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Review Article

Uterine Circulation: Is there is a special vascular portal uterine system?

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Abstrct

Keyword:

Arterio-venous abnormality; portal system; A-V shunt; uterine vascular system,

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Background: Arteriovenous abnormalities (like shunt, fistula, hematoma and aneurism) is a common circulatory complication in the human portal systems, it is either congenital or acquired. Uterine arteriovenous abnormalities include arteriovenous shunt, fistula, hematoma and aneurism. It is also congenital or acquired. So, these pathological similarities could be a prove for anatomical similarities between portal circulation and uterine vascular circulation? **Aim:** To compare pathological and anatomical portal circulation and pathological and anatomical uterine vascular circulation to find if there is a special vascular uterine portal system or not? **Methodology:** Review the old and recent published literatures that described both human portal system and uterine vascular anatomy.
Results: There are a proved similarity of pathological changes in human portal circulation and uterine arterio-venous abnormalities. But no prove to presence of a special anatomical vascular uterine portal system.
Conclusion: Pelvic vascular anatomy should be re-evaluated and investigated in vivo and in cadaveric samples using high technology methods including MRI, CT and A1 to approve if there is a special uterine portal circulation or not.

Introduction:

Research question: is the uterine circulation has a special portal system?

Scientific Assumption:

The pathological complication in the human portal systems include arteriovenous abnormalities (like shunt, fistula, hematoma and aneurism). The Arteriovenous abnormalities in portal systems either congenital or acquired.

The uterine arteriovenous abnormalities include arteriovenous shunt, fistula, hematoma and aneurism. It is also congenital or acquired.

If the same pathological changes, so could there is a special portal circulation system in the uterus? or if there is any pathology inside the uterus like D&C, vesicular mole, Caesarian section and\or myomectomy could initiate damage of the vascular system inside the uterus leading to that pathology?

Background:

According to Egyptian literatures, there are two main historical old observations related to pelvic circulation; **First one:** "Pelvic vascular anatomy should be reevaluated". "Prof. Ahmad Shafik (1933-2007). Professor of general surgery, Cairo University, one of famous figure and international experts of pelvic surgery.

In his busy laboratory and clinic in Cairo, Egypt, Shafik pioneered new advances in medical, bio-engineering and diagnostic technology. New routes for drug administration in advanced pelvic malignancy (bladder, prostate and uterus cancer) using rectourogenital communicating veins (haemorrhoidal, vesico-vaginal and the vesico-prostatic venous plexus) were evaluated. Submucosal anal injection with a high local concentration of chemotherapeutics agents could be given with reduced systemic effects. According to Shafik this anatomical pattern could explain the

supposed relationship between constipation and lower urinary tract symptoms (LUTS), causing mainly urinary tract infections in female patients[1] .**Second**:

" Level of progesterone measured around the uterus is significantly higher when use vaginal rout than systemic use" Prof. Mokhtar Tapozada, 1990s. Although serum levels were lower for buccal compared with the vaginal routes, the three routes (buccal, vaginal and rectal) produced similar uterine tone and activity. Rectal administration produced lower uterine tone and activity. Vaginal serum levels were two to three and a half times higher than those observed in prior misoprostol pharmacokinetic studies[2].

Physiological findings of the uterine circulation:

Uterine circulation refers to the blood flow system supplying the uterus, which is crucial for providing oxygen and nutrients, especially during pregnancy when it supports the developing fetus through the placenta. The uterine arteries branch of the internal iliac arteries, are the main vessels supplying blood to the uterus. They branch further into arcuate, radial, spiral, and basal arteries that supply the uterine muscle (myometrium) and the inner lining (endometrium)[3]. At term, uterine blood flow increases markedly, reaching about 600–700 ml/min, which is about 15% of maternal cardiac output. Most of this flow (around 80-90%) supplies the placenta, with the rest nourishing the uterine muscle[4].

The maternal blood flows through the spiral arteries into the placental intervillous space, where it bathes fetal villi directly for efficient exchange of oxygen and nutrients between maternal and fetal blood without mixing[5]

Maintaining proper uterine circulation is essential for a healthy pregnancy, as it directly affects placental function and fetal development[6].

