Histopathology

Lecture 6

Haemodynamic Disorders

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Haemodynamic

OVERVIEW: In general terms, the topic of hemodynamics deals with flow and distribution of blood and fluids within the body. To maintain the correct amount of intravascular and extravascular volumes, the body must maintain both **hydrostatic pressure** and **osmotic pressure**. An imbalance in either of these two pressures results in an abnormal distribution of fluid in the cells or interstitial tissues (Figure 1). The term used to describe excessive amounts of fluid within the interstitial tissues or within cells is **edema**.

The process of **coagulation** serves to maintain the integrity of the vasculature in the event of disruption of the vascular wall. Inappropriate coagulation can have deleterious consequences, however. For example, abnormal coagulation can result in vessel occlusion; thus the process must be closely controlled. An adequate supply of blood to the tissues is vital because it provides oxygen and nutrients to the cells and removes toxic metabolites from the cells. An inadequate amount of blood flow to an organ is termed **ischemia**.

*In vessels, **hydrostatic pressure** refers to the pressure pushing fluid out into the interstitial tissue. In interstitial tissue, hydrostatic pressure pushes fluid into the vessels. **Osmotic pressure**, which is imparted by the presence of dissolved solutes, pulls fluid into the vessels and into the interstitial tissue.*

*. **Ischemia** is an important cause of cellular dysfunction and, if severe, often leads to cell death.*

Shock can result from a decreased amount of blood (i.e., hypovolemic shock), failure of the heart to effectively pump the blood (i.e., cardiogenic shock), or generalized dilation of the vasculature system secondary to infection (i.e., septic shock).

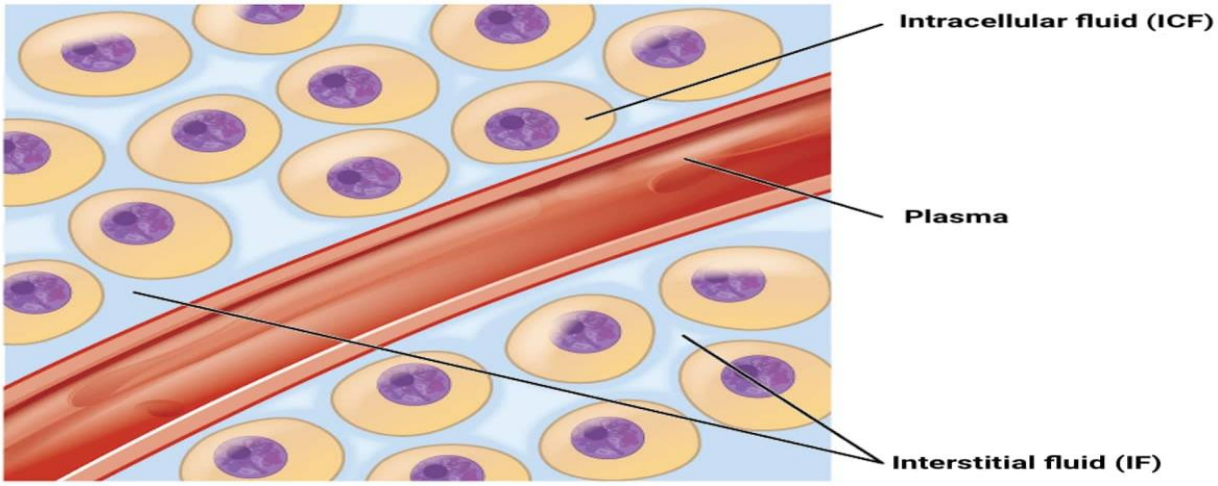


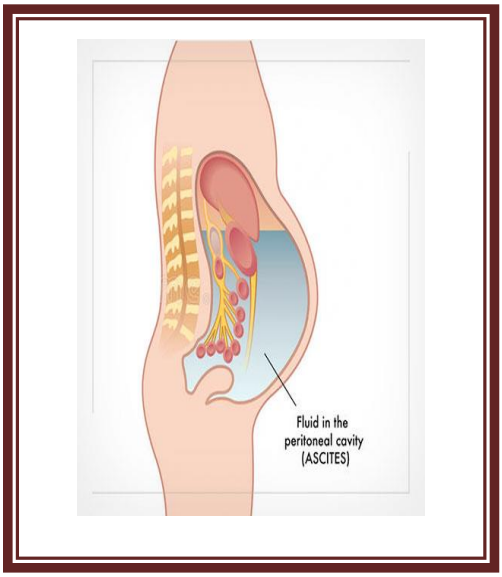
Figure 1. *interstitial tissues.*

EDEMA

Basic description: Accumulation of fluid within the cells, interstitial tissue, and body cavities.

Mechanisms of edema formation: Include increased vascular hydrostatic pressure, decreased plasma osmotic pressure, lymphatic obstruction, and inflammation. Increased vascular hydrostatic pressure is usually due to impaired venous return or arteriolar dilation.

Causes of increased vascular hydrostatic pressure:



■ **Heart failure**: The heart is not pumping blood as effectively as it should, so there is a back up of blood into the veins.

■ **Cirrhosis**: Fibrous scarring of the liver that impairs return of blood through the portal vein, thereby increasing venous pressure in portal vein tributaries and causing fluid to leak into the peritoneal cavity.

