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Assessing prevalence and patterns of renal vascular anatomic variants with contrast enhanced abdominal computed tomography at Tibebe Ghion Comprehensive specialized hospital Bahir Dar North West Ethiopia

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BAHIRDAR UNIVERSITY COLLEGE OF MEDICINE AND HEALTH
SCIENCE SCHOOL OF MEDICINE DEPARTMENT OF RADIOLOGY

ASSESSING PREVALENCE AND PATTERNS OF RENAL VASCULAR
ANATOMIC VARIANTS WITH CONTRAST ENHANCED ABDOMINAL
COMPUTED TOMOGRAPHY AT TIBEBE GHION COMPREHENSIVE
SPECIALIZED HOSPITAL BAHIR DAR NORTH WEST ETHIOPIA

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A THESIS SUBMITTED TO DEPARTMENT OF RADIOLOGY & SCHOOL OF
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Approval of Thesis for Defense

I hereby certify that I have supervised, read, and evaluated this thesis/dissertation titled "Prevalence and Patterns of renal vascular anatomic variants with contrast enhanced Computed Tomography, in patient's visiting radiology department at Tibebe Ghion Specialized Hospital" by Dr Belayinch worku prepared under my guidance. I recommend the thesis/dissertation be submitted for oral defense.

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ABSTRACT

Background: Renal vascular anatomical variations are common and clinically significant, particularly in renal transplantation, urological surgery, and interventional radiology. Meticulous preoperative evaluation of these variations using computed tomography (CT) or any other imaging is essential to reduce surgical complications. However, data on renal vascular anatomy in Ethiopia based on modern imaging techniques remains limited.

Objective: To determine the prevalence and patterns of renal vascular anatomical variants among patients undergoing abdominal CT imaging at Tibebe Ghion Comprehensive Specialized Hospital, Bahir Dar, Northwest Ethiopia.

Methods: A hospital-based retrospective cross-sectional study was conducted among 285 patients who underwent contrast enhancing abdominal CT imaging. Renal arterial and venous anatomies were evaluated for the presence, laterality, number, and type of vascular variants as well as its relation with demographic data and also some renal anomalies. Data were analyzed using descriptive statistics

Results: Of the 285 patients, 148 (51.7%) were male and 137 (48.3%) were female, with a predominance of middle-aged and elderly adults. Renal artery anatomical variants were identified in 93 patients (32.6%). Accessory renal arteries were present in 48 patients (16.8%), more commonly on the left side (10.8%) than the right (3.5%), with 2.4% showing bilateral involvement. Early branching of the renal artery was observed in 13.3% of patients. Aberrant renal arteries were relatively uncommon (3.5%). Renal vein variants were detected in 42 patients (14.8%). The most frequent venous variation was a retroaortic left renal vein (9.4%), followed by circumaortic renal veins (1.7%) and supernumerary renal veins (1.7%). Associated renal anomalies were rare (2.1%). There was statically significant association between renal anomaly and vascular variants

Conclusion:

Renal vascular anatomical variants are relatively common in this population, particularly arterial variations. Routine preoperative CT evaluation of renal vasculature is crucial for safe surgical and interventional planning.

Keywords: renal vascular, anatomical variants, abdominal CT imaging

ABBREVIATIONS AND ACRONYMS

CT: Computed Tomography

MDCT; multidetector computed tomography,

CTA: Computed Tomography Angiography

RV; Renal Vein

RA: Renal Artery

MRA: Magnetic Resonance Angiography

SMA; Superior Mesenteric Artery

AA: Abdominal Aorta

SPSS: Statistical Package for the Social Sciences

PACS; Picture Archiving and Communication System

TGSH; Tibebe Ghion Specialized Hospital

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1. INTRODUCTION

1.1 Background

In classical anatomical pattern, the renal vasculature is described as a renal artery (from the abdominal aorta) and a renal vein (tributary to the inferior vena cava). The arterial supply of the kidney arises bilaterally and anteriorly from the abdominal aorta at the level of the lumbar vertebrae L1 and L2, approximately one centimeter below the exit of the superior mesenteric artery and, at a variable distance from the renal hilum, divides into its two terminal branches, the anterior or prepyelic artery (AP) and the posterior or retropyelic artery (RP), which in turn divide into segmental branches. Collateral branches are distributed from this renal artery that will give rise to the inferior suprarenal arteries and branches for the renal capsule and proximal part of the ureter (1, 2). On the other hand, the venous return is responsible for draining blood from venous branches into the inferior vena cava where it empties nearly at the level of the second lumbar vertebra. Generally, they are located in an anterior position with respect to the artery and follow a reverse trajectory to the latter (3, 4).

The vascularization of the embryonic kidney originates from a group of lateral branches of the abdominal aorta. During the upward migration of the kidney to the lumbar region, many arterial branches regress and a main (hilar) artery supplies blood to the renal parenchyma (5, 6).

Despite sequential regression of those structures, the caudal arteries, located between the tenth thoracic segment and the third lumbar segment, can persist in the fully formed kidney, evolving into the superior and inferior polar arteries (5).

A wide range of clinically important anatomic variants and pathologic conditions may affect the renal vasculature, and radiologists have a pivotal role in the diagnosis and management of these processes. As many of these entities may not be suspected clinically, renal artery and vein assessment is an essential application of all imaging modalities. An understanding of the normal vascular anatomy is essential for recognizing clinically important anatomic variants as understanding of the protocols used to optimize imaging modalities also is necessary. Accessory renal arteries are found in approximately 30% of individuals and are present bilaterally in 10% of individuals. Anomalous renal vasculature is much more common in patients who have renal fusion and positional anomalies (7, 8).

Multiple or additional RAs are present in up to one-third of the population, although the frequency reportedly varies among different populations, ranging from 4% of Malaysian patients to 61.5% of Brazilian patients. Additional RAs may be considered as accessory (entering through the hilum) or

aberrant (with extrahilar penetration of the capsule), and additional RAs are usually found on one side only. Additional RAs usually arise from the aorta or iliac arteries, although rare origins from lumbar and mesenteric arteries have been reported. In extremely rare cases, there may be as many as eight or 10 RAs (9, 10). Investigators in a large study of CT angiography for renal transplantation workup reported that 1.6% of donor kidneys had three RAs and 0.1% had four RAs (11).

The renal vein is located directly anterior to the renal artery, although this position can vary up to 1–2 cm cranially or caudally relative to the artery. The right renal vein is generally 2–4 cm in length and enters the right lateral to posterolateral edge of the inferior cava vein. The left renal vein is typically 6–10 cm in length and enters the left lateral aspect of the inferior cava vein after passing posterior to the superior mesenteric artery and anterior to the aorta (12).

In their usual route, the renal veins (RVs) form in the renal hilum. Along this route, the right renal vein (RRV) receives tributaries, while the left renal vein (LRV) receives the left adrenal vein and the left gonadal vein, ending its journey in the inferior vena cava (IVC) at the level of the L1 vertebra. However, they do not present this way in all individuals, since variants may arise in embryonic development.