In a classical anatomical classification, the superficial venous system of the pelvis includes the circumflex and epigastric veins, while the intermediate layer includes the gonadal veins and ovarian and uterine plexuses. The deep venous system, though not directly described in detail for this specific classification, typically comprises the lumbar and sacral veins and vertebral venous plexuses[7].

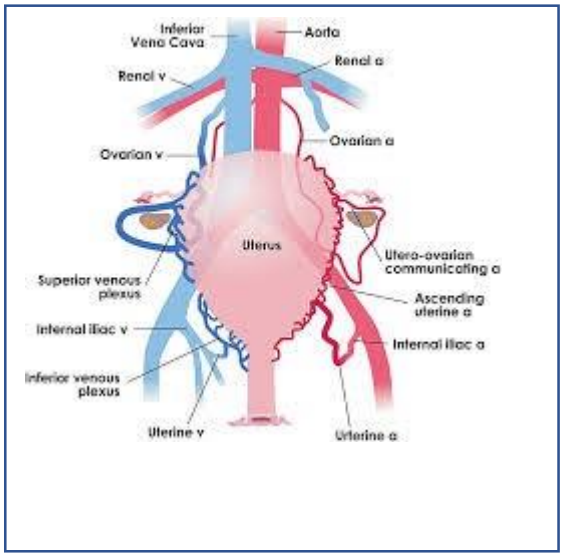


Fig 1: Uterine Circulation -1[8]

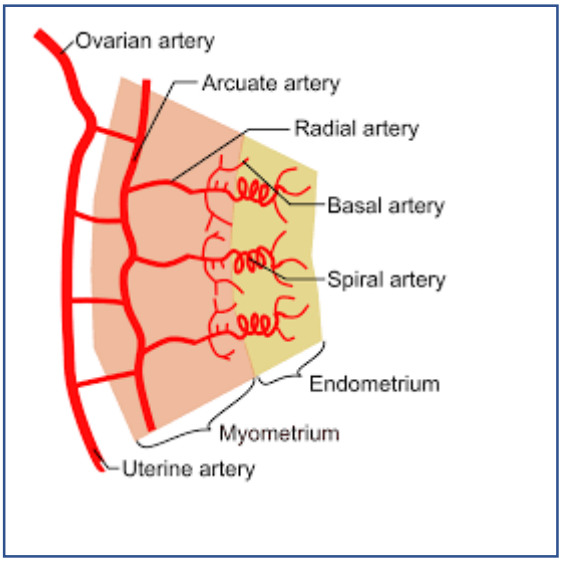


Fig 2: Uterine Circulation-2[9]

Physiological Portal system

Portal circulation is a system of blood vessels that carries blood from one capillary bed to another set of capillaries, or to a network of sinusoids, before returning to the heart, rather than directly to the heart. The most common example is the hepatic portal system, where nutrient-rich blood from the digestive organs and spleen flows to the liver's sinusoids for processing before entering the general systemic circulation. This prevents the substances absorbed from the gut from directly entering the rest of the body's circulation[10].

Types of human circulation:

Systemic circulation: Heart -artery- arterial capillaries- venous capillaries – veins – heart and Portal circulation: capillaries – vein- capillaries

Kinds of portal circulation known:

3 major

1- Hepatic portal circulation
2- Hypophysial pituitary portal circulation
3- Renal portal circulation

3 minor

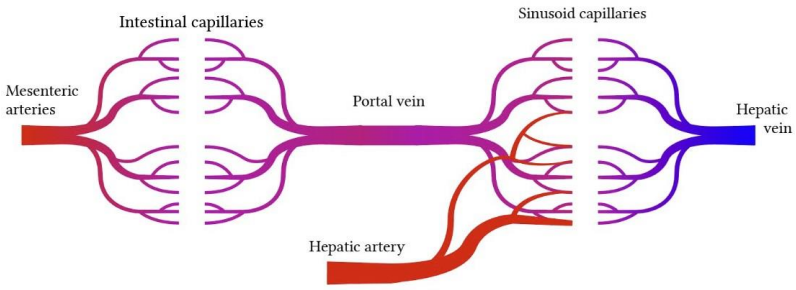
4- Placental circulation
5- Ovarian circulation
6- Testicular circulation

The essential structural elements of a portal system are:

- Feeding artery
- Primary capillary bed
- Portal vessel
- Secondary capillary bed
- Draining vein

Thus, it is possible to describe these systems by means of a childish diagram, variations on which will be repeated here for each system[11].

