

XIX. Abstract

The Impact of Flow Intensity Type Generated During Extracorporeal Circulation on Selected Clinical and Biochemical Parameters in Patients Undergoing Cardiac Surgery

Introduction

Extracorporeal circulation (cardiopulmonary bypass - CPB) is a widely used method for temporarily replacing the function of the heart and lungs during cardiac surgery. CPB is essential for performing heart surgeries but is associated with negative phenomena such as a generalized inflammatory response and multiorgan dysfunction, particularly damage to blood cellular components. A specific characteristic of the extracorporeal circulation system is the large surface area of contact between the patient's blood and foreign surfaces (oxygenator capillaries, drain systems, filters, cannulas, and connectors) lacking endothelium, which triggers a series of unfavorable biochemical and hematological reactions. Another non-physiological feature of the CPB system is the commonly used non-pulsatile linear flow of blood. Adverse events related to CPB intensify with its duration. While there are studies evaluating the overall impact of CPB on organ damage, there is a lack of research comparing the effects of different CPB methods. The increasing number of patients undergoing complex valve, coronary-valve, and aortic aneurysm surgeries with potentially prolonged aortic clamping and total extracorporeal circulation time creates a need to determine the most optimal way to conduct CPB.

Objective

The aim of this study is to assess the influence of different types of flow generated by various pumps used in extracorporeal circulation on selected clinical and biochemical parameters in patients undergoing cardiac surgery.

Materials and Methods

The study included 47 patients (9 females, 38 males) scheduled for complex cardiac surgeries (multi-valve, valve-coronary, or aortic aneurysm surgeries) requiring prolonged extracorporeal circulation time and aortic clamping time (expected clamping time over 100 minutes). The patients were randomly assigned to three groups with different extracorporeal circulation protocols:

Group 1 - non-pulsatile flow with roller pump (n=15 patients)

Group 2 - pulsatile flow with roller pump (n=15 patients)

Group 3 - non-pulsatile flow with centrifugal pump (n=17 patients)

The following parameters were evaluated:

a) Clinical parameters: total CPB time, aortic clamping time, ventilation time, postoperative ward stay time, hourly blood loss into drains, blood and blood product transfusion, diuresis during extracorporeal circulation, potential complications such as renal dysfunction (renal replacement therapy), neurological complications, circulatory failure (intra-aortic counterpulsation)

b) Biochemical parameters: hemolysis (LDH, free hemoglobin, haptoglobin, peripheral blood morphology with reticulocytes, free hemoglobin level in urine), assessment of inflammatory process (CRP, fibrinogen, haptoglobin in blood), renal function parameters (serum creatinine concentration, blood urea nitrogen), liver function assessment (unconjugated bilirubin, ALT, AST). Venous blood samples for analysis were collected: after anesthesia induction and before heparin administration, after the completion of extracorporeal circulation following protamine sulfate administration and hemodynamic stabilization, and on the first, second, third, and seventh day post-operation. Urine samples were collected before the initiation of ECC, after ECC completion with the volume obtained during circulation, and after ECC with the volume obtained from ECC completion until the patient's departure from the operating room.

Results

The mean aortic clamping time was similar in all groups. In Group 1, it was 119.53 (± 35.12) minutes, in Group 2: 112.27 (± 34.34) minutes, and in Group 3: 113.53 (± 22.6) minutes. A significant increase in CRP levels was observed in the three consecutive days after surgery, followed by a gradual decrease in values on the seventh day. Pronounced reticulocytosis was also observed on the seventh day after the procedure in all three groups. No differences were found between the groups regarding free hemoglobin content in urine, indirect and total bilirubin levels in serum, platelet count, and mean platelet volume.

Conclusions

1. Extracorporeal circulation significantly affects the body's homeostasis, causing destruction of blood cellular components, activating inflammatory processes, and increasing parameters associated with renal and liver damage.
2. Based on the conducted research, no superiority of any circulation type was demonstrated regarding the evaluated clinical and biochemical parameters.

Keywords: extracorporeal circulation, pulsatile flow, non-pulsatile flow, roller pump, centrifugal pump, hemolysis, inflammatory parameters, renal and liver damage

