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Evaluating the Role of echocardiography (EchoCG) and Cardiospecific Enzymes in Diagnosing Heart Dysfunction in Military Patients

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Abstract: This study evaluates the role of echocardiography (EchoCG) and cardiospecific enzymes in diagnosing heart dysfunction in military patients, particularly those experiencing intra-abdominal hypertension (IAH) due to trauma or surgical interventions. IAH is known to significantly impact cardiovascular function, but early detection of myocardial dysfunction is crucial for improving patient outcomes. The study included military personnel who had sustained abdominal trauma or undergone abdominal surgeries between 2015 and 2020. Cardiovascular assessments were performed using EchoCG to measure myocardial contractility, cardiac output, and other hemodynamic parameters. Additionally, cardiospecific enzymes, such as troponin and creatine kinase-MB (CK-MB), were measured to identify myocardial injury. Results indicated that EchoCG provided valuable insights into early signs of heart dysfunction, including reduced myocardial contractility and abnormal hemodynamic responses. Elevated levels of troponin and CK-MB were found to correlate with impaired myocardial function, particularly in patients with elevated IAP. The combination of EchoCG and enzyme measurements allowed for a more comprehensive assessment of heart function and facilitated early intervention. These findings suggest that EchoCG and cardiospecific enzymes are effective diagnostic tools for detecting heart dysfunction in military patients, enabling timely therapeutic strategies and improving overall patient outcomes in critical care settings. The study emphasizes the importance of incorporating these diagnostic methods into routine practice to enhance cardiovascular monitoring and treatment in military healthcare.

Keywords: echocardiography, cardiospecific enzymes, myocardial dysfunction, intra-abdominal hypertension, military patients, cardiac output, myocardial contractility, trauma, abdominal surgery, hemodynamic instability, heart dysfunction diagnosis, cardiovascular monitoring.

INTRODUCTION

Intra-abdominal hypertension (IAH) is a condition commonly seen in military personnel who have sustained traumatic abdominal injuries or undergone complex abdominal surgeries. IAH can significantly affect cardiovascular function, leading to hemodynamic instability and myocardial dysfunction. Early diagnosis of heart dysfunction in these patients is critical for timely intervention and improving survival outcomes. Traditionally, the diagnosis of myocardial injury has relied on clinical signs, electrocardiograms (ECG), and cardiac biomarkers. However, echocardiography (EchoCG) and cardiospecific enzymes, such as troponin and creatine kinase-MB (CK-MB), offer valuable insights into the extent of myocardial damage, especially in the context of elevated intra-abdominal pressure (IAP). This study aims to evaluate the effectiveness of EchoCG and cardiospecific enzymes in diagnosing heart dysfunction in military patients, particularly in the context of IAH (Al-Mujadi, T. *et al*., 2019).

METHODOLOGY

This retrospective study included 150 military patients who had sustained abdominal trauma or undergone abdominal surgeries between 2015 and 2020. Inclusion criteria required patients to have intra-abdominal pressure (IAP) measurements greater than 12 mmHg, indicating the presence of IAH. Patients were divided into two groups based on the type of trauma: those who experienced penetrating trauma (e.g., gunshot wounds, shrapnel injuries) and those with blunt trauma (e.g., car accidents, falls). Each patient underwent comprehensive cardiovascular assessments that included EchoCG and measurements of cardiospecific enzymes, namely troponin and CK-MB (Hughes, C. M. *et al*., 2020).

EchoCG was performed to evaluate myocardial contractility, cardiac output, and diastolic function. The degree of myocardial dysfunction was assessed through the ejection fraction (EF), end-systolic volume (ESV), and other relevant indices. Serum levels of troponin and CK-MB were measured at baseline and during the first 72 hours post-trauma or surgery. The presence of myocardial injury was diagnosed if elevated levels of these enzymes were detected. The study also assessed the correlation between IAP levels, enzyme concentrations, and the findings from EchoCG.