Hepatic portal circulation: The hepatic circulation it has *The* portal system.



- **Feeding artery:** mesenteric vessels: SMA, IMA, coeliac trunk
- **Primary capillary bed:** intestinal (villous) capillaries
- **Portal vessel:** the portal vein, confluence of mesenteric and splenic veins

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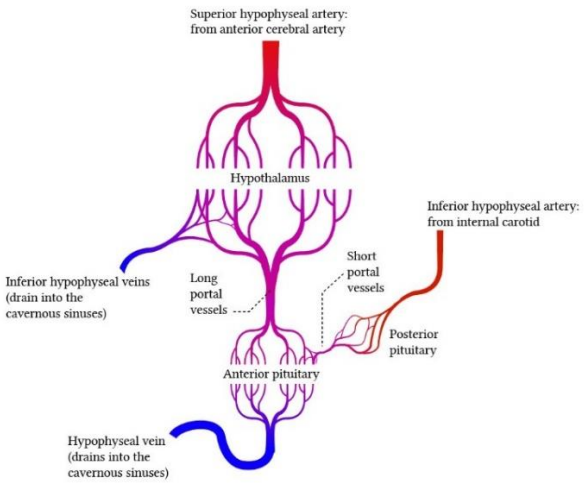
- **Secondary capillary bed:** hepatic sinusoids
- **Draining vein:** hepatic veins[12]

Pituitary portal circulation: There are two portal circulations here, which both drain into the same secondary capillary bed[13]



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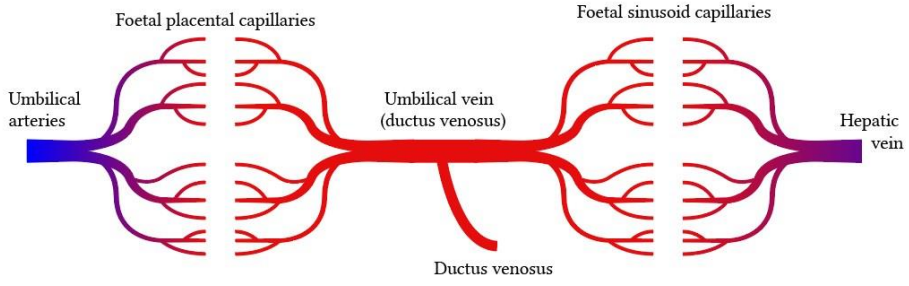
- **Feeding artery:** superior hypophyseal artery

- **Primary capillary bed:** hypothalamic capillaries and posterior pituitary capillaries
- **Portal vessel:** the long portal vessels and short portal vessels
- **Secondary capillary bed:** capillaries of the anterior pituitary
- **Draining vein:** hypophyseal veins, which variably drain into the cavernous sinuses[14]

Renal portal circulation: The renal portal system a portal vein which arises from other veins in the back half of the body. That vein connects directly to the peritubular capillaries to the kidney, which gives rise to fascinating pharmacological phenomena.

- **Feeding artery:** afferent arteriole
- **Primary capillary bed:** glomerular capillaries
- **Portal vessel:** efferent arterioles
  - **Secondary capillary beds:** Peritubular capillaries- Vasa recta
- **Draining vein:** Renal vein

Placental portal circulation: This is occasionally listed alongside the other portal systems, because it technically fits the definition (i.e. there are two capillary beds connected by a vessel without passing through the heart in between).



- **Feeding artery:** umbilical arteries
- **Primary capillary bed:** foetal placental capillaries
- **Portal vessel:** umbilical vein
- **Secondary capillary beds:** foetal hepatic capillaries
- **Draining vein:** foetal hepatic vein

Other lesser-known portal systems: The ovarian and testicular portal circuits, as well as adrenal and pancreatico-acinar portal systems. Not all of these have "primary" capillaries, and not all of them have been well demonstrated.

Pathology of portal circulation

In the portal system, thrombosis refers to the formation of a blood clot, partially or completely blocking the portal vein and its branches, often leading to portal hypertension. In contrast, an arteriovenous (AV) shunt is a direct connection between an artery and a vein, causing blood to bypass capillaries. While AV shunts are sometimes a normal physiological process (e.g., in the skin for thermoregulation), abnormal shunts can occur in the mesenteric circulation, sometimes in conjunction with portal vein thrombosis, leading to increased blood flow directly to the vein and altering systemic circulation[15].

