

Arteriovenous fistula

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Arteriovenous fistula is an **anomalous connection between the arterial and the venous system**.

Pathogenesis

Arteriovenous fistula causes a certain amount of blood to bypass the capillary network and "short circuit" arterial blood to the veins (venous return). This leads to **a decrease in peripheral resistance** in the involved arterial bed, an overflow of the venous network and **a decrease in blood supply** provided by an artery peripheral to the fistula. In the acute setting, the formation of a large A-V fistula may cause shock or death as a result of fatal haemorrhage into the venous network, for example in case of rare abdominal aortic aneurysm rupture into the inferior vena cava.

In most cases, in order to compensate for this condition, there is **an increase in cardiac output**, **vasoconstriction** in areas beyond the fistula and an **increase in circulating blood volume**. This results in **dilation** or even in **formation of aneurysm on** the inflow **artery** central to the fistula (large difference between systolic and diastolic blood pressure) as well as **dilation** of the involved **venous network**. Such compensation may last for several months or years and short shunting of normal blood flow gradually increases.

Symptomatology

General symptoms are related to the above-described pathogenetic mechanism.

Local symptoms:

- dilation of outflow veins and peripheral venous congestion with swelling, alternatively accompanied with trophic changes;
- dilation of the inflow artery;
- impalpable pulse peripheral to the fistula;
- insufficient blood supply or even ischemic changes;
- continuous systolic-diastolic murmur;
- palpable continuous thrill.

When the inflow artery proximal to the fistula is compressed, the murmur and the thrill disappear and generally there is a decrease in the increased pulse rate → **Nicoladoni-Brabham sign**.

General symptoms:

- tachycardia;
- shortness of breath;
- angina-related problems;
- enlargement of all heart sections;
- enlarged pulmonary vascular markings manifested on an X-ray image;
- ↓VC of lungs;
- ECG changes.

Presence and a degree of all symptoms depends on the size, character and length of the circuit.

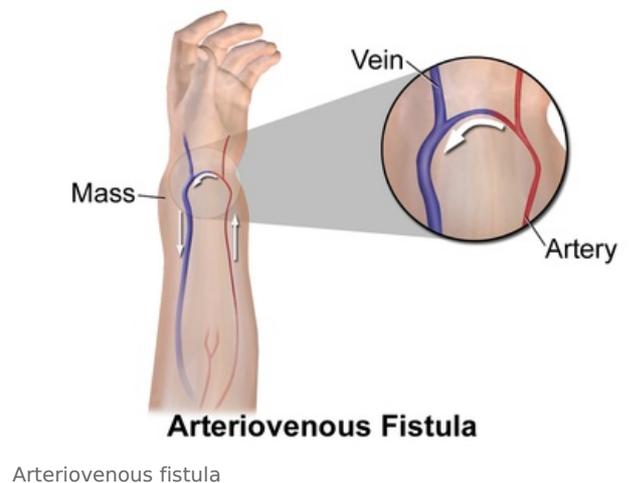
Congenital arteriovenous fistulae

These fistulae arise as a consequence of **a failure of differentiation** of embryonic vascular network into arteries and veins.

The numerous **communications** between the two systems persist or they are separated by thin **septa**, which may later be perforated. Congenital fistulae differ in their character, since failure may arise at any stage of differentiation and may be of various degrees.

Direct (truncal) fistulae

These rare fistulae occur predominantly **on extremities**, i.e., aa. a vv. femorales, brachiales femoral arteries and veins, brachial arteries and veins) and they are associated with **direct communication** between arteries and veins of **medium transparency**.



Symptomatology

Small isolated fistulae may be accidentally detected during an angiographic examination and they generally do not cause any symptoms to the patient.

Larger or multiple fistulae cause **dilation of veins** and they even lead to **varicose veins** at an early age. Especially suspicious are varicose veins which are particularly large, unilateral and have an atypical location. Skin tends to be **warmer** and there tends to be **hyperhidrosis** and **hypertrichosis**. When a fistula is located in proximity to epiphyseal cartilages and it is hemodynamically relevant before growth is completed, one of its manifestations tends to be **gigantism** of the affected extremity. General cardiovascular symptoms, such as murmur and thrill, are usually not present.

Diagnosis is made on the basis of anamnesis, symptoms enumerated above and angiography.

Therapy

This disease tends not to progress significantly for many years.

Indications for surgical treatment include local failure stemming from decompensation of the venous system, gigantism and exceptionally also general symptoms. The actual surgical intervention consists in dissection of the corresponding arterial and venous section and ligation of the fistula at the influx into the veins. Varicose veins are removed during the second phase of phlebectomy. Hyperhidrosis may be removed by performing lumbar sympathectomy or upper thoracic sympathectomy.

Localised fistulae (fistulae of tumorous origin)

Except for intracranial location, this form of fistula is rare and it is characterized by forming the **terminal part of the network**. Inflow arteries lead into cavernous sinuses, which are drained by an outflow vein.

