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Comparative Ultrasonographic, Morphological and Histological study of Abdominal and Pelvic Vascular System in Pregnant and Non-pregnant Local Rabbits

A Thesis

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Abstract

The abdominal and pelvic arteries an important function in controlling blood flow to essential organs. This role is especially critical during pregnancy because of the numerous physiological changes that occur to guarantee enough blood flow to the fetus and its supporting tissues. Studying the diameters and microstructure of these arteries contributes to enriching scientific knowledge that supports clinical and diagnostic aspects of veterinary medicine, especially when comparing pregnant and non-pregnant rabbits using advanced techniques such as color Doppler, anatomical injection, and histological examinations.

The current study aimed to measure the diameters of the abdominal and pelvic arteries and compare them between pregnant and non-pregnant female rabbits using color Doppler. Additionally, the precise anatomical distribution of these arteries was determined through latex injection and a three-dimensional model was created using resin casting.

Thirty adult female rabbits were used in these studies, divided into two equal main groups (pregnant female rabbits and non-pregnant female rabbits). Each main group was divided into three subgroups according to the type of examination used. Ten rabbits were used for anatomical studies, ten of which were allocated to vascular injection with colored latex, and ten others to injection of colored resin. An additional ten rabbits were used to study the histological composition of arterial walls. In addition, Doppler ultrasound examinations were performed on all rabbits from main group to assess the diameter of the abdominal and pelvic arteries.

In color Doppler examination, the hepatic, renal, and uterine arteries were identified, while the celiac artery and some of its branches were not detected due to the waves not penetrating the visceral organs. The results showed that the average diameter of the hepatic artery in non-pregnant

rabbits was 0.350 ±0.02 cm, compared to 0.196 ±0.005 cm in pregnant rabbits. The average diameter of the renal artery in non-pregnant rabbits was 0.224 ±0.01 cm, compared to 0.292 ±0.009 cm in pregnant rabbits. The average diameter of the uterine artery in non-pregnant rabbits was 0.199 ±0.01 cm, compared to 0.446 ±0.008 cm in pregnant rabbits using t-test of statistics analysis. The results indicated a decrease in the diameter of the hepatic artery in pregnant females, while a significant increase was observed in the diameter of both the renal and uterine arteries.

Anatomically, the rabbits were divided into two groups.The first group (ten rabbits), consisting of ten pregnant and non-pregnant rabbits, underwent arterial injections with latex. The second group (ten rabbits) underwent arterial injections with resin. We observed differences in the diameter measurements obtained after injection between the two substances. Latex is a flexible and elastic material, so when injected into vessels, it expands slightly, making them appears larger than normal. Resin, on the other hand, is a solid substance that hardens quickly and prevents the vessels from expanding, resulting in diameters closer to normal. Therefore, measurements obtained from resin injections are more accurate and reliable than those obtained using latex, especially when the goal is to analyze the actual diameter of vessels. The results indicated that latex injection facilitates accurate anatomical studies, while resin injection contributes to the creation of a 3D model of the arteries. The abdominal aorta gives rise to three main categories of branches: visceral, parietal, and terminal. Visceral Branches including (celiac artery, cranial mesenteric artery, renal arteries, ovarian artery, caudal mesenteric artery). Parietal Branches including lumbar artery. Terminal Branches including (common iliac arteries, median sacral artery). All of these branches were observed in all the rabbits studied. Histological examinations using Hematoxylin and eosin revealed clear differences in the composition of arterial walls between pregnant and non-pregnant rabbits. In pregnant females, increased

wall thickness of the abdominal and pelvic arteries was observed, with marked endothelial activity and hypertrophy of the muscular layer, suggesting a physiological response to the increased blood volume and circulation during pregnancy. In contrast, arteries in non-pregnant females exhibited a more regular and stable structure, with thinner walls and lower amounts of collagen and elastic fibers, reflecting a normal physiological state without elevated blood pressure or the need for structural changes.

Conclusion Pregnancy causes significant tissue changes in arteries, including increased arterial diameter, thickened arterial walls, increased collagen, and increased elastic fibers. These are adaptive changes intended to support increased blood flow during pregnancy.