Particularly, when studying RV anatomy, any greater complexity in the RV, due to its relationship with the abdominal aorta (AA) and the superior mesenteric artery (SMA), has its beginning in the embryonic development of these vessels. If anomalies occur in the embryogenesis of this vein, it can surround the AA or course posterior to it. These phenomena are known as the circumaortic renal vein and retro-aortic renal vein, respectively. Another important RV variation involves supernumerary veins, also known as multiple RV; instead of one venous trunk, up to four can be found. These variations are more frequently associated with the RRV (13).

The anatomy of the renal veins was studied by many authors, due to its major implications in abdominal surgery (e.g. nephrectomy, in kidney transplantation). Knowledge regarding the morphology and prevalence of vascular abnormalities is important in laparoscopic surgery when entering the Para-aortic region, as the repair of renal vessels is much more difficult compared to open surgery, often causing hemorrhage, a need for transfusion, or conversion to laparotomy. Various anatomical variants of the renal veins were associated with varicocele, nutcracker syndrome, pelvic congestion syndrome, hematuria, low-back pain, or renal ectopy. There are three main types of anatomical variants of renal veins: multiple renal veins, in which are identifiable two or more renal veins, either uni or bilaterally; retroaortic left renal vein (RLRV), in which the renal vein has a retroaortic course before entering the

inferior vena cava; and circumaortic left renal vein (CLRV), in which there are two or more renal veins forming a ring around the aorta (14).

1.2 Statement of The Problem

Variations in the patterns of blood supply and ramification of the abdominal vessels are common in the vascular bed of the genitourinary system, and knowledge of these variations is as important as is that of the so-called normal pattern. When planning surgical procedures such as partial nephrectomy, pyeloplasty for uretero pelvic junction stenosis, and kidney transplantation, imaging studies play an indispensable diagnostic role, which can determine the chosen surgical technique (5).

The diversity of vascular pattern can be explained on the basis of its development. The kidney that initially develops in the sacral region gradually ascends up and as it starts ascending, newer renal arteries start developing from the aorta. With the appearance of newer arteries, the caudal branches normally involute and disappear. A less complete reduction results in extra-renal branching or in multiple arteries arising independently from the aorta. Due to this unique character of the kidney, this unusual pattern of vascular distribution is observed (15).

There is significant variation in the anatomy of the renal arteries. These anatomical variations are of clinical and scientific interest, not solely for performing renal surgery or transplantation(16).

Multiple renal arteries occur on the left side in 26% of people and on the right side in 23%. Renal veins have a more uniform anatomic pattern than renal arteries. Ninety-two percent of people have one renal vein on each side. The left renal vein is approximately 7.5 cm and the right is 2.5 cm long(17).

Therefore, preoperative multisection computed tomography (CT) evaluation can provide necessary anatomic information in minimally invasive surgeries (18).

Multi-detector Computed Tomography (MDCT) is the choice for preoperative evaluation of living renal donors. Before its introduction with multiple reformations techniques like in the modern scanners, the exact anatomy of the relevant organs and their vasculature were in dilemma for surgeons. So, small and conspicuous vasculature went unnoticed, increasing the postoperative and the intraoperative complications (18).

A broad spectrum of renal vascular variations has been reported by anatomists and radiologists. The prevalence of these variations is extremely divergent in different populations. Therefore, radiologists and surgeons in different regions must be knowledgeable about the type and prevalence of the variants in their area of practice to avoid diagnostic pitfalls and for optimization of surgical techniques (19).

As evidenced from many studies the vascular variant of the kidney is prevalent and knowing it before any intervention helps to prevent significant complications. Though there are some studies done in Ethiopia, modern imaging based studies with adequate sample size is are limited in the country in general and in region in particular, so the purpose of this study is to assess the prevalence and patterns of renal vascular variants in tibebe ghion hospital as a region.

1.3 Significance of the study

Knowledge of prevalence of renal vascular variants aids radiologists and clinicians in correctly interpreting imaging results and accurate identification helps to minimize diagnostic errors that lead to misinterpretation of renal or vascular pathologies. Awareness of these variations is important particularly during renal surgeries which reduces intraoperative complications and improves surgical outcomes. Establishing population specific prevalence of variants also helps in modifying surgical approaches, supports medical education and training medical professionals, that's what I planned to do with my study.

In my study I will try to identify the frequency and distribution patterns of these variants as well as its variation with the demographic data and with renal anomaly in the regional population which in turn provides baseline data for further research, supports to improve patients' safety protocols and to have individualized treatment planning accordingly.

Renal vascular anatomy is known for presenting a wide range of variations as illustrated by previous cadaveric and imaging studies. However, In Ethiopia, there is very limited data on renal vascular anatomy, especially from modern imaging studies. Most of what is known comes from a few small cadaveric studies that cannot reflect living anatomy accurately. With the growing use of MDCT at advanced hospitals such as Tibebe Ghion Comprehensive Specialized Hospital, it is possible to visualize these vascular structures in detail among living patients. This offers an opportunity to create local reference data that will support surgeons, radiologists, and transplant teams. So this study will contribute up-to-date information which enhances anatomic knowledge, to support safer and effective clinical and surgical practice and contribute valuable data to the existing literatures on renal vascular anatomy and its variants on the regional population.

2. LITERATURE REVIEW

The incidence of multiple renal arteries is much higher than predicted by various studies. A comprehensive anatomic depiction of the renal arterial pattern aids in determining the technical feasibility of surgical and endourological interventions. It helps to avoid postoperative complications. Multidetector Computed Tomography (MDCT) is a minimally invasive alternative to conventional angiography in preoperative evaluation.

Imaging plays a crucial role in pre-transplant evaluation to enhance the probability of a successful outcome. Computed tomography angiography (CTA) is the most commonly used imaging modality; however, magnetic resonance angiography (MRA) can be used in selected cases (20).

This was a retrospective study conducted on 100 adult patients in India published in 2017, for whom aortic CT angiography was done for various indications. Accessory renal arteries were present in 36% of cases, with unilateral anomalies in 30% and bilateral in 6%. The dominant side of renal artery variations was the right side. All the accessory arteries took origin from the aorta, and 52.8% of these supplied the inferior pole of the kidney (21).

The renal arterial vasculature of 594 kidneys from 300 subjects (28 cadavers, 272 CT) was retrospectively studied in Australia published on May 2017. The number and pattern of renal arteries were categorized on the basis of laterality, point of origin and termination in the kidney (superior pole, hilum and inferior pole), symmetry and sex (22).

Multiple renal arteries were discovered in 22% of subjects and 12.12% of kidneys. The most common pattern observed was the presence of one variant renal artery (93.1%), compared to the finding of two (5.6%) and three (1.4%) multiple arteries. The aorta was the most frequent site of origin for anomalous vessels, while the hilum was the predominant point of entry. No significant difference was established between left- and right-sided kidneys (13.8% vs. 12.5%; $P = 0.627$); however, unilateral distribution was more common than bilateral additional renal arteries (16.7% vs. 3.4%; $P < 0.01$), and variations among males were more than females (27.2% vs. 15.2%; $P < 0.05$). A higher rate of multiple renal arteries was noted in cadaveric dissections compared to CT images (46.4% vs. 19.5%; $P < 0.01$) (22).