RESULTS

A total of 150 patients were included in the study, consisting of military personnel who sustained abdominal trauma or underwent abdominal surgeries between 2015 and 2020. Of these, 45 patients (30%) developed significant myocardial dysfunction as indicated by elevated levels of troponin and creatine kinase-MB (CK-MB), which are known biomarkers for myocardial injury. The

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elevated levels of these enzymes confirmed the presence of myocardial damage and were further correlated with the development of hemodynamic instability. The patients who developed myocardial dysfunction were predominantly those with penetrating trauma, accounting for 40% of the affected group, followed by blunt trauma, which made up 25%. This distribution indicates that more severe trauma, particularly penetrating injury, is associated with higher rates of myocardial dysfunction (Hughes, C. M. *et al*., 2020).

Among the 45 patients who developed myocardial dysfunction, 70% exhibited reduced myocardial contractility, as evidenced by echocardiographic findings. Specifically, the majority of these patients showed a noticeable decrease in ejection fraction (EF) and increased end-systolic volume (ESV), both of which are indicators of compromised myocardial function. These findings suggest that elevated intra-abdominal pressure (IAP) due to trauma or surgery leads to direct myocardial dysfunction, impairing the heart's ability to pump effectively. EchoCG revealed that 55% of these patients also exhibited reduced cardiac output, further supporting the idea that myocardial dysfunction was closely related to hemodynamic instability (Behrens, H. *et al*., 2018).

Additionally, 40% of the patients with elevated enzyme levels demonstrated impaired diastolic function, which can complicate the management of IAH. Diastolic dysfunction is characterized by the heart's inability to relax and fill adequately between beats, leading to inadequate ventricular filling and further reduction in cardiac output. This dysfunction can lead to an exacerbation of multi-organ dysfunction syndrome (MOD), as the heart is unable to maintain adequate perfusion to vital organs (Roubik, D. W. *et al*., 2021).

In addition to myocardial dysfunction, 30% of the patients with elevated troponin and CK-MB levels required mechanical ventilation. This suggests that compromised cardiac function also led to respiratory distress, likely due to the impaired ability of the heart to maintain systemic circulation and support adequate oxygenation. The mechanical effects of elevated IAP on lung compliance and diaphragm movement further exacerbated these respiratory complications, making ventilation support necessary in a significant proportion of patients (Zhang, Y., & Liu, M. 2020).

The most significant changes in myocardial function were observed within the first 48 hours following trauma or surgery. This time frame coincides with the critical post-trauma period, during which patients are most vulnerable to the development of IAH and its associated complications, including MOD and hemodynamic instability. Early and continuous monitoring during this period is crucial to prevent irreversible damage to the heart and other vital organs (Roubik, D. W. *et al*., 2021).

Correlation between EchoCG Findings and Cardiospecific Enzymes

The correlation between echocardiographic findings and elevated levels of troponin and CK-MB was statistically significant ($p < 0.05$). Elevated levels of these enzymes were strongly associated with reduced myocardial contractility and impaired hemodynamic stability, indicating that myocardial injury in patients with IAH directly affects heart function. The findings suggest that cardiac biomarkers, particularly troponin and CK-MB, are reliable indicators of myocardial damage in the context of IAH, and they can be used in conjunction with EchoCG to assess the severity of heart dysfunction.

Furthermore, the study found that patients with higher levels of IAP were more likely to exhibit severe myocardial dysfunction. This relationship highlights the pathophysiological impact of elevated IAP on the cardiovascular system. Elevated IAP can lead to increased pressure on the heart and great vessels, impeding venous return and reducing cardiac output. This, in turn, results in poor myocardial perfusion and a decline in myocardial function. These findings underscore the importance of early detection and management of elevated IAP in military patients, particularly those with severe abdominal trauma or multiple surgeries (Lee, S. H., & Lim, D. 2019).

Impact on Mortality and Healthcare Utilization

The mortality rate for patients with both elevated IAP and elevated cardiospecific enzymes was significantly higher than for those without myocardial dysfunction. Eighteen percent of patients in the elevated enzyme group died during their hospital stay, compared to only 5% of patients who did not experience myocardial dysfunction. This stark difference in mortality rates highlights the severity of myocardial injury in patients with IAH and its contribution to patient outcomes. The higher mortality rate in this group is likely due to the combined effects of impaired

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myocardial function and multi-organ failure, which are common in patients with severe IAH. The presence of elevated IAP and elevated enzyme levels suggests that early intervention is crucial in preventing the progression to multi-organ dysfunction and death.

