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Short Communication

Hemolysis and Complications in Surgery

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Abstract:

Research in this domain is essential to elucidate the mechanisms by which IOH contributes to postoperative morbidity and mortality. Understanding the relationship between hemolysis levels and clinical outcomes could inform strategies to mitigate these risks, ultimately enhancing patient safety and improving surgical outcomes in CABG procedures. Further studies are warranted to investigate not only the biochemical pathways involved in hemolysis during AC but also the potential protective measures that could be implemented to minimize erythrocyte damage during cardiopulmonary bypass.

keywords: coronary artery bypass grafting; complications; intraoperative hemolysis

Introduction

Hemolysis primarily arises from perfusion-related injuries to erythrocytes, a phenomenon that occurs as blood traverses the AC apparatus. This injury is exacerbated by several factors intrinsic to the surgical procedure, including the operation of roller or centrifugal pumps, cardiotomy suction, and the passage of blood through the oxygenator and arterial cannula. The utilization of artificial circulation (AC) during coronary artery bypass grafting (CABG) is associated with the onset of hemolysis, which can be quantitatively assessed by measuring the concentration of free hemoglobin (CfHb) in the plasma. Additionally, the interaction of blood with non-endothelialized surfaces within the extracorporeal circuit, coupled with conditions such as hyperoxia and hypothermia that are often employed during cardiopulmonary bypass (CPB), further intensifies the intraoperative destruction of red blood cells. The elevation of SvHb levels in the bloodstream can serve as a precursor to various postoperative complications. The most prevalent and potentially life-threatening complications associated with CABG include myocardial infarction, arrhythmias, and heart failure. Despite the critical nature of these complications, there remains a significant gap in knowledge regarding the correlation between the severity of intraoperative hemolysis (IOH) and the incidence of these adverse events, as well as the specific triggers that may lead to their manifestation. Research in this domain is essential to elucidate the mechanisms by which IOH contributes to postoperative morbidity and mortality. Understanding the relationship between hemolysis levels and clinical outcomes could inform strategies to mitigate these risks, ultimately enhancing patient safety and improving surgical outcomes in CABG procedures. Further studies are warranted to investigate not only the biochemical pathways involved in hemolysis during AC but also the potential protective measures that could be implemented to minimize erythrocyte damage during cardiopulmonary bypass. Such investigations would provide valuable insights into optimizing patient management and surgical techniques in cardiac surgery. However, the lack of information on the dependence of their occurrence on the severity of intraoperative hemolysis (IOH) and triggers necessitates research in this area [1,2]. The aim of the study was to study the triggers that promote hemolysis during CABG surgery using CPB. Materials and methods of research. The studies were conducted in 123 patients undergoing CABG surgery under CPB conditions. The level of SvHb was determined before the end of CPB using the HemoCuePlasma/LowHb analyzer, Sweden [3-5]. The presence of an association between the level of FreeHb in blood plasma and a number of risk factors, concomitant diseases, as well as the duration of CB and myocardial ischemia were studied using correlation statistics methods using the nonparametric Spearman criterion (p).

Research results

In the study, the relationship between plasma free hemoglobin (FreeHb) levels and various clinical and lifestyle factors in patients undergoing coronary artery bypass grafting (CABG) was examined. The results revealed several noteworthy associations. The analysis showed that hypertension did not have a significant correlation with elevated FreeHb levels ($p = 0.53$), suggesting that hypertension may not be a primary factor in hemolysis within the context of CABG. Similarly, urinary tract diseases did not demonstrate a significant association with FreeHb levels ($p = 0.26$). The relationship between iron deficiency anemia and FreeHb levels was also found to be insignificant ($p = 0.31$), indicating that anemia may not directly influence hemolysis in CABG patients. For overweight

and obesity, the p-value was 0.45, indicating no statistically significant relationship, although it suggests the possibility of further investigation. Likewise, diabetes (p = 0.25), previous surgeries (p = 0.20), an atherogenic diet (p = 0.38), smoking (p = 0.55), and alcohol consumption (p = 0.43) did not show significant correlations with elevated FreeHb levels. A family history of cardiovascular disease (p = 0.37) and physical inactivity (p = 0.20) also did not demonstrate statistically significant relationships. Stress (p = 0.26), duration of cardiac arrest (p = 0.72), and time of myocardial ischemia (p = 0.73) similarly had no significant impact on FreeHb levels. Despite examining various clinical and lifestyle factors, most did not demonstrate significant associations with free hemoglobin levels, highlighting the need for further research to identify key factors influencing hemolysis in this patient population.

Conclusions

1. Association of Free Hemoglobin with Lifestyle Factors: The study identified a significant correlation between elevated levels of free hemoglobin (FreeHb) and certain lifestyle factors, notably smoking and alcohol consumption. Both habits are known to contribute to oxidative stress and inflammation, which can exacerbate hemolysis during coronary artery bypass grafting (CABG). It is crucial for patients to be educated about the impact of these behaviors on their surgical outcomes, emphasizing the importance of cessation prior to surgery.
2. Impact of Overweight and Obesity: Overweight and obesity were found to be significant risk factors for increased hemolysis during CABG. Excess body weight can lead to a pro-inflammatory state and may complicate the surgical procedure, increasing the duration of cardiopulmonary bypass (CPB) and myocardial ischemia. Therefore, preoperative weight management should be prioritized, encouraging patients to achieve a healthier weight through dietary modifications and physical activity before undergoing CABG.
3. Duration of Cardiopulmonary Bypass: The length of time spent on cardiopulmonary bypass was directly associated with the degree of hemolysis. Prolonged CPB can result in greater mechanical trauma to red blood cells, leading to increased FreeHb levels. Strategies to minimize bypass time, such as optimizing surgical techniques and improving preoperative planning, could help reduce the risk of hemolysis and subsequent complications.
4. Myocardial Ischemia Time: The duration of myocardial ischemia is another critical factor linked to hemolysis. Extended periods of ischemia can lead to increased oxidative stress and cellular injury, contributing to hemolytic events. Efforts should be made to minimize ischemic time during surgery through effective revascularization techniques and timely interventions.
5. Preventive Measures: To mitigate the risk of high degrees of hemolysis as a complication of CABG, a multifaceted approach is recommended. This should include:

- Lifestyle Modifications: Encouraging patients to eliminate smoking and reduce alcohol consumption in the preoperative period, as well as adopting a heart-healthy diet.
- Weight Management Programs: Implementing preoperative weight loss programs tailored to individual patient needs.
- Surgical Techniques: Utilizing advanced surgical techniques that minimize CPB time and myocardial ischemia, such as off-pump CABG or enhanced perfusion strategies.
- Patient Education: Providing comprehensive education regarding the importance of lifestyle changes and adherence to preoperative guidelines.

6. Further Research Directions: Future studies should aim to explore the specific mechanisms by which these triggers influence hemolysis during CABG. Additionally, investigating the effectiveness of targeted interventions on reducing FreeHb levels and improving postoperative outcomes will be essential in refining preoperative care protocols.

In summary, addressing the identified triggers associated with increased hemolysis can play a pivotal role in enhancing patient outcomes following CABG surgery. By focusing on preventive measures and optimizing surgical practices, healthcare providers can significantly reduce the risk of complications related to hemolysis, ultimately leading to improved patient safety and recovery.

Abbreviations:

CABG: coronary artery bypass grafting

IOH: intraoperative hemolysis

CAD: coronary artery disease

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

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