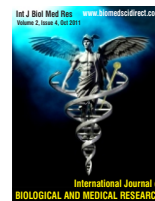


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### Original Article

## Variations of Gonadal Artery: Embryological basis and clinical significance

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#### ABSTRACT

With the advancement of new operative techniques within the abdominal cavity, the anatomy of gonadal vessels has assumed much more importance. Knowledge of variations of the gonadal artery is essential during renal and gonadal surgery as these variations may influence the blood flow to the kidney and gonadal glands and cause some pathological conditions as varicocele and gonadal atrophy. **Aims:** This study was designed to assess the percentage of variations in origin and course of the gonadal arteries and discuss their clinical significance and embryonic development to educate clinicians involved in abdominal and urogenital surgical procedures. **Methods:** Material of this study comprised of 30 well embalmed dissection room cadavers of known sex. The abdominal cavity was opened by routine dissection procedure and the origin and course of gonadal arteries was traced. Variations in number, origin and course of the gonadal arteries were also observed. **Results:** In the present study, the gonadal artery was normal in the origin, number and course in 55(91.6%) cases. In the remaining 5 (8.3%) cases different variations were observed. The variations found in this study include the gonadal arteries arching over the renal vein (1.6%), arising from the renal arteries (6.6%) and passing through a hiatus in the renal vein. Male and female ratio was 2:1 and all the variations were encountered in male cadavers. **Conclusion:** The awareness of such arterial variations could be of paramount importance to the vascular surgeons and urologist and oncologist, during surgery in the retroperitoneal region. The presence of such anomalies, if unrecognized, could prove to be hazardous during surgery.

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### 1. Introduction

With the advancement of new operative techniques within the abdominal cavity, the anatomy of gonadal vessels has assumed much more importance. The gonadal vessels must be preserved to avoid the possible complications following damage of these vessels. Many complications may arise during laparoscopic surgery of the male abdomen and pelvis, due to unfamiliar anatomy in the operative field [1].

The gonadal arteries are paired vessels that usually arise from the abdominal aorta at the second lumbar vertebral level. Each

artery passes obliquely downwards and posterior to the peritoneum on the psoas major muscle. Descending on the posterior abdominal wall, each testicular artery enters the inguinal canal through the deep inguinal ring [2]. Then it accompanies the ductus deferens to testis while ovarian artery on arriving at the upper opening of the lesser pelvis passes inward and between layers of suspensory ligament of the ovary to reach the broad ligament of the uterus. Then it runs medially below the uterine tube and turns backwards into mesovarium where it breaks into branches which enter the ovary at the hilus [3]. Though the anatomical features of the gonadal vessels are relatively constant, occasional developmental and anatomical variations have been reported. [4] The anomalies of the gonadal arteries include variations of their origin, course and number. In 5–6% of cases it originates from the main or accessory renal artery and is referred as an aberrant gonadal artery [5]. Ambos et al revealed that the gonadal artery may serve as a source of collateral blood supply to the kidney through the capsular arteries in some conditions as renal artery stenosis and renal tumors. [6].

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Certain vascular and developmental anomalies of kidneys can be associated with variations in the course of the gonadal arteries as the vasculature of kidneys and gonads derived from the lateral mesonephric branches of dorsal aorta. Knowledge of these variations of the gonadal artery is essential during renal and gonadal surgery as these variations may influence the blood flow to the kidney and gonadal glands and cause some pathological conditions as varicocele and gonadal atrophy.

To the clinician any unusual course or location of the gonadal artery may be of importance in pursuing a course of specific surgical procedures or in diagnostic pathology associated with gonadal anatomy. Therefore this study was designed to assess the percentage of variations in origin and course of the gonadal arteries and discuss their clinical significance and embryonic development to educate clinicians involved in abdominal and urogenital surgical procedures.

