

## Abnormal Origin of Inferior Phrenic Artery from Right Renal Artery- A Cadaveric Study

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### Abstract

### Original Research Article

**Background:** The embryology and anatomy of Inferior phrenic artery are less probed subjects considering its importance in management of Hepatocellular carcinoma through TACE. The anatomical variations of IPA which are usually less studied are being considered in this study. **Objective:** To study the anatomical variations in the origin of Inferior Phrenic artery mainly from right renal artery and to highlight its importance in various clinical applications. **Methods:** 50 well embalmed cadavers from the Department of Anatomy, Stanley Medical College are included in this study through conventional dissection method. **Results:** Of the 50 cadavers all of them had normal origin of IPA from abdominal aorta as paired structures on the lateral aspect except for 2 cases where the IPA took its origin from Right Renal Artery. **Conclusion:** Anatomical variations in vascular system are highly important especially less understood system of Inferior phrenic artery which has been proved to be clinically crucial of late. Knowledge of these variations is quite essential for the entire medical fraternity specifically Anatomists, Surgeons and Radiologists.

**Keywords:** Inferior Phrenic Artery, Right Renal Artery, Abnormal, Anomalous, Cadaver, Anatomic Variations, Abdominal Aorta.

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## INTRODUCTION

Abnormal origin of Inferior Phrenic artery from renal artery is a not so common variation of renal artery/ inferior phrenic artery. Inferior phrenic arteries are paired arteries which are direct branches of abdominal aorta. The two inferior phrenic arteries may take their origin from the abdominal aorta, the celiac artery, or from a trunk that shoots from the celiac artery or aorta. One of the inferior phrenic arteries may also arise from the renal arteries. The inferior phrenic arteries separate across the crura of the diaphragm and the muscular bundles that hook the diaphragm to the lumbar spine. The arteries run upward and laterally beneath the crurae. The left artery passes behind the esophagus, while the right artery passes behind the inferior vena cava. In the back of the central tendon, both the inferior phrenic arteries divide again into medial and the lateral branches. These arteries also branch into the superior suprarenal branches and the suprarenal gland. Small branches from these arteries may reach the spleen and liver and supply their capsules.

Renal arteries are paired arteries arising from abdominal aorta. The level of origin of renal arteries is between L1 and L2 below the origin of Superior

mesenteric artery. Kidneys are important organs receiving 20% of cardiac output through right and left renal arteries each dividing into segmental, lobar, interlobar and arcuate arteries. Arcuate arteries further divide into interlobular arteries which give rise to afferent arterioles of the glomeruli. Variations in renal vascular system are one of the most common among vascular variations in the body. These vascular variations are highly important for anatomists and surgeons since a prior thorough knowledge of the variations is essential for surgeries such as donor nephrectomy in renal transplantation for successful anastomosis.

As mentioned earlier, Inferior phrenic artery can originate from celiac trunk, or from a common trunk from aorta branching into right and left IPA, or from adrenorenal system, mesentericocolic system. According to Pulakunta's observation out of 32 cases of cadaver dissection on the study of IPAs, the incidence of anatomical variations are as follows- origin from Aorta(61%), Celiac trunk(28), Left gastric artery (3%), Renal artery (4%), Middle adrenal artery (3%).

## Aim

The aim of this study is to elucidate the possible anatomical variations of the origin of Inferior Phrenic artery especially the right IPA from the Right renal artery in 50 cadavers (31 male and 19 female) in our department and to highlight the importance of accurate knowledge of such variations among the Anatomists, Surgeons and Radiologists.

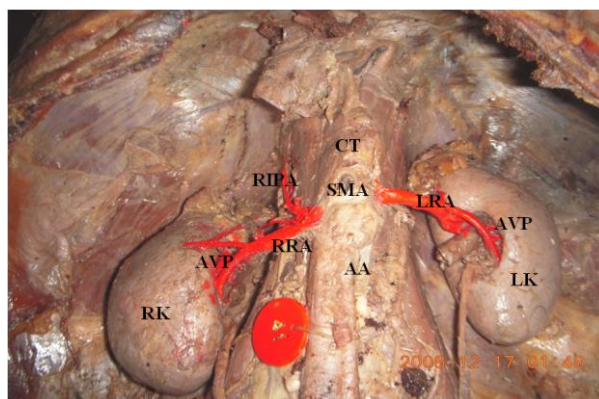
## MATERIALS AND METHODS

The study was done on 50 unclaimed, adequately embalmed cadavers between the age of 20 and 60 years of age comprising of 31 male and 19 female cadavers from the Department of Anatomy, Stanley Medical College, and Chennai. The study period was 3 years. All the cadavers were well prepared and their abdomen opened with the Conventional Dissection Method using a midline incision extending from xiphoid process to pubic symphysis curving around the umbilicus. Specimens were marked

