.5%) compared to Wang et al. (24.2%). Both studies found that elevated troponin levels were associated with increased mortality. In terms of risk factors, our study identified hypertension and atrial fibrillation as significant risk factors for elevated troponin levels, while Wang et al. identified severe hypoxemia, arrhythmia, shock, and multiple organ dysfunction syndrome as independent risk factors of T2MI.

As high-sensitivity serum troponin play important role in diagnosis or exclusion of acute myocardial infarction, it can be used to assess morbidity and expect prognosis in Intensive Care Unit patients. Our study demonstrated a substantial incidence of myocardial infarction (MI) in patients without a history of acute coronary syndrome. Notably, patients with atrial fibrillation (AF) had a significantly higher risk of MI; after adjusting for preexisting medical conditions as well as AF, ICU admission and mechanical ventilation were associated with troponin elevation. Additionally, our findings suggest that the high rate of MI in mechanically ventilated patients is independent of the presence of AF.

Conflict of interest: The authors declare no conflict of interest.

Acknowledgment

We would like to thank the participating patients who helped us in this study.

[DOI: 10.22088/jbums.25.1.372]

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[DOI: 10.22088/jbums.25.1.372]