## 2. Materials and Methods

Material of this study comprised of 30 well embalmed dissection room cadavers of known sex. The human cadavers were serialized from 1-30 with suffix M for male & F for female. The abdominal cavity was opened by routine dissection procedure, and the retroperitoneal structures were exposed. The connective tissue surrounding the great vessels and their branches and tributaries, were removed to provide a clear field of vision. The origin and course of gonadal arteries was traced. Variations in number, origin and course of the gonadal arteries were also observed,

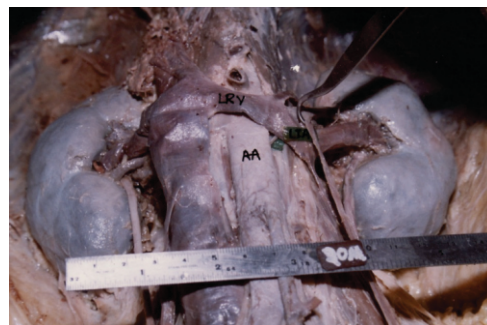
## 3. Results

In the present study, the gonadal artery was normal in the origin, number and course in 55(91.6%) cases as per the description that is usually referred to in standard anatomical textbooks. In the remaining 5 (8.3%) cases different variations were observed. The variations found in this study include the gonadal arteries arching over the renal vein (1.6%), arising from the renal arteries (6.6%) and (1.6%) passing through a hiatus in the renal vein. No doubled, tripled gonadal artery was found in our study. Male and female ratio was 2:1 and all the variations were encountered in male cadavers.

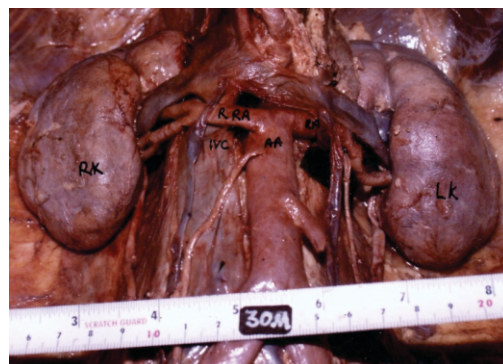
**Variation 1-** In one case (20M), left testicular artery after arising from the abdominal aorta distal to the origin of the renal artery, ascended up behind the left renal vein and then arched at its upper border to run downwards accompanying the testicular vein. This type is also called the arched testicular artery (of Luschka) because it passes, in succession, posterior, superior, and anterior to the renal vein [7]. Pattern on the opposite side was normal (Fig.1).

**Variation 2-** According to Shoja [5] gonadal artery, which originates from the main or accessory renal artery, is referred as an aberrant gonadal artery. In our study, aberrant gonadal artery was present in 4(6.6%) cases, out of which it originated from the accessory renal artery in 3(5%) cases, and from the main renal artery in one (1.6%) case (Fig-1). Right and left instances were equal.

**Figure 1. Showing arching of left testicular artery (LTA) over the left renal Vein (LRV) after arising from abdominal aorta (AA).**



**Figure 2. Showing left aberrant gonadal artery arising from main renal A.AA- Abdominal aorta, IVC- Inferior venacava, RRA-Right renal artery, RA- left renal artery, RTA- right testicular artery, LTA- Left testicular artery.**



**Variation 3-** Out of four cases of aberrant gonadal artery, in one case (19 M) the left testicular artery was arising from left accessory renal artery and passing through a hiatus in the left plexiform renal vein (Fig-3). This variation is very rare and clinically important

**Figure 3. Showing Left testicular artery (TA) arising from accessory renal artery (ARA) and traversing through the hiatus in left renal vein (LRV). AA-Abdominal aorta, MRA- Main renal artery.**



#### 4.Discussion

With the advent of newer surgical and diagnostic techniques, understanding of atypical anatomical presentations gains more importance. A deep knowledge of variations of gonadal arteries and their relations to the adjacent structures is essential in avoiding the complications in operative surgery [4]. According to Bergman et al[8] and Notkovich [9], there is no sex related difference in the course and origin of the gonadal arteries. This is in contrast with the results of the present study which agrees with the findings of Çiçekcibaşı [10] that the gonadal artery variations are more commonly found in male than female