A descriptive and observational study of renal vascular anatomy was carried out by dissecting 16 renal blocks from 8 cadavers belonging to the bodies donated to science, and used for teaching the Degree of Medicine, from the Department of Human Anatomy and Histology of the Faculty of Medicine in the University of Zaragoza on 2024.

The prevalence of arterial variations was 75% (56.3% for polar renal arteries, 12.5% for pre-hilar branching and 6.25% for double communicating arterial arch) and venous was 62.5% (12.5% for polar renal veins, 25% for late venous confluence, 6.25% for triple renal vein and 18.75% for double circumaortic renal vein) (23).

A total of 1,452 patients who underwent MDCT angiography were retrospectively evaluated for the presence (number, length, origination, destination, branching pattern and course) of the renal vein variation published on 2015 in china.

Renal vein variations were observed in 358 patients (24.7 %, 358/1,452), which included 103 patients (7.1 %, 103/1,452) with left renal vein (LRV) variations, 279 patients (19.2 %, 279/1,452) with right renal vein (RRV) variations and 24 patients (1.7 %, 24/1,452) with bilateral renal vein variations. The frequency of RRV variations was significantly higher than that of LRV variations ($p < 0.05$). No statistically significant correlation was found between variations of renal vein (LRV and RRV) and gender ($p > 0.05$). According to the morphology of the renal vein, we classified LRV variations into five types: type I, circumaortic LRV (2.1 %, 31/1,452); type II, retroaortic LRV (2.1 %, 30/1,452); type III, abnormal reflux (1.7 %, 24/1,452); type IV, late venous confluence of LRV (0.9 %, 13/1,452); type V, rare type (0.3 %, 5/1,452), and RRV variations into three types: type 1, additional renal vein (18.7 %, 271/1,452); type 2, abnormal reflux (0.4 %, 6/1,452); type 3, rare type (0.1 %, 2/1,452) (24).

Currently, multi-detector computed tomographic (MDCT) angiography is a key imaging modality for the assessment of RA and RV and has changed the role of DSA. The accuracy of MDCT angiography in the evaluation of renal vascular anatomy varies between 95% and 100%. The MDCT angiography examinations of 504 patients (317 men, 187 women) with a mean age of 56.4 years $\pm$ 11.7 (SD) (range: 18–92 years) were retrospectively reviewed on 2016 in turkey, Istanbul, to determine the number and branching pattern of the RAs and the number and variations of the RVs (retroaortic or circumaortic left RV, late venous confluence).

The prevalence of multiple RAs was 31.3% (22.2% for two RAs, 7.5% for three RAs, 1.4% for four RAs, 0.2% for five RAs) and prehilar branching was 6.5%. The prevalence of multiple right RVs was 21.6% (19.2% for two RVs, 2.2% for three RVs and, 0.2% for four RVs). The prevalence of circumaortic left RV was 5.2%, retroaortic left RV was 4.2% and, late venous confluence was 7.3%. No associations were found between gender and presence of RA or RV variations ($P = 0.630$ and 0.650 , respectively) (25) .

Conventional angiography is the gold standard method to examine vascular structures; however, it is an invasive procedure and it is not adequate to determine renal vein variations in detail. Multidetector computed tomography (MDCT) is a highly sensitive method, allowing for the examination of the overall renal vascular anatomy along with arteries and veins together

The abdominal CT (128 slice) images of 460 patients, taken between 2019 and 2021 in turkey, were retrospectively analyzed in axial and coronal planes and published on 2022. The presence and number of accessory renal arteries and early branching in the main renal artery were evaluated. Then, bilateral renal vein variations were investigated.

Of the 450 patients included in the study, the mean age was 53 years. No variations were detected in 378 renal arteries on the right side (84%) and 392 renal arteries on the left side (87.1%). The most common variation in renal arteries was an accessory inferior hilar artery in 7.5% and 6% rates on the right and left, respectively. An accessory inferior renal polar artery was observed at an overall rate of 1.3%. An accessory superior renal hilar artery was found at 3.3% and 2% rates on the left and the right, respectively. An accessory superior renal polar artery was found at an overall rate of 3.5%. Multiple variations in the renal arteries were observed at a rate of 6.4%. Early branching was observed at a rate of 4.9% on the right and 2.2% on the left. The presence of two and three right renal veins was observed at rates of 13.1% and 0.6%, respectively. Retroaortic and circumaortic left renal veins were found at 3.5% and 4.4% rates, respectively. The compression on the anterior and posterior left renal veins was observed at 4.6% and 0.9% rates, respectively (26).

This retrospective, descriptive imaging study of the variations in renal vascular anatomy was carried out at the Radiology Department of a tertiary healthcare facility in Southwest Nigeria among patients aged 18 years and above, scanned between 2011 and 2016. The aortic CTAs and abdominal CECT images of 200 patients were studied, which included 102 (51%) females and 98 (49%) males

Vascular variants were present in 37 females, (36.3 % of all females) and 63 males (64.3% of all males). Vascular variants were noted to be significantly commoner in males, ($P = 0.000075$). All the arteries were branches of the abdominal aorta. The arterial variants observed were accessory renal arteries seen on the right in 20 patients (10.0%) and 26 patients (13%) on the left, of these 7 patients (3.5%) had accessory arteries bilaterally. Four of the patients had more than one accessory artery making a total of 60 accessory arteries in 56 patients. Early branching was seen in 4.0% (right) and 0.5% (left) as well as precaval RRA seen in 4.5%. 7 of the 9 precaval renal arteries (77.8%) were accessory arteries to the right lower pole. Early renal arterial bifurcation was significantly more common on the right side ($P =$

0.016). Of the arterial variants, the inferior polar accessory artery was the most prevalent (15.5%) and was also more commonly seen on the left side. Venous variants observed were late confluence seen in 3.0% (right) and 2.5% (left); multiple renal veins were seen in 2.5% (right) and 2.5% (left), while retroaortic left renal veins were seen in 2.0% of the cases. One patient (0.5%) had a left-sided IVC that terminated in the left renal vein. Being low slice CT (4slice) and CECT rather than CTA was considered as a limitation of the study (19).

Awareness of the possible anatomical variations of renal arteries is mandatory for surgical management during renal transplantation, assessment of reno-vascular hypertension, repair of abdominal aorta aneurysm, urological procedures and angiographic interventions.

Both cadaveric (50 patients) and radiological (150 CTA) descriptive studies were conducted from July 2015 to July 2016 in Sudan, Khartoum.

There was a total of 62 SRA occurring in 51 subjects i.e. 25.5% of the cases. Bilateral supernumerary renal arteries were in nine of them (4.5%). SRA were superior polar in 8 subjects (12.9%), hilar in 18 (29.03%) and inferior polar in 36 subjects (58.05%). The difference in the frequency of the SRA between the cadaveric and the radiological studies was statistically non-significant on the right side (p value = 0.472) as well as on the left side ($p=0.228$) (27).

