16.5C: Platelet Plug Formation

At the site of vessel injury, platelets stick together to create a plug, which is the beginning of blood clot formation.

LEARNING OBJECTIVES

Describe the formation of a platelet plug

KEY TAKEAWAYS

Key Points

- Platelets adhere to the damaged endothelium to form a platelet plug, temporarily sealing the break in the vessel wall.
- Activated platelets release factors to stimulate further platelet activation, perpetuating plug formation in a positive feedback loop, while other factors stimulate the coagulation cascade and maintain vasoconstriction.
- Platelets adhere to the collagen fibers in the vessel wall by becoming adhesive and filamentous due to the stimulus of von Willebrand factor.
- During platelet aggregation, platelets bind to von Willebrand factor and fibrinogen to stick together and seal the break in the endothelium.
Key Terms

- **von Willebrand Factor**: The factor responsible for causing platelet adherence and aggregation. It is increased by positive feedback during platelet activation.
- **collagen**: A glycoprotein that forms elongated fibers, usually found in the extracellular matrix of connective tissue such as the matrix beneath the vascular endothelium.

The second critical step in hemostasis, which follows vasoconstriction, is platelet plug formation. The three steps to platelet plug formation are platelet adherence, activation, and aggregation.

Platelet Adherence

**Platelets**: A blood slide of platelets aggregating or clumping together. The platelets are small, bright purple fragments.

Normally, the endothelial cells express molecules that inhibit platelet adherence and activation while platelets circulate through the blood vessels. These molecules include nitric oxide, prostacylcine (PGL2) and endothelial ADP-ase.

During an injury, subendothelial collagen from the extracellular matrix beneath the endothelial cells is exposed on the epithelium as the normal epithelial cells are damaged and removed, which releases von Willebrand Factor (VWF). VWF causes the platelets to change form with adhesive filaments (extensions) that adhere to the subendothelial collagen on the endothelial wall.

Platelet Activation

After platelet adherence occurs, the subendothelial collagen binds to receptors on the platelet, which activates it. During platelet activation, the platelet releases a number of important cytokines and chemical mediators via degranulation. The released chemicals include ADP, VWF, thromboxane A2, platelet-derived growth factor (PDGF), vascular endothelial growth factor (VEGF), serotonin, and coagulation factors. The extra ADP and VWF is especially important because it causes nearby platelets to adhere and activate, as well as release more ADP, VWF, and other chemicals. Platelet plug
formation is considered a positive feedback process because ADP and VWF levels are successively increased as more and more platelets activate to form the plug.

ADP: The chemical structure of ADP, a molecule that causes platelet activation and is involved in the positive feedback component of platelet activation.

The other factors released during platelet activation perform other important functions. Thromboxane is an arachidonic acid derivative (similar to prostaglandins) that activates other platelets and maintains vasoconstriction. Serotonin is a short-lived inflammatory mediator with a vasoconstrictive effect that contributes to vascular changes associated with inflammation during an injury. PDGF and VEGF are involved in angiogenesis, the growth of new blood vessels and cell cycle proliferation (division) following injury. The coagulation factors include factor V and VIII, which are involved in the coagulation cascade that converts fibrinogen into fibrin mesh after platelet plug formation.

Platelet Aggregation

The final step of platelet plug formation is aggregation of the platelets into a barrier-like plug. Receptors on the platelet bind to VWF and fibrinogen molecules, which hold the platelets together. Platelets may also bind to subendothelial VWF to anchor them to the damaged endothelium. The completed plug will cover the damaged components of the endothelium and will stop blood from flowing out of it, but if the wound is large enough, blood will not coagulate until the fibrin mesh from the coagulation cascade is produced, which strengthens the platelet plug. If the wound is minor, the platelet plug may be enough to stop the bleeding without the coagulation cascade.