##### Arched gonadal artery

The arched gonadal arteries arise from the aorta behind or below the renal vein and course upwards to arch over the renal vein. In our study no such variation was detected on the right side

##### Prevalence of arched gonadal artery

Authors	No of cases	left	left
Pick & Anson (1940)	194	2%	none
Notkovitch (1956)	183	20.3%	8%
Naito et al. (2006)	59	6.7%	none
Bandopadhyay & Saha (2009)	80	3.8%	none
Wadhva and Soni (2004)	30	1.7%	none
Present study(2011)	60	3.3%	none

This table may indicate some sort of racial variation as prevalence of this variation and absence of such a loop on the right, corroborate that of all the above authors but not with that of Notkovich [9].

The variations in the gonadal arteries are attributed to their embryological origin which is very complex. Nine lateral mesonephric arteries are divided into the cranial, middle and caudal group. The gonadal arteries are persistent branches of mesonephric arteries that develop cranially and caudally to the renal pedicle. From those branches generally caudal one develop as a definite gonadal artery and others atrophy. The sex gland descends and the kidney ascends. If the artery persisting was situated cranial to renal pedicle then it will appears crossing in front of pedicle with the descend of gland and if kidney ascends still higher carrying its renal vein to a higher level than the origin of the gonadal artery, then the latter will be forced to follow an arched course around the vein as found in present case (Fig-4) The fact, that on the left side, the kidney ascends generally higher than on the right, gives us a clear explanation of the higher frequency of this variation on the left side. [9]

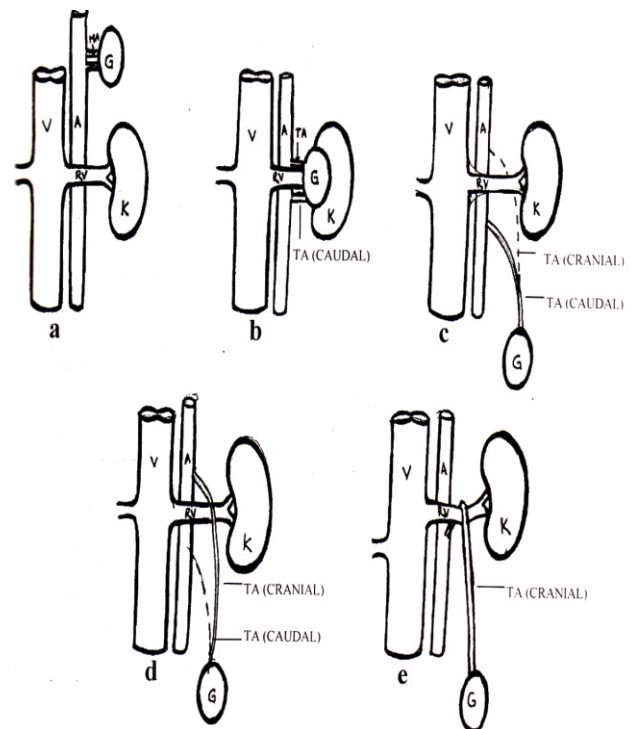


Figure-4 Stages of development of arched testicular artery:

- a- Gonads before crossing the mesonephrons
- b- Gonads crossing the mesonephrons
- c- Atrophy of cranially situated artery
- d- Persistence of cranially situated artery
- e- Ascend of the kidney leading to arching of testicular artery (TA)

MA- Mesonephric artery, RV-Renal vein, G-Gonad  
K-Kidney,A-Aorta,V-Inferior vena cava.

