Anastomoses, Collateral Circulation and End Arteries

1. Anastomosis

Definition

An **anastomosis** is a communication between two or more blood vessels, allowing blood to pass from one vascular channel to another.

It may occur between:

- **Arteries → arterial anastomosis**
- **Veins → venous anastomosis**
- **Arteries and veins → arteriovenous anastomosis**

Types of arterial anastomoses

A. Non-patent or insignificant anastomosis

- Communication exists anatomically but is normally too small to provide adequate blood supply if the main artery is suddenly blocked.

B. Potential or functional anastomosis

- Small channels are normally present but can enlarge following gradual arterial obstruction.
- They become important **collateral vessels**.

C. Free or adequate anastomosis

- Anastomotic channels are sufficiently large to maintain blood supply after occlusion of one arterial route.

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2. Collateral circulation

Definition

Collateral circulation is the alternative blood supply to a tissue provided through pre-existing or subsequently enlarged anastomotic vessels when the main arterial pathway is narrowed or obstructed.

Mechanism

Main artery

↓ obstruction

Pre-existing anastomoses enlarge

↓

Collateral vessels carry blood

↓

Tissue remains perfused

The enlargement is promoted by increased blood flow and **shear stress**, with vascular remodeling and enlargement of smooth-muscle/arterial channels.

Important point

Slow obstruction is much more likely to allow effective collateral circulation than **sudden occlusion**, because time is available for collateral vessels to enlarge.

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3. Important sites of arterial anastomoses

Site	Important anastomosis	Significance
Brain	Circle of Willis	Provides potential collateral supply between major cerebral arterial territories
Scalp	Branches of external and internal carotid arteries	Rich collateral supply; wounds may bleed heavily
Around shoulder	Subclavian and axillary artery branches	Collateral pathway around shoulder
Elbow	Superior/inferior ulnar collateral with recurrent arteries	Maintains blood flow around elbow

Wrist/hand	Radial and ulnar arteries → superficial and deep palmar arches	Important collateral supply to hand
Hip	Superior/inferior gluteal, circumflex and perforating branches	Collateral pathways around hip
Knee	Genicular and descending/recurrent branches	Rich periarticular anastomosis
Ankle	Anterior/posterior tibial and fibular branches	Collateral circulation around ankle
Foot	Dorsalis pedis and plantar arterial networks	Collateral supply to foot
Anterior abdominal wall	Superior and inferior epigastric arteries	Important collateral route between subclavian and external iliac systems
Rectum	Superior, middle and inferior rectal arteries	Anastomoses between portal and systemic venous systems are clinically important

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4. Clinical significance of collateral circulation

A. Protection against arterial obstruction

Gradual narrowing of a major artery can be compensated for by enlargement of collateral vessels.

Example:

Gradual femoral/popliteal obstruction → collateral channels enlarge → limb may remain viable.

B. Important in arterial surgery

Surgeons assess collateral circulation before ligating or interrupting an artery.

C. Important in coronary circulation

Coronary arteries have relatively limited effective intercoronary collateral circulation under normal conditions. However, **chronic coronary artery disease can stimulate development of collateral vessels**.

D. Around joints

When a joint is flexed, an artery may be compressed or kinked. **Periarticular anastomoses** help maintain blood flow.

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5. End arteries

Definition

An **end artery** is an artery whose terminal branches have **no significant arterial anastomosis capable of maintaining adequate blood supply** to the territory supplied by that artery.

Therefore:

Occlusion → ischemia → possible infarction/necrosis

Types

1. Anatomical (true) end artery

There is **no anastomosis** with another artery.

Examples:

- Central artery of retina
- Segmental arteries of kidney
- Central branches supplying some CNS territories

2. Functional end artery

Small anastomoses may exist anatomically, but they are **insufficient to maintain tissue viability after sudden occlusion**.

Examples often cited:

- Coronary arteries
- Arteries supplying some areas of the brain

The distinction is clinically useful but not absolute; vascular territories and collateral capacity can vary.

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6. Significance of end arteries

Sudden occlusion

End artery blocked

↓

No adequate collateral flow

↓

Ischemia

↓

Infarction

↓

Necrosis and loss of function

Clinical examples

Central retinal artery occlusion → sudden interruption of retinal blood supply
→ severe visual loss/blindness.

Coronary artery occlusion → myocardial ischemia
→ myocardial infarction if prolonged.

Renal segmental artery occlusion → infarction of the corresponding renal segment.

Anastomosis vs collateral circulation vs end artery

Concept	Meaning	Effect of arterial obstruction
Anastomosis	Communication between vessels	May provide an alternative route
Collateral circulation	Effective alternative blood supply through anastomoses	May preserve tissue viability

End artery	Artery with no adequate collateral arterial supply	Occlusion causes ischemia/infarction

One-line examination summary

Anastomoses are vascular communications; collateral circulation is the functional alternative blood supply provided through such communications, particularly after gradual arterial obstruction; an end artery has no adequate collateral supply, so its occlusion produces ischemia and often infarction of its territory.