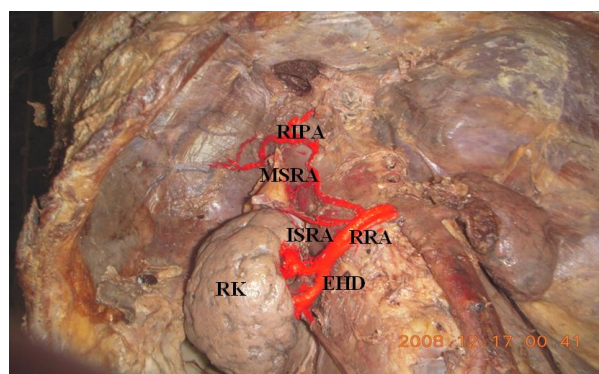
appropriately and photographs were taken. Anatomical markings were done on the photographs using photo editor software.

## RESULTS

It was observed that out of the 50 cadavers only 2 cadavers had an abnormality in the origin of Inferior Phrenic Artery. In both the cadavers the IPA was found to be originating from Right Renal Artery. One had a direct origin from the Right renal artery. The other had a common arterial trunk from right renal artery which branched into right inferior phrenic artery and right middle suprarenal artery. In both the cadavers the left inferior phrenic arteries took their origin from the abdominal aorta. All the other 48 cadavers had a normal origin of right and left IPAs as paired structures from the lateral aspect of abdominal aorta. Incidentally both the anomalies were observed in two of the male cadavers.



**Fig-1: Showing inferior phrenic arising from right renal artery**



**Fig-2: Showing inferior phrenic and middle supra renal arising from a common trunk from right renal artery**

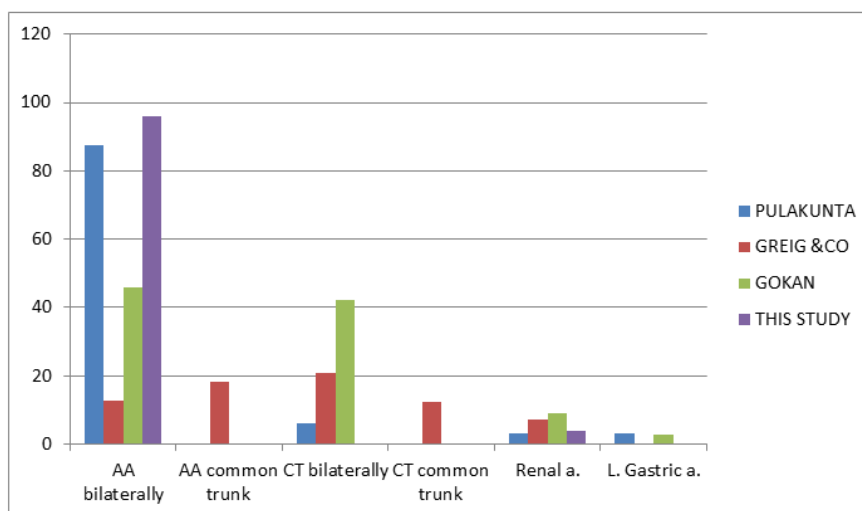
## DISCUSSION

According to this study the incidence of abnormal IPA origin was found only in two cadavers, both arising from the right renal artery, which is 4%. This is in concordance with the findings of Pulakunta et al which was 3.12%. Gokan *et al.* described in his study that the incidence of origin of IPA from right renal artery is 9% and Greig & co had 7% of RRA origin, which is almost double that of this study. Moreover in

the other studies there were quite a good amount of variations in IPA's origin from celiac trunk and as a common trunk from abdominal aorta and rarely from left gastric arteries and suprarenal arteries. But no such variations were observed in this study, which could be possibly explained due to racial differences. Since both the abnormalities were observed among male cadavers and also the incidence rate is low, gender differences in the study could not be commented about efficiently.