Renal transplantation is the preferred treatment of patients suffering from end stage renal disease. Because of challenges in performing surgical vascular anastomosis in variant renal anatomy, knowledge on renal vascular anatomy is very important in the pre surgical workup of potential kidney donors. These anatomical variations differ geographically and ethnically.

A retrospective cross-sectional, descriptive study was conducted at Kenyatta National Hospital, Department of radiology and published on December 2017. Adults between the ages of 18 to 75 years were included in the study.

The extra renal branching was identified in 30 out of the 204 cases representing a prevalence of 14.7%. Bilateral extra renal branching was seen more commonly than unilateral branching. Among the 30 cases with extra renal branching, 23 (11.3%) cases had bilateral extra renal branching while the remaining 7 (3.43%) cases of extra renal branching occurred unilaterally. Extra renal branching occurred in 27 (13.2%) cases on the left hand side kidney and in 26 (12.7%) cases on the right kidney. However, early extra renal branching was rare and occurred in only 5 (16.6%) out of the 30 cases. Most of the extra renal branching in both the left (24 out of 27) and right (24 out of 26) kidneys occurred more than 2 cm

from the kidney. lack of PACS system and being retrospective study was considered as the limitation of the study (28).

Anatomical variations in the renal vasculature complicate surgical techniques and necessitate meticulous preoperative planning.

A descriptive cross-sectional study was performed on 160 potential kidney donors who underwent renal CTA from January to December 2022 in Sudan.

Of the 160 subjects, 57.5% had normal single renal arteries bilaterally, whereas 42.5% had variations in renal artery anatomy. Accessory renal arteries were identified in 25.6% of the participants, whereas early branching occurred in 17%. Variations were more common in males, with 37% exhibiting accessory renal arteries compared with 16.1% in females ($p = 0.008$). Bilateral accessory renal arteries were identified in 3.8% of the donors. Circum-aortic left renal vein (1.3%) and Transposition of the inferior vena-cava (1.3%) were also detected (29).

The incidence of renal artery variations varies greatly by ethnic group; for example, a study showed that the prevalence was 37.1% in African people, 17.4% in Indian populations, 35.3% in Caucasians, and 18.5% in “colored” groups. Similarly, a Nigerian study reported renal artery variations in 50% of cases, with 32% having accessory renal arteries and 18% with early branching of the renal artery. Similar rates were recorded in other regions: 51% in Turkey and India, 22% in Australia and 31.9% in Nepal (29).

Observational based study was conducted by using 30 cadavers (60 sides) obtained from the Department of Human Anatomy of six Ethiopian Medical Schools, on 2018.

In the study a total of 30 cadavers, 25 (83.3%) male and 5 (16.7%) female cadavers were observed. The total number of renal arteries examined, including accessory renal arteries were 73 of which 33 (45.21%) were on the right side and 40 (54.79%) on the left side, originating from abdominal aorta.

Among the total 30 cadavers, 10 (33.33%) of the cases had accessory renal arteries in 7 (63.63%) on the left side and 3 (27.27%) on the right side. The accessory renal arteries were found in 10 cadavers. Of these, bilateral accessory renal artery was found in a single case. The remaining cases possess unilateral accessory renal arteries. A single accessory renal artery was observed in 7 (63.63%) of the cases, while double accessory renal arteries were identified in 3 (27.27%) of the case. Among the total 10 accessory renal arteries, 8 (80%) of them enter into the kidney parenchyma in the inferior pole of the kidney while 2 (20%) of accessory renal arteries enter through the hilum of the kidney. All accessory renal arteries were originated from the abdominal aorta. The average distance of accessory renal arteries from the superior mesenteric artery is 3.5 cm (30).

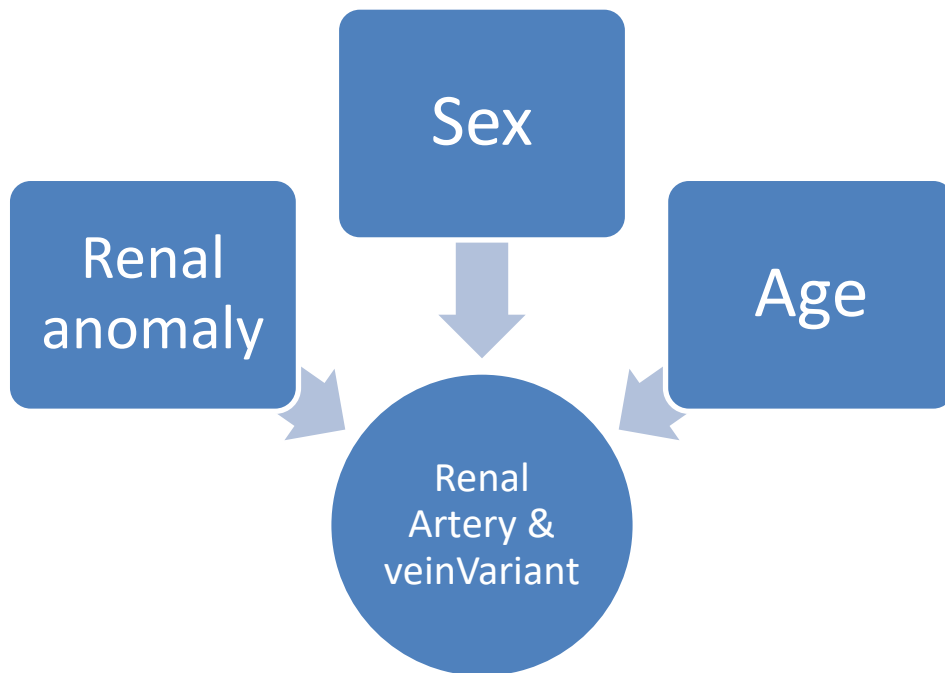
Institution based cross-sectional study was performed through a retrospective review of the charts of kidney donors underwent donor nephrectomy at the transplantation center in addisababa from 2015 to 2020.

There were 240 kidneys from 120 donors. Renal vascular variations of any kind were found in 59 kidneys (25 rights and 34 left) among 46 (38.8 %) donors (29 male, 17 female). Variations were significantly more common in males, $P = 0.035$. Arterial variations identified in this study were accessory renal artery, which is the most common variation (23.3 %), early branching (prehilar) renal artery (10.8 %) and unusual branching pattern of renal artery (4.1 %). The identified renal venous variations were accessory renal vein (9.1 %), late confluence of renal vein (0.8 %) and retroaortic left renal vein (0.8 %)(31).

Despite extensive research on renal artery variations in many groups majority are done outside Ethiopia and adequate sample study on renal vasculatures are lacking as country in general and in the region in particular, so in my study I will try to address such gaps and contribute information to the physicians who will practice on renal interventional procedures in the region.

3. CONCEPTUAL FRAMEWORK

Renal vascular variants are common as described from pervious study and this study aims to assess the prevalence and patterns of renal vascular variants as well as their relationship with three independent variables as illustrated on the diagram below.