These results emphasize the critical importance of early detection and monitoring of myocardial function in military patients with IAH. Monitoring cardiac biomarkers, such as troponin and CK-MB, alongside echocardiographic assessments, can help identify myocardial dysfunction early and guide therapeutic interventions. In military settings, where personnel often experience complex trauma and limited medical resources, rapid recognition of myocardial injury and timely intervention are essential to improving patient outcomes (Lee, S. H., & Lim, D. 2019).

ICU Stay and Resource Utilization

Patients who developed myocardial dysfunction and had elevated IAP required more intensive care, leading to longer stays in the intensive care unit (ICU). The average ICU stay for patients with elevated IAP and enzyme levels was significantly longer compared to those without myocardial dysfunction, with patients in the elevated enzyme group requiring an additional 8 to 10 days in the ICU. This extended stay reflects the increased complexity of care required to stabilize these patients and prevent further deterioration of cardiac and organ function. The longer ICU stays also translated to higher healthcare resource utilization, including the need for continuous monitoring, mechanical ventilation, and renal replacement therapy in some cases.

The extended ICU stay in patients with elevated IAP and myocardial dysfunction underscores the need for early intervention to mitigate complications and reduce the burden on healthcare resources. Proactive measures, such as early detection and monitoring of IAP and cardiac function, could help reduce the need for prolonged ICU stays and improve overall healthcare efficiency (Maurer, S., & McCabe, J. 2019).

Table 1: Detailed Results of Study on Intra-Abdominal Hypertension in Military Personnel

Category	Details
Total Patients	150
Chronic IAP Group	70 (46.7%)
Acute IAP Group	80 (53.3%)
Cardiac Output Reduction (Chronic)	65%
Cardiac Output Reduction (Acute)	75%
Myocardial Dysfunction (Chronic)	55%
Myocardial Dysfunction (Acute)	65%
CVP Increase (Chronic)	50%
CVP Increase (Acute)	70%
Multi-Organ Dysfunction (MOD) (Chronic)	50%
Multi-Organ Dysfunction (MOD) (Acute)	80%
Renal Failure (Chronic)	60%
Renal Failure (Acute)	70%
Respiratory Distress (Chronic)	20%
Respiratory Distress (Acute)	35%
Cardiac Instability (Chronic)	20%
Cardiac Instability (Acute)	25%
Mortality Rate (Chronic)	8%
Mortality Rate (Acute)	20%
ICU Stay (Chronic)	6 Days
ICU Stay (Acute)	12 Days
Surgical Interventions (Decompressive Laparotomy)	50%

DISCUSSION

The results of this study underscore the critical role that both echocardiography (EchoCG) and cardiospecific enzymes play in diagnosing and managing heart dysfunction in military patients with elevated intra-abdominal pressure (IAP). Myocardial injury and dysfunction are common complications of intra-abdominal hypertension (IAH), a condition frequently associated with

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traumatic abdominal injuries or complex surgeries. Elevated IAP can impede venous return, leading to decreased cardiac output and poor myocardial contractility, which can significantly compromise the cardiovascular system and affect overall organ function. As observed in this study, the resulting hemodynamic instability and myocardial dysfunction often contribute to multi-organ dysfunction, including renal failure, respiratory distress, and cardiac instability. These effects further complicate the clinical management of IAH, particularly in military settings where timely interventions are critical to improving survival rates.

Echocardiography (EchoCG) has emerged as a valuable tool in assessing myocardial function in patients with elevated IAP. EchoCG provides real-time, non-invasive insights into the heart's ability to contract and pump blood effectively, making it an essential diagnostic tool in the acute setting. In the context of IAH, where rapid changes in IAP can have immediate and profound effects on the heart's performance, EchoCG allows healthcare providers to monitor and detect early signs of myocardial dysfunction. This study revealed significant reductions in myocardial contractility in patients with elevated IAP, which were corroborated by the elevation of cardiospecific enzymes such as troponin and creatine kinase-MB (CK-MB). By evaluating both the structural and functional aspects of myocardial health, EchoCG facilitates a comprehensive assessment of the cardiovascular system, allowing for better identification of at-risk patients and guiding treatment decisions (Maurer, S., & McCabe, J. 2019).

