Abstract

In bad shape? effects of negative pressure on platelets in the context of cardiopulmonary bypass

Fannar Theódórs 25 September 2026

Background
Blood components are exposed to a harsh artificial environment during extra corporeal circulation in a cardiopulmonary bypass (CPB) operation which is unlike anything seen in normal physiology.
Components of the circuit add to overall shear stress experienced by the blood through turbulent flow and pressure. Shear stress is a key factor of cellular damage during extra corporeal circulation. Vacuum assisted venous drainage (VAVD), where negative pressure on the venous side is increased with the help of a vacuum pump, is commonly used in the clinic. Today the safe operational limits of VAVD are informed by studies on hemolysis or gross patient outcomes. We employed an ex-vivo extra corporeal circulation model to study potential negative effects of increased negative pressure on platelet biology to exclude confounding factors.

Methods
Blood from 10 healthy volunteers was exposed to progressively increased negative pressure, and its effects on platelet aggregation function, activation, and morphology was measured. Impedance aggregometry was used to measure aggregation after stimulation through three different pathways. Flow cytometry was used to measure activation by p-selectin expression, activation after stimulation, and change in morphology.

Results
Aggregation after stimulation through the ADP receptor was decreased when -60 and -120 mmHg negative pressure was applied. Passive p-selectin activation was significantly increased with -120 mmHg pressure. P-selectin expression per platelet after stimulation was decreased with -60 mmHg pressure. Flow cytometric measurements of cell morphology showed significant change with -60 and -120 mmHg pressure.

Conclusion
Results of this study show that high venous side pressure negatively affects platelets in a downscaled extracorporeal circuit. Findings may contribute to the mechanistic understanding of negative pressure associated shear stress and its consequences for platelets in the context of CPB and other extra corporeal circulation treatments more broadly.