Chapter One
Introduction

1.1 Introduction

The abdominal-vascular system, in animals has received significant particular attention from researchers, due to it is crucial role in different physiological function which including blood supply, hormonal transport and nutrition. In addition, it is essential to guarantee the success of organs, and vascular structures in animal models. The rabbit is a one of the most common small pet species (Mauricio *et al*., 2023). A comprehensive understanding of vascular anatomy and three-dimensional structure in laboratory animals is of paramount importance (song and zhang, 2019). Therefore, research in this field is important to enhance methods related to organ transplantation and blood vessel repair in animal models (Mauricio *et al*., 2023).

During pregnancy, the mother's vascular system undergoes changes due to the body's physiological adaptations during pregnancy (Tan and Tan, 2013). Factors such as branching and curvature patterns play a major role in balancing the elasticity of the blood vessel structure to maintain good health of the body (Secomb, 2016). This is because the arteries are very sensitive to hormonal changes and changes in blood dynamics, which can lead to major functional and structural changes (Ahmed *et al*., 2024). In fact, during the estrus period, the female witnesses changes in blood pumping and cardiac output, in addition to an increase in the pelvic plasma volume (Eke *et al*., 2022).

Many studies have been conducted throughout pregnancy examining alterations in the smaller sized arteries and arterioles, such as the uterine and placental blood vessels (Fournier *et al*., 2021). But, few have studied changes in the large elastic arteries, such as the aorta of pregnant mammals (Vargas *et al*., 2023).

The anatomical assessment of the vascular system in the abdominal cavity is crucial and difficult for ultrasonography, surgical operations in animals and humans, and research it demands understanding of vascular blood flow principles (Al Saffar and Almayahi, 2019).

Researching the anatomy regarding the vascular system inside abdominal cavity is essential and complex, particularly when it comes to performing ultrasound directed surgical procedures in animals and humans (Krotscheck *et al*., 2007; Abidu-Figueiredo *et al*., 2008). Fascinating the detailed three-dimensional arrangement of the abdominal blood vessels in rabbits has never been earlier documented (Taylor *et al*., 2022). This highlights the importance of investigating the rabbit's abdominal vasculature through methods like dissection and three-dimensional ultrasound imag (Rojo *et al*., 2023). The abdominal cavity contains an extensive vascular network, where arteries, veins, and capillaries are intricately connected to the reproductive, urinary, and digestive systems (Russo *et al*., 2015).

Ultrasound is a precise, reliable, non-invasive image technique without adverse effects (Lazim and Al-Watar, 2025; Muhammad and Aziz, 2022). Furthermore, it may be used in Doppler mode to note invasively assess the shape and geometry of arterial walls of the abdominal (Maslak and Freund, 1991), and detect as well as treat vascular disorders (Golemati and Cokkinos, 2022). Three-dimensional structure, neovascularization of the creation of new arteries, and arterial wall elasticity may provide helpful information for risk stratification and early and accurate recognition of vascular disease (Liu *et al*., 2021). The latest developments in ultrasound technology include shear wave imaging, voltage-gated ultrasound, contrast-enhanced ultrasound, and three-dimensional ultrasound imaging, which allow for assessing these vascular tissue features (Golemati and Cokkinos,

2022). Lately, simple and economical techniques been developed to enable practical and in depth investigations of the vascular anatomy (Morichon *et al*., 2024). This allows researchers to perform comprehensive 3D studies more efficiently and effortlessly (Besançon *et al*., 2021). Especially, the three dimensions model experiment can be successfully performed using a basic optical microscope, making it more accessible to educational and research institutions (Del Rosario *et al*., 2022).

1.2 Aim of the Study

The present study aims to conduct a comprehensive comparative evaluation of abdominal and pelvic arterial system in pregnant and non-pregnant local female rabbits through the integration of ultrasonographic (color doppler), anatomical (latex and resin vascular injection), and histolological techniques by measure and compare arterial diameters, map precise anatomical distributions and assess structural adaptations of arterial wall associated with pregnant in order to enhance scientific understanding of vascular changes during gestation and provide clinically retevaut reference data fan veterinary diagnostic and research applications.