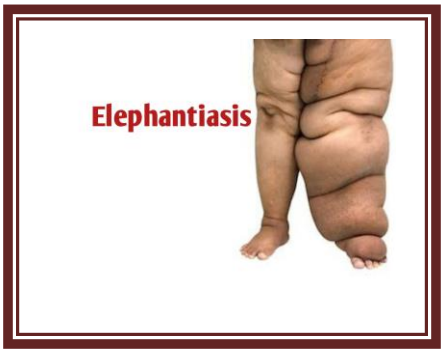
. ■ **Venous obstruction**: For example, a tumor pushing on a vein will cause back up of blood, eventually with leakage of fluid into the interstitium.

Causes of decreased plasma osmotic pressure:

■ Decreased production of albumin by the liver: A decreased level of albumin results in edema through decreased plasma osmotic pressure.

■ **Increased loss of protein by the kidney** (e.g., certain glomerular diseases) or **in the gut** (e.g., protein-losing gastroenteropathy).

■ **Malnutrition**



Causes of lymphatic obstruction:

Lymphoma compressing the thoracic duct or lymphatic channels; certain parasitic infestations, such as **elephantiasis**.

Causes of Inflammation:

An important component of acute inflammation is increased vascular permeability, which causes edema.

Effects of edema depend upon organ involved

■ In soft tissues of the extremities: Edema usually produces no clinically significant damage. Over time, edema can cause changes in skin, but these are usually only cosmetic.

■ In the lungs: Edema fluid fills the alveoli and pleural cavities, impairing the ability of the lung to oxygenate the red blood cells (Figure 2 A and B).

■ In the brain: The brain is in a rigid compartment; edema causes the brain to swell, producing increased intracranial pressure (Figure 3). When the brain swells, there are only a few places into which it can expand. These expansions of the brain through available spaces are called herniations.

Important concepts and terms

■ **Transudate**: Protein and cell-poor fluid .Cardiac failure or decreased protein levels cause a transudate.

■ **Exudate**: Protein and cell-rich fluid. Inflammation causes an exudate.

■ **Dependent edema**: Occurs in the extremities and areas of the body where accumulation of fluid is dependent upon gravity. Dependent edema is most commonly associated with heart failure.

■ **Pitting edema**: When the skin and underlying soft tissues of a leg with edema are compressed with fingers, the impressions remain. This type of edema is most commonly associated with heart failure and is usually a transudate (Figure 4 A and B).

■ **Anasarca**: Generalized edema of the entire body that is most commonly associated with glomerular protein loss by the kidneys.

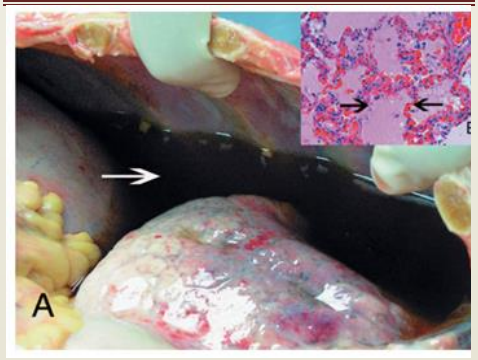


Figure 2. Pleural effusion with pulmonary edema. A, Accumulation of fluid in the pleural cavities. B, Microscopic section from a patient with pulmonary edema. The edema fluid (arrows) stains light pink.

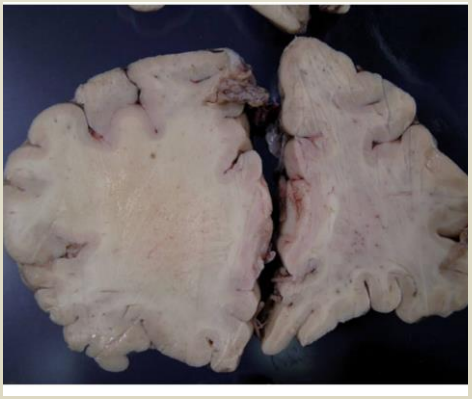


Figure 3. Cerebral edema. This patient had a neoplasm on the left side of the brain. The edema of the brain was confined to the left cerebral hemisphere (the site of the tumor).

SHOCK

Basic description: Generalized hypoperfusion of the body (i.e., not enough blood is being circulated to supply the organs with the oxygen they require). The three main types of shock are cardiogenic, hypovolemic, and septic.

CARDIOGENIC SHOCK

Basic description: Failure of the heart as a pump.

HYPOVOLEMIC SHOCK

Basic description: Lack of enough blood (due to loss) to properly perfuse the body—most commonly due to trauma.

SEPTIC SHOCK

Basic description: Generalized vascular dilation caused by an infectious organism, usually due to lipopolysaccharides (LPS) in the cell wall of gram-negative bacterial organisms such as *Escherichia coli* , *Pseudomonas*, and *Klebsiella*. Blood pools in the venous system and peripheral vasculature and not enough returns to the heart to be pumped out.

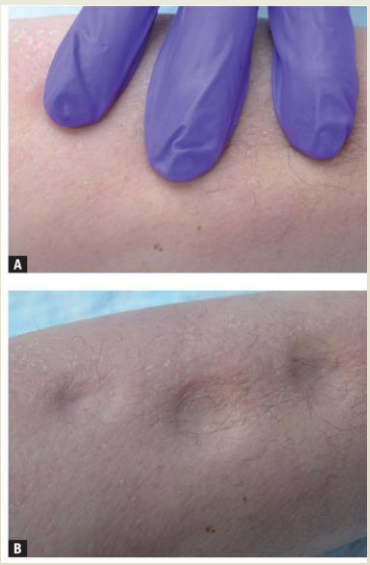


Figure 4. Pitting edema. Compression of the tissue with fingertips (A) leads to temporary impressions (B). This form of edema is com monly associated with left-sided congestive heart failure and occurs most often in the lower extremities.