An arteriovenous (AV) fistula is an irregular connection between an artery and a vein. Usually, blood flows from the arteries to tiny blood vessels (capillaries), and then on to the veins. Nutrients and oxygen in the blood travel from the capillaries to tissues in the body. With an arteriovenous fistula, blood flows directly from an artery into a vein, avoiding some capillaries. When this happens, tissues below the avoided capillaries receive less blood[16].

Uterine Arteriovenous malformation:

A V shunt, or arteriovenous shunt, in the uterus is a rare but dangerous condition where arteries and veins connect abnormally, causing heavy, potentially life-threatening vaginal bleeding. It is a cause of abnormal uterine bleeding (AUB) that often results from trauma or surgical procedures like dilatation and curettage (D&C)[17].

Post C section:

An acquired uterine AVM is a rare complication where a cesarean section (CS) or other uterine trauma leads to abnormal connections between the uterine arteries and veins, bypassing the usual capillary network[18].

Post myomectomy:

A uterine arteriovenous malformation (AVM) can develop after a myomectomy, a surgical procedure to remove uterine fibroids, resulting in an acquired AVM due to the trauma of the surgery. Symptoms may include heavy and abnormal vaginal bleeding and can be life-threatening[19].

Post D&C:

Uterine arteriovenous malformations are a rare cause of abnormal uterine bleeding. With the increased utilization of surgical gynecology, the prevalence of acquired uterine AVM will likely increase. Thus, uterine AVM is an important differential that should be considered in any patient who presents with abnormal uterine bleeding[20]. In the present case, a D&C was likely the inciting event that led to the formation of an acquired uterine AVM[21].

Current available methods to study uterine vascular system:

- Electromagnetic flowmeter method: This invasive method measures blood flow in the uterine artery directly, often during surgery[22].

- Doppler ultrasound: Transvaginal color and pulsed Doppler ultrasound is a widely used noninvasive technique to assess uterine artery blood flow. It evaluates flow velocity waveforms, resistance index (RI), pulsatility index (PI), vessel diameter, and volumetric blood flow. This method allows measurement of blood flow in uterine arteries and subendometrial arteries, providing information about blood flow velocity and vascular impedance[23].
- Vascular Casting and 3D Reconstruction: Involves injecting casting material into uterine vessels and then imaging the casts with thin-slice computed tomography (CT) to obtain 3D reconstructions of vascular anatomy. This method provides detailed morphological models of uterine arterial supply useful for research and teaching[24].
- Nitrous oxide method: An older method used to measure uterine blood flow and metabolism[25].
- Magnetic Resonance Imaging (MRI) including 4D Flow MRI: Provides non-invasive detailed anatomic and hemodynamic assessment independent of plane orientation, capturing blood flow and vessel geometry, even in locations inaccessible by ultrasound[26].
- Doppler echocardiography along with ultrasound can be used to calculate cardiac output which, combined with blood flow velocity and vessel diameter, estimates uterine volumetric blood flow[27].
- Reference ranges for uterine vein dimensions can also be used for assessing circulation in research settings[28].
- Anatomical and cadaveric studies: Dissection and radiological investigations including CT angiography with 3D reconstruction provide detailed descriptions of uterine artery anatomy and its variants[29].
- Angiography: Used especially in interventional procedures and assessment of uterine vascular abnormalities[30].

- Microscopy and scanning electron microscopy: Used in research to study microvascular architecture especially in uterine cervix[31].

Our Assumption:

By integrate all these information, and in referral to Professor Ahmad Shafik hypothesis in pelvic anatomy should be re-evaluated, also the observation of Professor Mokhtar Tapozada about pelvic circulation and our observation about the similarity of portal arterio-venous pathology to the pathology of uterine arterio-venous abnormalities may raise the possibility of presence of special uterine portal circulation.

Re-evaluation of pelvic vascularity and uterine vascularity is highly needed using high technology methods, AI and also anatomical for living and cadaveric studies are needed to explain the actual causes of uterine A-V abnormality.

Conclusion:

There is similarity of vascular portal system pathology with uterine arterio-venous abnormalities. Advanced anatomical vascular pelvic studies are highly recommended to explore if the is a special uterine portal circulation or not.

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