**Table-1**

Variations- origin of IPA	Pulakunta	Greig & co	Gokan	This study
Abdominal aorta bilaterally	87.5%	12.7%	46%	96%
Abdominal aorta as a common trunk	-	18.1%	-	-
Celiac trunk bilaterally	6.25%	20.9%	42%	-
Celiac trunk as a common trunk	-	12.2%	-	-
Renal artery	3.12%	7%	9%	4%
Left gastric artery	3.12%		2.7%	-

**Fig-3**

Knowing vascular embryology paves way to understand the anomalies better. The mesonephric arteries develop on each side of the aorta, being distributed throughout the mesonephric area from the sixth cervical to the third lumbar segments. At first they only supply the mesonephros, but later they supply in addition, the suprarenal glands, the renal or metanephric mass and also the reproductive glands. As growth occurs, the more cranial part of the mesonephros together with its vessels disappears before those at the caudal end have reached their maximal development. The mesonephric arteries in the thoracolumbar region traverse an area which is occupied in varying degree, at different levels by the suprarenal gland, the mesonephros laterally, and more ventrally the reproductive gland. Within this area the arteries form a network, the 'rete arteriosum urogenitale'. From the network the mesonephros, metanephros and the gonads are supplied with arterial vessels, these organs being thus independent of single branches for their blood – supply. Eventually some of the roots which supply this network degenerate, the area which they previously supplied are taken over by a neighbouring root. The persistence of some mesonephric arteries could account for the variation of origin of the adult segmental arteries from the aorta.

The embryological basis of the anomalous origin of IPA has not been properly elucidated. But Felix's ladder theory which states, 'All the mesonephric arteries may persist; from them are formed the phrenic, suprarenal, renal and internal spermatic arteries' which

explains the origin of IPA from supra renal, renal and gonadal arteries. Isogai et al comments that, at embryonic day 14.0, branches from the gonadal artery or the abdominal aorta supply the cranial part of the paraaortic ridge which is supposed to be the future adrenal primordium. The most cranial part of these adrenal arteries, i.e. the prospective IPAs, reaches the diaphragm at the embryonic day 14.3. By the 15th day, the adrenal arteries and subsequently the IPAs establish their definitive branching pattern of the adult. This new theory can substantiate the origin of IPA from celiac trunk or as a common trunk from posterior aspect of aorta.

Pre-operative evaluation is crucial to know the accurate course of renal and phrenic arteries. This can be achieved by Digital Subtraction Angiography (DSA) which has been the cornerstone in diagnosing vascular anatomic variations, though it is an invasive method. Recently Multi-detector Row Computed Tomographic (MDCT) Angiography is proving to be a very useful tool in providing the high definition 3D picture of the vascular system delineating the anomalies accurately. Anyhow the high dose of radiation still remains to be a concern regarding MDCT. Newer techniques to reduce the radiation exposure in MDCT are in experimental phase. Magnetic Resonance Angiography is another non-invasive imaging modality useful in this setting.

A recent breakthrough in the management of Hepatocellular carcinoma is the discovery of the additional extrahepatic supply of HCC in the bare area

by Inferior Phrenic artery, right more than left. Eventhough surgery has proved to be the most effective treatment of HCC, unresectable tumours are managed by Trans-catheter Arterial Chemo Embolisation (TACE) of hepatic arteries. Now with the knowledge of IPA's involvement in HCC, TACE has been successfully employed in embolising the IPAs in HCC.

## CONCLUSIONS

This study has made its humble contribution in stressing the importance of appropriate knowledge of the anatomical variations of Inferior Phrenic Artery by

- Anatomists to understand the embryology and anatomy better and to update the literature time to time.
- Surgeons to anticipate the difficulties intra-operatively and to harvest proper renal graft for successful vascular anastomosis
- Radiologists for accurate pre operative diagnosis and for Transcatheter Arterial Chemo Embolisation of IPA in HCC by interventional radiologists.

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