

EMBRYOLOGICAL BASED IDENTIFICATION OF DIFFERENT ANATOMICAL PATTERNS OF SUPERFICIAL VENOUS SYSTEM

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Embryogenesis of the venous network of the lower limbs:

The theory of the angioguiding nerves

The genesis of lower limb's veins is induced by the three angioguiding nerves of the embryo: along the limb axis, the sciatic nerve or axial nerve; ventrally, the pre-axial nerve or femoral nerve; and dorsally, the post-axial nerve which becomes the posterior femoral cutaneous nerve.

The axial venous plexus becomes the sural vein and the distal trunk of small saphenous vein. Ventrally, the pre-axial venous plexus becomes the femoral vein and the long saphenous vein. Dorsally, the post-axial venous plexus becomes the post-axial or dorsal extension of the small saphenous vein. Therefore, the capillary blood vessels will differentiate along the angioguiding nerves and produce (with each other) several anastomoses, setting the final layout of the venous system.

First, axio-pre-axial anastomosis at the thigh level, the way out for the deep femoral vein. Mostly the above-knee junction, connecting the axial plexus and its popliteal anastomosis. Dorsally, with the post-axial venous plexus: it is the arch of the small saphenous vein. Ventrally, with the pre-axial venous plexus: it is the origin of the modal popliteal vein. Lastly, the Giacomini vein represents the post-axio pre-axial anastomosis of the root of the thigh.

Thus, the popliteal level becomes a crossroad for the three plexuses at birth.

At the thigh level, the axial plexus usually becomes a little arcade along the sciatic nerve, the pre-axial plexus giving rise to the femoral vein with a small collateral canal.

Anatomical variations according to embryo's development

A) ABNORMAL DEVELOPMENT OF AXIAL VENOUS PLEXUS

1. The variations of the venous axis at the *popliteal level*, The biradicular origin of the popliteal exists in this form in 56% of normal cases. In practice, variations come down to two broad possibilities: the single collector, sometimes made up of several different embryological segments, resulting in a hybrid vessel and an aberrant course, either axial, satellite to the sciatic nerve, or profunda femoris, satellite to the shaft of the femur. Doubling (bifid or by bifurcation) opens up an additional channel, either parallel or divergent, which considerably modifies the conditions of venous return. A lesion affecting one branch only, e.g. a solitary thrombus, may have no clinical manifestations and marking of collectors during imaging.
2. The variations of the *venous axis at the thigh level* are also interesting. According to the development of the three axes, we can observe:
 - I. normal small venous arcades of the sciatic nerve and deep femoral and femoral veins joining in the upper or lower part of the popliteal fossa;

- II. a huge trunk called sciatic vein or ‘persistent sciatic vein’ connected to the deep femoral vein, which could be the main venous axis of the thigh, if the femoral vein is hypoplastic;
- III. the same disposal, of course, could be seen with the arterial axis, known as the ‘persistent sciatic artery’.

B) ABNORMAL DEVELOPMENT OF PRE-AXIAL VENOUS PLEXUS

1. The variations of GSV trunk

- I. Duplicity of saphenous trunk
 - Global (duplex GSV)
 - Segmental (bifid trunk of GSV)
- II. atresia / hypoplasia
- III. interruption (termination in perforating vein)
- IV. plexiform saphenous network

2. The variations of collateral veins of GSV

- I. High Termination (GSV trunk of thigh) of:
 - Anterior intersaphenous vein
 - Posterior intersaphenous vein (Leonardo v.)
- II. Isolated termination of femoral anterior saphenous v. in femoral vein (true Accessory Saphenous Vein)

3. The variations of Femoral vein atresia / hypoplasia

C) ABNORMAL DEVELOPMENT OF POST-AXIAL VENOUS PLEXUS

1. The variations of SSV trunk

I. The termination types of the SSV: First of all, the presence of an arch (or French ‘crosse’) is not constant in a normal population (70%). The arch is more frequent in varicose patients because it is often responsible for the pathological reflux in this area. The reflux coming from higher points, popliteal or deep femoral vein, is scarcely feeding the superficial network. Using a practical and surgical classification,¹⁰ there are five possible termination types for the SSV according to the presence (A and B) or the absence (C, D and E) of SPJ.

- a. Type A: Normal SPJ located less than 5 cm above the popliteal crease (83%)
 - J Type A₁: isolated termination in popliteal vein (62%)
 - J Type A₂: termination in medial gastrocnemial vein “common trunk” (21%)
- b. Type B: High SPJ, equal or more than 5 cm above the crease (6%)
- c. Type C: No SPJ, SSV continued through the Giacomini vein (5%)
- d. Type D: No SPJ, short termination at the leg level (1%)
- e. Type E: No SPJ, plexiform deep termination in the thigh muscles (5%).

II. The ‘deep extension’ of SSV: Named axial extension because it is located dorsally, near the tibial nerve (axial nerve of the embryo). It could join an axial arcade (or sciatic nerve arcade), which is located ventrally to the sciatic nerve.

III. The 'dorsal extension' of SSV: Also named post-axial or cranial extension of the SSV (postaxial nerve of the embryo), it is located more superficially, but below the muscular fascia, companion of the femoral posterior cutaneous nerve. It often perforates the fascia at various levels and extends with the Giacomini vein (subcutaneous vein) to join GSV.

IV. Global or Segmental proximal atresia of SSV trunk (continuity with sural vein)

V. Plexiform saphenous network

2. The variations of collateral veins of SSV

- I. Intersaphenous Communicating vein (absence)
- II. Achillean tributary