4. OBJECTIVES

4.1 General Objectives

- ✓ To Assess the pattern and prevalence of renal vascular variants among patients who undergo contrast enhanced abdominopelvic ct At Tibebe Ghion Comprehensive Specialized Hospital,Bahirdar,Ethiopia

4.2 Specific Objectives

- ✓ To determine the overall prevalence of renal vascular anatomic variants
- ✓ To determine the pattern of distribution of renal vascular variants (arterial and venous) based on laterality
- ✓ To describe the most common patterns of renal artery and vein variations
- ✓ To assess the association of vascular variants with age, sex and renal anomalies

5. METHODS AND MATERIALS

5.1 Study Design

An institution-based retrospective cross-sectional study was conducted

5.2. Study area and period

Tibebe-ghion comprehensive specialized is located about 10km south of bahirdar city, one of specialized teaching hospital in the region; serving for more than 5 million people. As one of the main teaching and research center, radiology department is one of the main components and it's organized with advanced state of the art diagnostic imaging modalities including digital x-ray, 128 slice CT and 3Tesla MRI machines among the others

The study will be conducted at TGSH, radiology Department of hospital, and Bahirdar, North West Ethiopia from September 1, 2025 – January 30 2025

5.3 Population

- Source population ;
 - Patients who have visited TGSH radiology department and underwent abdominopelvic CT scan during the study period
- Study population:
 - Patients who have visited TGSH and referred to the Radiology Department to do either triphasic CT (which includes arterial ,venous and delayed phases) or Post-contrast CT (which include arterial and Portal venous) within the specified study period.

5.4 Sample Size Determination

In previous study from Sudan, 42% was used as the proportion for the calculation of sample size in our study(29). Based on the calculation indicated below, we set out to collect 285 patients' data who met inclusion criteria in the study period.

CI = 95% confidence interval, P value = 0.42, Z score = 1.96, 5% margin of error (E =0.05)

So based on the sample size formula we can calculate the total sample as follows

- $$n = \frac{Z^2 * p * (1-p)}{E^2}$$
 - Where n is the sample size, Z the z-score corresponding to the desired α , p the expected accuracy of the proposed method, and E half the width of its confidence interval
 - So
$$n = \frac{1.96^2 * 0.42 * (1-0.42)}{0.05^2} = 374$$
- so based on the adjusted formula for finite population, by estimating 800 CECT will be done with in the study period; the sample size was 256.
- by adding the 10 % non-respondent rate, the final sample size was 285

5.5. Sampling method

- Since its simple and insures equal chance across the population
A probability sampling method called systematic random sampling was used till the desired sample size.

5.6. Study Variables

5.6.1 Dependent variables

CT scan finding patterns of renal vasculature

5.6.2. Independent variables

Socio-demographic factors; age, sex, renal anomaly

5.7. Operational definitions

- Hilar artery – Branch of the aorta that enters the kidney close to or at the hilum
- Superior polar artery – Branch of the aorta that enters the kidney at the upper pole.
- Inferior polar artery – Branch of the aorta that enters the kidney at the lower pole
- Early bifurcation – Branch of the aorta that divides less than 2cm from the lateral margin of the aorta on the left or that divides behind the IVC on the right side
- Precaval artery – RRA that is anterior to the IVC

- Late confluence – Multiple venous tributaries that join within 1.5 cm of the confluence with the IVC on the right or 1.5 cm of the lateral margin of the abdominal aorta on the left
- Retroaortic – The right renal vein that courses posterior to the abdominal aorta and drains into the lower lumbar portion of the IVC
- Circumaortic – The left renal vein which is divided into anterior and posterior limbs that encircle the abdominal aorta
- Varicocele- an abnormal enlargement of the pampiniform venous plexus in the scrotum
- Nutcracker syndrome- compression of left renal vein between the abdominal aorta and the superior mesenteric artery
- Pelvic congestion syndrome- chronic pelvic pain due to ovarian vein varicosities/congestion

5.8. Data Collection methods

- Data was obtained using structured data collecting checklist prepared in English and Googleforms.
- The checklist includes questions on medical record number, socio-demographic characteristics of the patient and CT scan finding patterns of the renal vasculature including arteries and veins normal anatomy as well as patterns, numbers and laterality of the variant anatomies.it also contains any associated anomalies of the kidney
- The CT scan examination was performed using 128 slice CT machine with contrast which includes both arterial & venous phases and clearly visualized images without artifact and who fulfils the inclusion criteria was included in the data and the findings was reviewed and submitted by the principal investigator

5.9 Inclusion and Exclusion Criteria

Inclusion criteria

- All patients who have abdominopelvic CT with contrast done appropriately without artifact and clearly visualized images during the study period was included in the study

Exclusion Criteria

- those patients with contrast-enhanced CT with artifacts and/or if the image was not clearly visualized for different reasons like nephrectomy ,renal or abdominal lesion obscuring the renal vasculature or images with incomplete data or ct scans done without contrast was excluded from the study

5.10 Data processing and analysis

Data was checked for completeness and consistency and entered, cleaned then analyzed by SPSS v 25 computer software based on specific and general objectives. Since the purpose of the study was to describe the frequency and patterns of renal vascular variants as well as its variation with age, sex and renal anomaly, descriptive analysis method, including prevalence estimates, was used and also comparison with chi square test as well as association with fisher exact test was done and Results were presented using tables and figures represented in percentages and summarization and comparison of data was done

5.11 Quality assurance

The questionnaire was prepared in English using googlforms and was used to collect data. In order to evaluate the clarity of the findings, difficult images was evaluated together with radiology resident friends

At the end of each case, i was checking each completed checklist for completeness and consistencies.

5.12. Ethical consideration

In order to respect patient's right and regulation of the hospital where the study was conducted, ethical considerations was taken into account and a formally written letter was obtained from Bahirdar university ethical review board. Confidentiality of information was secured by removing individual identifiers including name and addresses of patients.

5.13. Reporting and dissemination plan

The findings of the study will be submitted to bahirdar university, department of clinical radiology.it will be presented for those who will use findings for diagnosis & treatment decisions. Finally, after formal preparation of the final report, the copy of the report will be submitted for evaluation and possible future publication

6. RESULTS

6.1 Demographic characteristics of the study participants

A total of 285 patients participated in this study conducted at Tibebe Ghion Comprehensive Specialized Hospital in Bahirdar, Northwest Ethiopia. Of these, 148 (51.7%) were male, and 137(48.3%) were female. The participants were almost equally distributed between the two sexes, with only a small difference in favor of males. This balanced sex composition provides a good basis for examining renal vascular anatomic variants among both male and female patients.

The ages of the patients in the study varied from 20 years and below to 65 years and above. Most participants were middle-aged or older adults. The largest group consisted of patients aged 65 years and above (22.7%), followed closely by those aged 43–53 years (20.6%) and 32–42 years (20.3%). Patients aged 54–64 years accounted for 17.5%, while those aged 21–31 years made up 14.0% of the study population. Only a small number of participants were 20 years or younger (4.9%).

Overall, the age distribution shows that the study largely involved adults in their mid to later life, which is relevant for evaluating renal vascular anatomic variants commonly detected during adult diagnostic imaging.