Apart from the developmental and morphological interest in arching gonadal arteries, they are of practical importance from a clinical and surgical view point [15]. Looping of the left testicular artery might lead to compression of the left renal vein, which may precipitate engorgement of the left testicular vein leading to varicocele. The renal vein hypertension may lead to proteinuria and hematuria in addition to varicocele. Satheesha described a similar case of arching of the testicular artery, which was passing between the two divisions of the renal vein [16]. The testicular artery may get compressed between the renal veins, which may lead to degeneration of the testis.

##### Aberrant gonadal artery

According to Notkovich [9] gonadal arteries of renal origin were found in 14% of cases taking origin either from the principal renal artery or from its branches or from an accessory renal artery. Soja et al [5] named this variation as aberrant gonadal artery.



### Prevalence of arched gonadal artery

Authors	No of dissections	left (%)	Right (%)	Total Percentage
Pick and Anson(1941)	50	10.0	6.1	16.1
Notkovich(1956)	100	8.1	6.5	14.6
Asala et al. (2001)	150	-	-	2.6
Wadhava & Soni(2004)	60	6.6	3.3	10.0
Soja et al.(2007)	98	3.0	11	14
Pai et al (2008)	68	2.9	5.9	8.8
Present study(2011)	60	3.3	3.3	6.6

Gonadal artery was found to be arising from renal artery by different authors in percentage range of 2.6% to 16.1% as compared to present study finding of 6.6%. Çiçekcibaşı [10] revealed that the middle group of lateral mesonephric arteries gave rise to gonadal artery that originated from the renal artery. The study of Shoja et al[5] demonstrated that aberrant gonadal arteries tend to originate from kidneys that possess an accessory arterial supply and hypothesized that aberrancies of the gonadal artery are a part of a common embryologic error resulting in the persistence of the future accessory renal artery [5]. It is known that genetics, various chemical agents, growth/transcription factors and homodynamic forces may all take part in the selection and persistence of a particular congenital vascular channel. However, the particular embryonic signals that result in the formation of an accessory renal artery or aberrant gonadal artery are yet unknown.[2]

The surgeons should take into account the aberrant origin and course of the gonadal arteries when operating near a renal pedicle or in the retroperitoneum [18]

A gonadal artery with origin from an inferior polar renal artery may be injured during the percutaneous treatment of the syndrome of pielo-ureteral junction, so it becomes a major contraindication. The aberrant gonadal artery shows a major significance in partial or total nephrectomy and in renal transplant. When aberrant gonadal artery represents the single blood supply of the gonad, without a second supply from the aorta or other arterial sources, it may become a major risk. Thus it becomes imperative to preserve the gonadal artery carefully in order to prevent any vascular troubles of the gonad. All these indicate the importance of the arteriography or Doppler ultrasound examination of the renal hilum, prior to any surgical procedure within the region [19]. Siniluoto et al observed a case of infarction of the left testis secondary to transcatheter embolization of a malignant left renal tumor with absolute ethanol. This is probably due to the testicular artery arising from renal artery and its branches[20].

Mirapeix et al[21] had reported a case where the right testicular artery passed through the bifid renal vein and explained the presence of a bifid right renal vein, as the persistence of the 2 embryonic renal veins. In our study the left testicular artery was arising from left accessory renal artery and passing through a hiatus in the left plexiform renal vein (Fig-2) According to Tartar et al [22], these two persistent embryonic veins are actionally in the form of network of venous. It leads to formation of hiatuses and the course of the testicular artery through the hiatus is explained by considering that during of development, the gonadal artery reached the gonad after passing between the 2 persistent embryonic renal veins. This variation is important, not only from a developmental standpoint, but also from a physiological prospective. Accessory arterial vasculature and an unusual origin and path of the testicular artery is worth reporting in efforts to educate clinicians involved in abdominal and urogenital surgical procedures [23]

### 5.Conclusion

During this study we got certain combinations of variations, which are rare in literature. The awareness of such arterial variations could be of paramount importance to the vascular surgeons and urologist and oncologist, during surgery in the retroperitoneal region. The presence of such anomalies, if unrecognized, could prove to be hazardous during surgery.

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