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ENDOTHELIAL GLYCOCALYX PROTECTION IN MODERN ANESTHESIOLOGY: FROM BASIC SCIENCE TO CLINICAL PRACTICE

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Background: The endothelial glycocalyx (EG) is a dynamic layer covering the luminal surface of vascular endothelial cells and plays a central role in vascular permeability, mechanotransduction, inflammation, coagulation, and microcirculatory homeostasis. Contemporary understanding of the EG has contributed to a revised interpretation of the classical Starling principle and has highlighted its importance in perioperative fluid distribution and endothelial barrier function.
Objective: To summarize the current understanding of endothelial glycocalyx biology and injury and to examine its implications for perioperative anesthetic management and potential protective strategies.
Methods: A focused narrative synthesis was performed based on three reviews addressing the basic science and clinical implications of the endothelial glycocalyx, the effects of anesthetic drugs and techniques, and the emerging role of glycocalyx preservation in perioperative medicine. Particular attention was given to mechanisms of glycocalyx degradation, fluid management, ischemia–reperfusion injury, inflammation, metabolic stress, and anesthetic-related effects.
Results: Perioperative glycocalyx injury is a multifactorial process associated with surgical trauma, inflammation, ischemia–reperfusion, hyperglycemia, oxidative stress, and mechanical or hemodynamic disturbances. Glycocalyx degradation may increase endothelial permeability, promote interstitial fluid accumulation, impair microcirculatory function, and contribute to postoperative organ dysfunction. From an anesthesiological perspective, preservation of adequate intravascular volume while avoiding both hypovolemia and unnecessary hypervolemia represents an important physiological principle. The available literature also suggests that anesthetic drugs and techniques may influence glycocalyx integrity; however, clinical evidence remains heterogeneous and insufficient to establish a specific anesthetic technique as universally glycocalyx-protective. Potential therapeutic approaches, including albumin, fresh frozen plasma,

sphingosine-1-phosphate–related pathways, and pharmacological modulation of endothelial injury, remain areas of active investigation.

Conclusion: Endothelial glycocalyx preservation represents an emerging concept linking vascular biology with modern perioperative anesthesiology. Current evidence supports a multifactorial approach focused on maintaining normovolemia, adequate tissue perfusion, minimizing inflammatory and ischemia–reperfusion insults, and avoiding unnecessary fluid administration. Further prospective clinical studies are required to determine whether glycocalyx-targeted interventions can improve patient outcomes and to establish clinically applicable strategies for endothelial protection.

Key words: endothelial glycocalyx; perioperative medicine; anesthesia; fluid management; endothelial protection