

Influence of Varying Degrees of Intraoperative Hemolysis on Left Ventricular Ejection Fraction After Coronary Artery Bypass Grafting

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Abstract:

Studies have been conducted on 123 patients with coronary artery disease with CABG. The assessment of the degree of IOH is made by the level of free hemoglobin (Hb). In accordance with the level of [Hb] at the end of the operation, patients with CABG surgery are divided into three groups: 1 – without IOH ($Hb \leq 0,1$ g/l), $n = 43$, 2 – with low IOH (l IOH, $Hb > 0,1$ g/l and $< 0,5$ g/l, $n=42$), 3 – with high IOH (hIOH, $Hb \geq 0,5$ g/l, $n=38$). This study demonstrates a clear association between intraoperative hemolysis (IOH) and diminished postoperative left ventricular ejection fraction (LVEF) recovery in patients with coronary artery disease undergoing coronary artery bypass grafting. While CABG generally improves LVEF, the degree of this improvement is significantly attenuated by the severity of IOH. This suggests that IOH plays a detrimental role in myocardial recovery following CABG. Our findings contribute to a deeper understanding of the pathophysiological mechanisms underlying complications arising from CABG. The negative correlation between free hemoglobin levels and postoperative LVEF indicates that the hemolytic process itself may contribute to impaired cardiac function. This warrants further investigation into the specific pathways involved, such as the inflammatory cascade and oxidative stress induced by free hemoglobin release

Key words: hemoglobin; left ventricular ejection fraction; coronary artery; myocardial; oxidative stress

Introduction

The aim was to study changes left ventricular ejection fraction in patients with coronary artery disease after coronary artery bypass surgery (CABG) with different levels of intraoperative hemolysis (IOH).

Methods. Studies have been conducted on 123 patients with coronary artery disease with CABG. The assessment of the degree of IOH is made by the level of free hemoglobin (Hb). In accordance with the level of [Hb] at the end of the operation, patients with CABG surgery are divided into three groups: 1 – without IOH ($Hb \leq 0,1$ g/l), $n = 43$, 2 – with low IOH (l IOH, $Hb > 0,1$ g/l and $< 0,5$ g/l, $n=42$), 3 – with high IOH (hIOH, $Hb \geq 0,5$ g/l, $n=38$). The study of the left ventricular ejection fraction was carried out using echocardiography before and after the postoperative period. Statistical processing was carried out using Statistica 10.0 for Windows (StatSoft, Inc., USA) using non-parametric statistics.

Results of research. Our findings demonstrate a significant impact of intraoperative hemolysis (IOH) on postoperative left ventricular ejection fraction (LVEF) in patients undergoing coronary artery bypass grafting

(CABG) for coronary artery disease. Preoperatively, all patient groups exhibited reduced LVEF [1-2]. While CABG resulted in improved LVEF across all groups postoperatively, the magnitude of this improvement varied significantly depending on the degree of IOH. Specifically, patients in the high IOH group (hIOH, $Hb \geq 0.5$ g/L) experienced a median LVEF improvement of 5.39% (interquartile range: -8.7% to 16.0%). This increase was substantially lower than the improvements observed in the no IOH group ($Hb \leq 0.1$ g/L) and the low IOH group (lIOH, $Hb > 0.1$ g/L and < 0.5 g/L), which exhibited median LVEF improvements of 22.92% (IQR: 11.86% to 33.33%) and 12.73% (IQR: 5.77% to 23.53%) respectively. These differences were statistically significant ($p < 0.001$ for both comparisons). Furthermore, a strong negative correlation ($r = -0.61$) was observed between free hemoglobin levels and postoperative LVEF, reinforcing the detrimental effect of IOH on myocardial contractility [3,4,5]. This suggests that the higher the degree of hemolysis during CABG, the less the left ventricle recovers its ejection function post-surgery. These results highlight the adverse impact of IOH on cardiac function following CABG in patients with coronary

artery disease. The observed correlation between IOH severity and LVEF recovery underscores the importance of minimizing hemolysis during surgery [6,7]. This understanding contributes to a more nuanced understanding of the mechanisms underlying CABG complications and informs strategies for both pre- and postoperative management to improve patient outcomes. Further research is warranted to investigate the specific mechanisms by which IOH impairs LVEF recovery and to develop targeted interventions to mitigate these effects [7].

Conclusion

- **Mechanism of IOH's effect:** The strong negative correlation between free hemoglobin levels and postoperative LVEF suggests that the hemolytic process itself contributes to impaired myocardial recovery. Further research is needed to elucidate the specific mechanisms involved, such as inflammation and oxidative stress.
- **IOH negatively impacts LVEF recovery:** This study confirms that increased intraoperative hemolysis (IOH) is associated with reduced improvement in left ventricular ejection fraction (LVEF) after coronary artery bypass grafting (CABG) in patients with coronary artery disease.
- **Clinical implications-minimizing IOH:** Minimizing IOH during CABG is crucial for optimizing postoperative cardiac function. This can be achieved through refined surgical techniques, optimized cardiopulmonary bypass management, and potential pharmacological interventions.
- **Furthermore, preoperative risk stratification** based on factors associated with increased IOH risk could help identify patients who may benefit from more intensive perioperative monitoring and management.

Similarly, postoperative monitoring of LVEF and other markers of cardiac function is crucial, particularly in patients with evidence of significant IOH. Early identification of impaired LVEF recovery can facilitate timely interventions to prevent further deterioration and improve long-term prognosis. Future research should focus on developing and evaluating strategies to minimize IOH and its impact on cardiac function following CABG.

Abbreviations:

CABG: coronary artery bypass grafting

IOH: intraoperative hemolysis

LVEF: left ventricular ejection fraction

Hb: free hemoglobin

Conflict of Interest: The authors declare that there are no conflicts of interest

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