Variable	Category	Frequency (n)	Percentage (%)
Sex	Male	148	51.7
	Female	137	48.3
Age group (years)	≤20	14	4.9
	21–31	40	14.0
	32–42	58	20.3
	43–53	59	20.6
	54–64	50	17.5
	≥65	65	22.7

Table1. Socio-demographic characteristics of study participants at Tibebe Ghion Comprehensive Specialized Hospital, Bahirdar, Northwest Ethiopia (n = 285)

6.2 Distribution of renal artery variants

Among the 285 patients included in the study, 93 (32.6%) were found to have renal artery anatomic variants, while 192 (67.4%) had normal renal artery anatomy, thus about one out of every three patients showed some form of renal artery variation.

Among those with renal artery variants, the abdominal aorta was the most common site of origin, seen in 88 patients (30.8%). A very small proportion of variant arteries originated from the common iliac artery, observed in 5 patients (1.75%).

Accessory renal arteries were observed in 48 patients (16.8%), with distribution of 31 patients (10.8%) had an accessory artery on the left side, 10 patients (3.5%) had it on the right side, and 7 patients (2.4%) had bilateral accessory renal arteries. with most having a single accessory artery (43 patients, 15.0%). Only 4 patients (1.4%) had two accessory arteries, and a single patient (0.35%) had three accessory arteries.

Aberrant renal arteries were relatively uncommon, observed in only 10 patients (3.5%). Of these, 7 patients (2.5%) had an aberrant artery on the right side, 2 patients (0.7%) on the left side, and only 1 patient (0.3%) had bilateral aberrant arteries. 6 patients (2.3%) had an inferior polar aberrant renal artery, while 4 patients (1.4%) had a superior polar aberrant renal artery, and all of these patients had a single aberrant renal artery.

Early branching was observed in 38 patients (13.3%), with distribution as follows: 18 patients (6.3%) on the left side, 12 patients (4.2%) on the right side, and 8 patients (2.8%) with bilateral early branching.

Variable	Category	Frequency (n)	Percentage (%)
Renal artery variant	No	192	67.4
	Yes	93	32.6
Origin of variant	Aorta	88	30.8
	Common Iliac artery	5	1.7
Accessory renal artery	No	237	83.2
	Left	31	10.8
	Right	10	3.5
	Bilateral	7	2.4
Number of accessory arteries	0	237	83.2
	1	43	15.0
	2	4	1.4
	3	1	0.3
Aberrant renal artery	No	275	96.5
	Left	2	0.7
	Right	7	2.5
	Bilateral	1	0.3
Number of aberrant arteries	0	275	96.5
	1	10	3.5
Type of aberrant artery	Inferior	6	2.3
	Superior	4	1.4
Early branching renal artery	No	247	86.7
	Left	18	6.3
	Right	12	4.2
	Bilateral	8	2.8

Table 2. Distribution of renal artery variants among study participants at Tibebe Ghion Comprehensive Specialized Hospital, Bahirdar, Northwest Ethiopia (n = 285)

6.3 Prevalence of renal vein variants

Among the 285 patients included in the study, the majority, 243 (85.3%), had normal renal vein anatomy, while 42 patients (14.7%) exhibited renal vein variants.

This indicates that renal vein variants were less common than renal artery variants in this population, but still present in the proportion of about 1 in 7 patients undergoing imaging.

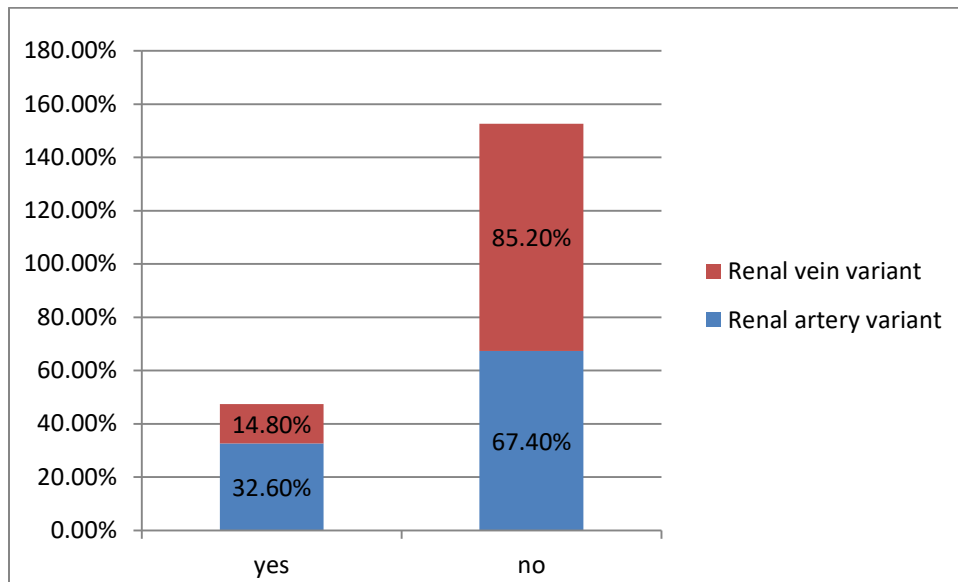


Figure 1. Renal artery variants and Renal Vein Variant

Types of renal vein variants (retro-aortic veins)

Retro-aortic left renal veins were observed in 27 patients (9.4%), and all cases occurred on the left side. only 5 patients (1.7%) had a circumaortic renal vein, all located on the left side.

Supernumerary renal vein was observed only in 7 patients (2.45%) all of which were on the left side. Only 4 patients (1.4%) exhibited a delayed confluence, all of which occurred on the left side.

Among those with supernumerary veins, 4 patients (1.4%) drained into the inferior vena cava (IVC), 2 patients (0.7%) drained into a common iliac vein, and 1 patient (0.3%) drained into the superior mesenteric vein (SMV).



Figure2. Retroaortic left renal vein

6.4 Associated renal anomalies

Among the 285 patients included in the study, the vast majority, 280 (97.9%), did not have any associated renal anomalies. Only 5 patients (2.1%) had associated anomalies, of those, 3 patients (1.0%) had a fusion anomaly (horse shoe kidney) and 2 patients (0.7%) had a positional anomaly (ectopic pelvic kidney).

Variable	Category / Side	Frequency (n)	Percentage (%)
Renal vein variant (overall)	No	243	85.2
	Yes	42	14.8
Supernumerary vein	No	278	97.5
	Left	7	2.45
Retro-aortic vein	No	258	90.6
	Left	27	9.4
Circumaortic vein	No	280	98.3
	Left	5	1.7
Delayed confluence vein	No	281	98.6
	Left	4	1.4
Drainage pattern of supernumerary veins	Inferior vena cava (IVC)	4	1.4
	Common iliac vein	2	0.7
	Superior mesenteric vein (SMV)	1	0.3

Table 3 .Renal vein variants and related characteristics among study participants (n = 285)

Age, renal anomaly vs. Renal Artery & vein variants

There was statistically significant association between renal anomaly with, renal vein and artery variants ($p = 0.015, 0.004$) respectively, this indicates that the distribution of renal artery and vein variants has relations with renal anomalies in this study population

There was no statistically significant association between age group vs renal vein and artery variants ($p > 0.05$). This indicates that the distribution of renal artery and vein variants was comparable across all age groups in this study population.