Symptomatology

These fistulas are most commonly located in **soft cranial coverage** and in **knuckle-bones**. They manifest as **limited glomerulus** of spiral and pulsating arteries, which gradually increases in size and invades adjacent areas. They generally appear at a young age.

Diagnosing localised fistulae of tumorous origin is not problematic. The typical presentation is appearance and palpation of coiled and binging arteries as well as presence of continuous thrill and murmur.

Therapy

It is recommended to perform surgical removal of fistulae of tumorous origin as soon as possible after diagnosis. These fistulae tend to increase in size over time and they may "pull in" other arterial endings into the circuit of the fistula.

In case of **smaller fistulae**, surgical intervention consists in ligation of the inflow artery, extirpation of the whole fistula and ligation of all outflow veins. Puncture of soft tissue can be generally closed by means of stitches or skin relocation.

Large fistulae tend to be supplied by multiple veins, which need to be examined by means of an angiographic examination. The surgical procedure should be divided into two phases. In the first phase, inflow arteries are embolised and ligated. During the second phase of the surgical procedure, the actual extirpation is performed. In order to correct resulting defects, reconstructive plastic surgeries are necessary.

Generalised multiple fistulae

These are **the most frequent** type of congenital fistulae. They are characterised by connections between arteries and veins, which are formed by extensive cavernous structures. They affect mainly whole **extremities** or their parts. Their manifestation falls under the so-called F.P. Weber syndrome.

Symptomatology

The symptoms start to manifest in early childhood. The affected part of the extremity is warmer and **varicose veins, hyperhidrosis** and **gigantism** are present.

The disease **progresses fast**. Over the course of several years, further tissues are infiltrated by cavernomatous structures, including bones, in which cavernomatous structures create honeycomb structure. The growth of cavernomes may lead to destruction of whole muscular groups and due to pressure, it may cause excruciating and medicine-resistant **pain**. Vein obstruction progresses, **swelling, trophic changes and peripheral ischemy** are present. Peripheral ischemy may sometimes result in **gangrene**. Short-circuited amount of blood increases, which leads to presentation of characteristic symptoms.

Angiography can show dilated inflow artery, fast filling of dilated deep veins and clouds of higher opacity in soft tissues, which represent the actual fistulae.

Therapy

Surgical intervention is indicated for patients with cardiac insufficiency (heart failure) and more serious local complications, such as ulceration, ischemic necrosis or pain. Surgery is also recommended for patients with a severely progressing disease. Currently, surgical treatment is still palliative and if successful, it may stabilise the disease and slow down its progress. Extensive cavernomatous sinuses, which invade subcutaneous space, muscles and bones, cannot be surgically removed.

The most commonly used surgical procedure is the so-called **skeletonization with partial extirpation** of those cavernomas which cause the most severe symptoms. It consists in ligation of peripheral branches of arterial section, which supply the fistulae. After surgery, the remaining fistulae attract collaterals even from remote areas. Later, local and general symptoms reappear and ischemia may progress to gangrene. Together with progressing cardiac insufficiency, this may lead **amputation** of extensive parts of the affected area.

Acquired arteriovenous fistulae

They result almost exclusively from **simultaneous injury of an artery and an adjacent vein**. They are typically found in aa. a vv. femorales, popliteales, brachiales a a. carotis comm. with v. jugularis int. Due to an increase in the use of invasive radiological procedures carried out to perform catheterization and endovascular procedures, the incidence of small iatrogenic fistulae is increasing. Occasionally, they may also arise as a result of war injuries due to bullets and shrapnel, fractures involving bone fragments, perforation of arterial aneurysm into an adjacent vein and disruption of the wall of a vein by an inflammatory process. They are intentionally created during intervention in haemodialysis patients.

Morphological types of fistulae:

1. **direct fistulae** - immediate connection between an artery and a vein (iatrogenous);
2. **indirect fistulae** - a connection is mediated by an indirect aneurysm, originally by a pulsating haematoma (traumatic).

Symptomatology

Local and general symptoms are identical to the symptoms caused by congenital fistulae and their intensity is proportionate to the size and length of time of existence of the fistula. Diagnosis is determined on the basis of anamnesis, signs of venous congestion and peripheral insufficient blood supply, continuous murmur and thrill which is typical mainly of traumatic fistulae.

Therapy

Every AV fistula should be removed as soon as possible. Postponed surgical removal might be complicated by development of serious alterations especially in the inflow artery, i.e. dilation or even formation of aneurysms, sclerosis of the artery wall. Surgical removal consists in **removal of the fistula** and **reconstruction of the artery and the vein**. Ligation can be performed only in case of an artery of lower extremity or an ulnar artery. Early surgical interventions have very good and permanent results.

References

Related Articles

- Arteriovenous malformation
- Arterial injury
- Blood capillaries, function, direction

Source

- FIRT, Pavel a Jaroslav HEJNAL. *Cévní chirurgie*. 2. vydání. Praha : Karolinum, 2006. 323 s. ISBN 8024612518.