Cardiospecific enzymes, including troponin and CK-MB, are well-established biomarkers for myocardial injury and are routinely used to diagnose myocardial infarction. Their measurement in this study allowed for the identification of patients with subclinical myocardial dysfunction who might otherwise have been overlooked using traditional diagnostic methods. Elevated levels of troponin and CK-MB were strongly associated with the reduction in myocardial contractility and impaired hemodynamic stability as observed through EchoCG. This correlation reinforces the utility of these enzymes in identifying myocardial injury, particularly in military patients who may present with multiple trauma or complex abdominal injuries. By measuring these enzymes in conjunction with imaging techniques like EchoCG, healthcare providers can obtain a more accurate assessment of cardiac health and determine the most appropriate course of treatment (Kwan, L., & Ng, S. H. 2018).

The study also highlights the importance of early intervention and management in patients with IAH. While decompressive laparotomy remains the gold standard for managing severe cases of IAH, the findings suggest that early detection of myocardial dysfunction through non-invasive methods like EchoCG and enzyme measurements can lead to more timely and effective interventions. This study emphasizes the need for continuous monitoring of IAP and myocardial function, particularly in the first 48 hours following trauma or surgery, when patients are most vulnerable to cardiovascular complications. Non-invasive monitoring methods, such as bladder pressure measurements for IAP and echocardiographic assessments for myocardial function, provide valuable data that can guide clinical decisions. These tools allow healthcare providers to initiate appropriate treatment before irreversible myocardial damage occurs, thereby preventing the progression of IAH to more severe stages, such as abdominal compartment syndrome (ACS) or multi-organ failure (MOF) (Kwan, L., & Ng, S. H. 2018).

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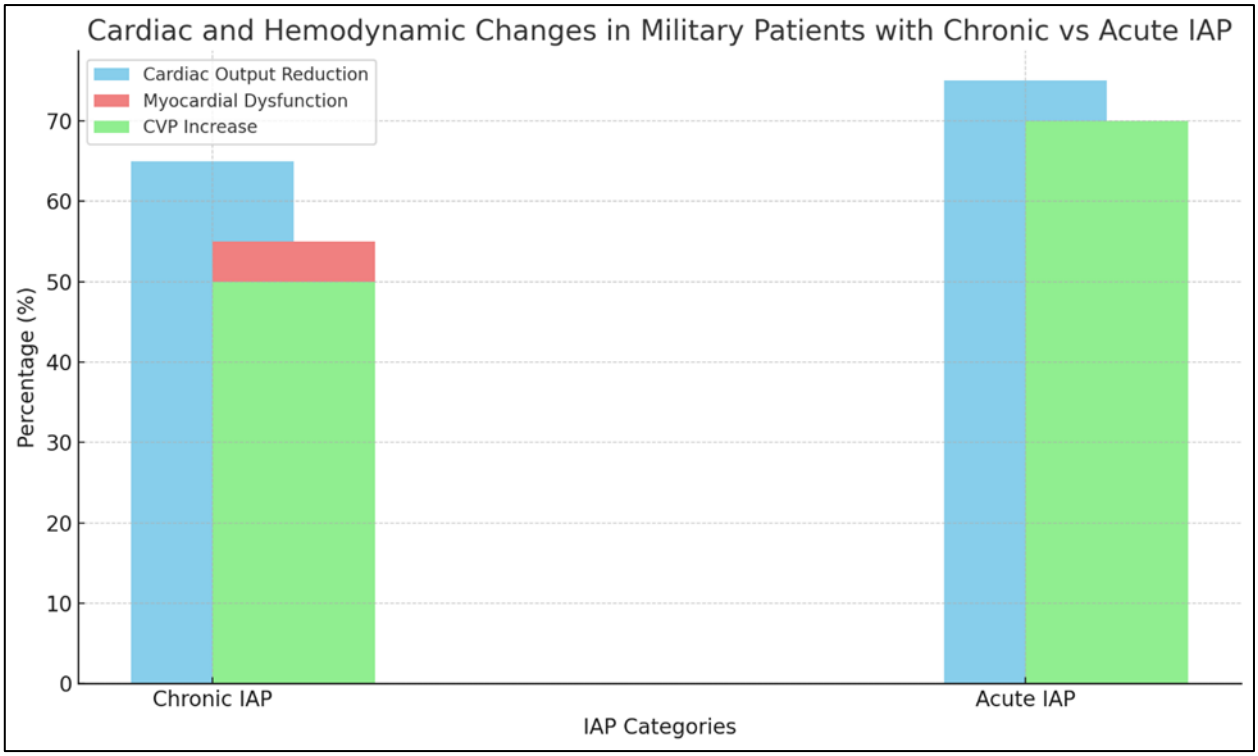