Males had a slightly higher likelihood of having a renal artery variant than females this difference was statistically significant ($p = 0.04$).

In contrast renal anomaly has significant association with renal arterial as well as veins variant with fisher exact test p value of 0.003 & 0.043 respectively

7. DISCUSSION

This study assessed the prevalence and patterns of renal vascular anatomical variations among patients who underwent imaging at Tibebe Ghion Comprehensive Specialized Hospital in Northwest Ethiopia. The findings show that renal vascular variants are relatively common in this population, reinforcing their clinical relevance during diagnostic evaluation and surgical or interventional planning.

7.1 Socio-demographic characteristics

The study population included almost equal numbers of male and female participants, with a slight predominance of males. This balanced sex distribution provided a reliable basis for evaluating renal vascular variations without marked gender-related sampling bias. Similar distributions have been reported in radiology-based studies from Nigeria and Kenya, suggesting that hospital imaging populations often shows comparable gender patterns (19, 26).

Most participants were middle-aged or older adults, with the highest proportion aged 65 years and above. This age profile is consistent with previous MDCT and CTA studies, in which renal vascular variations are commonly identified during imaging performed for vascular, abdominal, or urological indications in adult and elderly populations (25, 27).

7.2 Prevalence of renal artery variants

Renal artery variants were identified in nearly one-third (32.6%) of patients, indicating that these variations are not uncommon in the local population. This prevalence is comparable to reports from Turkey (31.3%) and Sudan (42.5%), while lower rates have been described in Australia (22%) and India (17–22%) (21, 22, 25, 29). Such differences across studies may be attributed to ethnic and genetic factors, variations in imaging techniques, and differences in study design, including cadaveric versus radiologic approaches.

The relatively high prevalence observed in this Ethiopian cohort aligns with reports suggesting that renal arterial variations occur more frequently in African populations than in some Asian groups (29). These findings highlight the importance of generating population-specific data to support clinical decision-making.

7.2.1 Accessory renal arteries

Accessory renal arteries were present in 16.8% of patients, with unilateral accessory arteries being more common than bilateral ones. The left side was affected more frequently than the right. This pattern is similar to findings from Australia and Ethiopia, where unilateral accessory arteries predominated and bilateral cases were relatively rare(22,

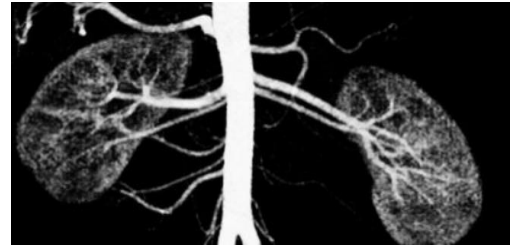


Figure 3 .Accessory arteries

31) . However, the prevalence in the present study is lower than that reported in studies from India (36%), Nigeria (32%), and Sudanese kidney donors (25.6%) (12, 21, 29) .

In keeping with previous studies, nearly all accessory renal arteries in this study originated from the abdominal aorta (21, 22, 27, 30). This consistent finding reflects the embryological process of renal ascent, during which persistent mesonephric arteries give rise to accessory vessels.

7.2.2 Number and pattern of accessory arteries

Most patients with accessory renal arteries had only a single additional vessel, while the presence of two or more accessory arteries was uncommon. This pattern mirrors observations from Australia and Ethiopian cadaveric studies, where single accessory arteries accounted for the vast majority of cases (22, 30). From a clinical perspective, this is important, as increasing numbers of accessory arteries are known to complicate surgical procedures, particularly renal transplantation and vascular anastomosis (25, 29).

7.2.3 Early branching of the renal artery

Early branching of the renal artery was identified in 13.3% of patients, with unilateral involvement being more common than bilateral. This prevalence is higher than that reported in Turkey (6.5%) and Nigeria (approximately 4%), and comparable to the overall extra-renal branching rates reported in Kenya, although true early branching was rare in that study (19, 25, 26). Variations in definitions, measurement thresholds, and imaging resolution may partly explain these differences.

Clinically, early branching is important because it shortens the available length of the main renal artery, potentially increasing the technical difficulty of renal transplantation and endovascular interventions (25). The relatively high prevalence observed in this study underscores the need for meticulous preoperative vascular assessment.

7.2.4 Aberrant renal arteries

Aberrant renal arteries were relatively uncommon in this study, occurring in only 3.5% of patients. Inferior polar aberrant arteries were more frequent than superior ones, a pattern that has been widely reported and is explained by the persistence of inferior embryonic renal arteries during

development (19, 27, 30). Although infrequent, these vessels are clinically significant, as they often supply specific renal segments and may be at risk of inadvertent injury during surgical or interventional procedures if unrecognized (25, 29).

7.3 Renal vein variants

Renal vein variants were evenly distributed between genders, indicating that sex may play a role in arterial but not venous anatomical differences.

Renal vein variants were identified in 14.7% of patients, making them less common than arterial variations in this cohort. This prevalence is lower than that reported in large MDCT studies from China (24.7%) and Turkey (over 20%), but is comparable to findings from Nigeria and Ethiopian donor-based studies (19, 24, 25, 31). Differences in sample size and imaging protocols, likely contribute to this variability.

All retroaortic and circumaortic renal veins observed in this study were located on the left side, consistent with established embryological patterns and previous reports (24-26). Notably, the prevalence of retroaortic left renal vein (9.4%) in this study is higher than that reported in China, Turkey, and Nigeria (19, 24, 25). This may suggest population-specific anatomical differences and emphasizes the value of local imaging data in clinical practice.

Supernumerary renal veins and delayed venous confluence were rare and occurred exclusively on the left side. Similar low prevalence have been reported in studies from Kenya, Turkey, and Ethiopia (26, 27, 31). Despite their rarity, these variations are clinically important, particularly in renal transplantation and retroperitoneal surgery, where venous injury can lead to significant complications.

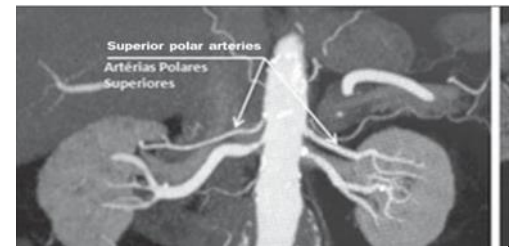


Figure 4. Ct angiography, aberrant artery

7.4 Associated renal anomalies

Associated renal anomalies were identified in only a small proportion (2.1%) of patients, with fusion and positional anomalies being the most common. This low prevalence is consistent with previous imaging-based studies, which generally report renal parenchymal anomalies less frequently than vascular variations (27, 31).

