

Invited Review

The natural history of pelvic veins

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Abstract

The paired leg and pelvic veins as well as the gonadal and renal veins flow into the unpaired inferior vena cava. The abdominal aorta splits into two iliac branches. This results in numerous crossings of the closely adjacent vessels and causes hemodynamic effects. The reason behind this lies in the embryological development. Early on in human development, primitive arteries and veins form from a capillary network. The limb, renal and testicular veins as well as the inferior vena cava develop from the cardinal vein system and are initially created in pairs. Remodelling and regression processes in the cardinal venous system during embryonic development explain the special anatomy of the retroperitoneal veins as well as the pathophysiological conditions underlying the various forms of PeVD.

Keywords: Pelvic veins, embryonic development, cardinal veins

INTRODUCTION

One particular feature of the venous system in the limbs is that the paired leg and pelvic veins, as well as the gonadal veins and the renal veins, empty into the unpaired inferior vena cava (IVC). The abdominal aorta, which runs parallel to it, splits into its two terminal branches to supply the limbs. While the IVC lies to the right of the abdominal aorta, the leg veins do not follow the same logic and lie, not to the right of their accompanying artery, but instead medial to the artery on both sides of the body. Therefore, they cross nearby vessels numerous times. This topographical relationship can have haemodynamic effects. The gonadal veins do not run symmetrically either. While the right gonadal vein (*V. ovarica* or *V. testicularis*) empties into the IVC, the left gonadal vein drains into the left renal vein. In order to understand this structure, one needs to consider embryonic development.

The vascular system develops in several stages starting in the third week of gestation. At this time, a capillary network begins to develop into a reticular network. The primitive arteries and veins develop at a later stage. During this stage, blood drains from the

caudal half of the body through a temporary embryonic venous system known as the cardinal vein system. It consists of paired cardinal trunk veins and paired subcardinal and supracardinal veins.

Two anastomoses enable the two parts of the system to communicate. The distal anastomosis of the cardinal trunk veins is known as the iliac anastomosis. By the seventh week of gestation, the iliac veins have formed from this and from distal parts of the cardinal veins. Another anastomosis - the sub-supracardinal anastomosis - is located in the renal segment which, during development, gives rise to both renal veins.

The cardinal trunk veins regress completely on both sides. A remarkable anomaly is that the left supracardinal vein also regresses, while the right supracardinal vein develops into the infrarenal inferior vena cava, which remains unpaired from this point onwards. The proximal part of the IVC develops from the right subcardinal vein. By the end of embryonic development, all that remains of the six, initially symmetrical, paired cardinal veins are the distal part of the right supracardinal vein and the

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proximal part of the right subcardinal vein, which now form the IVC, and the caudal parts of the subcardinal veins, which have become either the *V. ovarica* or the *V. testicularis* [1-3] (Figure 1).

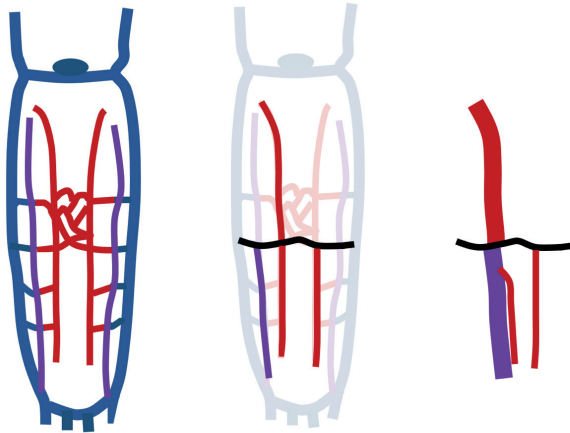


Figure 1. The inferior vena cava and the pelvic and leg veins develop from the embryonic cardinal vein system. Left: The paired cardinal veins (blue), supracardinal veins (purple) and subcardinal veins (red), with sub-supracardinal anastomosis in the renal segment (proximal) and the iliac anastomosis (distal). Centre and right: The cardinal veins regress almost completely. Only the proximal subcardinal vein on the right and the distal supracardinal vein on the right remain and form the inferior vena cava. The two renal veins (black) develop from the renal anastomosis. The distal subcardinal veins persist as the gonadal veins (according to Avery [3]). Figure from Hirsch et al. [4]

CONCLUSION

Deciphering these complicated developmental stages has yielded three important insights: it shows how the symmetrical venous system of the legs develops an unpaired inferior vena cava, it explains why the left ovarian or testicular vein drains into the IVC via the left renal vein (“renal segment”), and it sheds light on why the right vein empties directly into the VCI. Importantly, the developmental stages also explain the wide variation between individuals, which is the result of disrupted or altered growth phases.

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