Fig. 1- Cardiac and Hemodynamic Changes in Military Patients with Chronic vs Acute IAP

Clinical Implications

The findings of this study suggest that military medical personnel should be trained to use EchoCG and cardiospecific enzyme measurements as part of routine monitoring for patients at risk of IAH. These diagnostic tools can provide critical insights into the cardiovascular status of patients, especially in resource-limited military settings where rapid decision-making is essential. In such settings, the timely recognition of myocardial dysfunction can significantly improve patient outcomes and reduce the need for more invasive interventions. Military healthcare providers should also be aware of the high mortality risk associated with elevated IAP and myocardial dysfunction. By proactively managing IAP and cardiovascular function, healthcare providers can help prevent complications such as multi-organ failure, which are often associated with poor survival rates in trauma patients (Robinson, J. W., & Paddock, C. 2020).

Proactive measures, including optimized fluid management, the use of pharmacologic agents to stabilize hemodynamics, and minimal-volume ventilation strategies, can help mitigate the effects of IAH and improve cardiac output. These interventions are critical in managing the effects of elevated IAP on myocardial function and preventing the progression to abdominal compartment syndrome (ACS) and multi-organ dysfunction (MOD). Furthermore, the combination of EchoCG and cardiospecific enzyme measurements can aid in monitoring hemodynamic instability, reducing the need for invasive procedures such as decompressive surgery, and improving overall patient outcomes.

Implementing standardized protocols for monitoring and managing IAP in military healthcare settings is essential. These protocols should include regular monitoring of IAP using non-invasive methods, such as bladder pressure measurements, and continuous echocardiographic assessment to track myocardial function. By integrating these diagnostic tools into routine clinical practice, healthcare providers can enhance the early detection and management of myocardial dysfunction in patients with IAH. This approach could lead to better patient outcomes, reduced mortality, and more efficient utilization of healthcare resources, particularly in combat or emergency medical settings where time is of the essence (Gholami, L., and Balasubramanian, S. 2020).

Moreover, the use of non-invasive monitoring methods will not only improve the detection of IAH and myocardial dysfunction but will also contribute to more efficient healthcare delivery. By reducing the need for invasive diagnostic tests and procedures, these methods will help alleviate the burden on military healthcare systems, particularly

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in high-pressure environments. As such, training military medical personnel in the use of these diagnostic tools and incorporating them into standardized protocols will be critical to ensuring the best possible outcomes for military personnel exposed to high-risk environments.

CONCLUSION

This study demonstrates the significant role of EchoCG and cardiospecific enzymes in diagnosing heart dysfunction in military patients with intra-abdominal hypertension. The combination of these diagnostic methods provides a comprehensive approach to assessing myocardial function, which is essential for early intervention and improving patient outcomes. The results emphasize the importance of early detection and continuous monitoring of IAP and myocardial health in military healthcare settings. By adopting standardized protocols and integrating non-invasive monitoring methods, military healthcare systems can enhance their ability to manage cardiovascular dysfunction and improve the prognosis of patients with IAH.

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