Study	Sample/Method	Artery Variants	Accessory Rate	Vein Variants	Key Notes
our study	285/CT Ethiopia	32.6%	16.8%	14.7% (retro 9.4%)	Male bias arteries; anomalies ass.
Ethiopian Cadaver (2018)	30 cadavers	33.3% accessory	33.3%	NR	Left-dominant; inferior 80%
Addis Donor (2015-20)	120 donors/charts	38.8% overall	23.3%	10.7% (accessory 9.1%)	Male higher (p=0.035)
Sudan CTA (2022)	160 donors	42.5%	25.6%	2.6% circumaaortic	Male 37% vs female 16%
Nigeria CT (2011-16)	200 patients	~50%	28%	~8%	Male dominant (p<0.001); left inferior
Turkey MDCT (2016)	504 patients	31.3% multiple	NR	21.6% right multiple	
China MDCT (2015)	1452 patients	NR	NR	24.7%	Right > left veins

Table 4. Discussion summary

8. CONCLUSION

This study shows variations in renal vasculatures are fairly common among patients who underwent CECT at Tibebe Ghion Comprehensive Specialized Hospital. About one-third of the participants had some form of renal artery variation, while renal vein variations were observed in a smaller but still important proportion, dictates standard renal vascular anatomy should not be assumed in routine clinical practice.

Accessory renal arteries were the most frequent arterial variation, usually occurring on one side and left side predominant. Majority of these arteries originated from the abdominal aorta. Early branching of the renal artery was also observed in a considerable number of cases, highlighting the need for careful interpretation of imaging before any surgical or interventional procedure. Although aberrant arteries were less common, their presence is clinically significant as they supply specific renal segments which will have complication if left unnoticed.

Renal vein variations were less frequent than arterial variations and were confined to the left side, with retroaortic and circumaortic left renal veins being the most common. Despite these venous variants were relatively rare, they are important to recognize, particularly during renal transplantation, urological surgery, and retroperitoneal interventions, to prevent serious complications.

Most vascular variations occurred without associated renal structural anomalies, suggesting that vascular variations often exist independently and may not be detected unless specifically evaluated; reinforce the value of detailed pre-procedural imaging.

8.1 Clinical implications

The relatively high frequency of renal vascular variations observed in this study highlights the critical role of MDCT/ angiography in preoperative and pre-interventional assessment. Detailed knowledge of renal arterial and venous anatomy is essential for renal transplantation, management of renovascular hypertension, abdominal aortic aneurysm repair, and urological or interventional radiologic procedures (25). Careful identification of these variants can reduce operative risks and improve patient outcomes.

9. STRENGTH AND LIMITATIONS OF THE STUDY

A major strength of this study is its reliance on modern imaging techniques (128-slice CT), which allow relative precise visualization of vascular structures as compared to cadaveric studies.

This study has a few limitations that should be kept in mind when interpreting the findings.

First, being conducted in a single tertiary hospital, the results may not fully represent the wider Ethiopian population.

Second, because the study was retrospective, it depended on existing imaging records thus, the researchers had no control over scanning conditions or contrast timing at the time the images were acquired.

Third, although CECT is a reliable tool for assessing renal vascular anatomy, very small accessory vessels or subtle variations may have been overlooked, particularly in cases affected by motion artifacts or suboptimal image quality.

Despite these limitations, the study provides useful baseline information on renal vascular anatomy in Northwest Ethiopia and highlights the importance of careful pre-procedural imaging in routine clinical practice.

10. RECOMMENDATIONS

- Careful pre-procedural imaging: surgeons and radiologists should always evaluate renal blood vessels thoroughly before surgery, transplantation, or any interventional procedure. Renal vascular variations are common, and assuming a standard anatomy can lead to complications.
- Detailed reporting: Radiologists should clearly describe any variations in the number, origin, or course of renal arteries and veins in their reports. Using a structured reporting system can help ensure that surgeons and interventional teams receive all necessary information.
- Surgical planning: Surgeons and transplant teams should incorporate imaging findings into their plans to avoid unexpected challenges during operations, reducing the risk of vascular injury and improving patient safety.
- Team collaboration: Hospitals and training institutions should encourage close collaboration between radiologists, surgeons, and interventional specialists. Discussing complex cases together can help everyone better understand vascular anatomy and make safer decisions.
- Future research: Larger, multicenter studies with the gold standard imaging (MDCT angiography) are needed to capture the full range of renal vascular variations in Ethiopia. Prospective studies linking these variations to surgical outcomes could provide practical guidance for clinical practice.
- Medical education: Local data on renal vascular variations should be incorporated into teaching and clinical guidelines so that healthcare professionals are aware of these variations from early in their training.

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12. APPENDIXES:

12.1. Checklist

Bahirdar University, school of medicine and health sciences

Questionnaire prepared for the assessment of anatomic variants of renal vasculature on patients who have contrast enhanced abdominopelvic CT at Tibebe Ghion Comprehensive Specialized Hospital, bahirdar, North Ethiopia

Since the data collectors are trained final year radiology residents and the data will be collected from the PACS system, there is no need of translation of either the questionnaire or information sheet into Amharic language

Part I. Socio-Demographic characteristics of the subjects

1. Sex of the study subject a. Male b. Female 2. Age of subject ____years. 3. MRN of the patient...

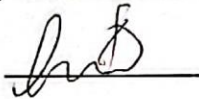
Parts II CT scan findings

1. Renal vascular anatomic variants present A. yes B. no
2. Type of variants detected a. Artery... b. Vein..... c. both
3. Origin of the variant artery a. aorta.....b. SMA....c. iliac artery....
4. Type of artery variants detected
 - a. Accessory artery.....1. right... 2.left...3.bilateral
 - b. Number of accessory artery, 1.....2.....3....4...)
 - c. Aberrant artery (inferior polar... superior polar... 1, right....2.left....3.bilateral.....
 - d. Peripheral branch 1. Right ...2.left....3.bilateral...
5. Type of venous variant detected
 - a. supernumerary vein....1. Right ...2.left....3.bilateral...
 - b. drainage of the supernumerary vein 1. IVC....2.ilic vein....3.other
 - b. delayed confluence, , 1. Right ...2.left....3.bilateral...
 - c. circumoartic,, 1. Right ...2.left....3.bilateral...
 - d. retro artic.....1. Right ...2.left....3.bilateral...
6. Any associated renal anomaly A. yes.... B.no.....
7. If yes to Qn6 type of renal anomaly detected a. fusion anomaly.....b. position anomaly. .c. other (specify)...

12.2 Declaration

This is to certify that the thesis entitled "assessing prevalence and patterns of renal vascular anatomic variants in patients having contrast enhancing abdominopelvic CT at tibebe ghion comprehensive specialized hospital bahirdar, north west Ethiopia" submitted in partial fulfillment of the requirements for Specialty Program for Clinical Radiology in Bahir Dar University; College of Medicine and Health Science, Department of Clinical Radiology, is a record of original work carried out by me and has never been submitted to this institution or any other to get degree or certificates. The assistance and help I received during this investigation have been duly acknowledged.

Dr. Belayineh worku



14/02/2026

Name of the candidate

1. Adane Bekele

2. Adane Afework

Signature





Date

27/08/2018

01/08/18

Advisor's name

Signature

Date

