A Study of Variations in the Origin of Inferior Phrenic Artery in Adult Human Cadavers with Clinical and Embryological Significance

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ABSTRACT

Introduction: The knowledge of variations of the arteries is important for the clinical, radiological and surgical diagnosis. The incidence of normal origin of inferior phrenic artery from abdominal aorta is 92%. Other sources of origin may be celiac trunk, renal artery, suprarenal, and hepatic, left gastric or superior mesenteric arteries accounting for 8% of cases.

Aim: To study the normal and anomalous origin of inferior phrenic artery and to discuss the embryological basis and clinical significance of the variations.

Materials and Methods: Fifty formalin fixed cadavers were dissected to observe the variations in the origin of inferior phrenic artery in the Department of Anatomy, M. S. Ramaiah Medical College, Bangalore.

Results: Inferior phrenic artery arose from abdominal aorta in forty three cadavers. Both right inferior phrenic artery and left inferior phrenic artery arose as a common trunk from abdominal aorta in one cadaver. Right inferior phrenic artery originated from celiac axis in one cadaver. Left inferior phrenic artery originated from celiac axis in four cadavers. Both left and right inferior phrenic arteries originated as common trunk from celiac axis in three cadavers. Right inferior phrenic artery originated as a common trunk with right renal artery from abdominal aorta in one cadaver and as a common trunk with accessory renal artery from the abdominal aorta in one cadaver.

Conclusion: Precise knowledge of usual and anomalous origin of inferior phrenic arteries are essential for surgeons, anatomists, researchers and interventional radiologist for performing transcatheter embolization of not only of hepatic artery but also of the right inferior phrenic artery, which is the commonest extrahepatic collateral supply of hepatocellular carcinoma.

INTRODUCTION

Inferior phrenic arteries (IPA) are the chief arteries supplying the diaphragm. They usually originate from the dorsal surface of Abdominal Aorta (AA), just above the level of Coeliac axis/Artery (CA) as paired arteries and occasionally it also arise from AA as common trunk with CA, from CA itself or from renal artery (RA) [1]. The Right Inferior Phrenic Artery (RIPA) and Left Inferior Phrenic Artery (LIPA) diverge from each other across the crura of the diaphragm and run obliquely upward and laterally along its inferior surface [2]. They also supply other organs like adrenal glands, oesophagus, stomach, liver and retroperitoneum [3]. As stated by Pick and Anson, Quain was the first person to describe the origin of inferior phrenic artery [4]. There are very few anatomy textbooks which gives clear descriptions of inferior phrenic artery. They have received increased attention in recent days due to its clinical importance. Hepatocellular Carcinoma (HCC) is the commonest tumour of liver cell origin and hepatic artery was considered to be the major artery supplying it. The commonest source of extrahepatic collateral blood supply to HCC was Inferior phrenic arteries and most frequently supplies the tumours in the bare area of liver [5]. Any unresectable HCC is treated by transcatheter chemoembolization of hepatic artery as well as right inferior phrenic arteries. Accurate knowledge of the variation in the origin of inferior phrenic arteries is very beneficial for interventional radiologists, oncologists and for surgeons [6]. The present study has been taken up to highlight the various origins of inferior phrenic artery with their clinical importance and embryological basis and compare our observations with previous studies.
MATERIALS AND METHODS
A study was conducted in Department of Anatomy, M S Ramaiah Medical College Bangalore. Fifty formalin fixed cadavers (42 Male and 08 Female), aged between 45-70 years were dissected for the study and it was conducted over a period of five years i.e., from 2010-2015. The cadavers with visible trauma, pathology or prior surgeries were excluded from the study. Routine dissection of the abdomen was carried out following the Cunningham's Manual of Practical Anatomy [7]. After removal of lesser omentum, the proximal part of abdominal aorta and its branches were identified and periarterial sympathetic plexus was removed. After removal of stomach and pancreas, the origin of inferior phrenic arteries was identified and then, they were traced both proximally and distally.

RESULT
Out of 50 adult human cadavers studied, in 42(84%) cadavers the inferior phrenic artery arose from the abdominal aorta. Other unusual origins of inferior phrenic arteries are shown and summarized in [Table /Fig-1-8]. RIPA and LIPA originated as Common Trunk (CT) from the abdominal aorta in 1(2%) cadaver, RIPA originated from CA independently in 1(2%) cadaver and LIPA arose from CA independently in 4(8%) cadavers. Both LIPA and RIPA originated as common trunk from CA in 3(6%) cadavers. RIPA arose from right renal artery in 1(2%) cadaver and from accessory renal artery in 1(2%) cadaver. RIPA originated as a common trunk (CT) with right renal artery from abdominal aorta in 1(2%) cadaver.

DISCUSSION
The vascular variations are commonly observed during dissection, the knowledge of variations in their origin, course and branches are very important for radiologists and surgeons [8].

The RIPA and LIPA arise with almost equal frequency from AA and CA, either independently or as a common trunk. Less frequently they also arise from left gastric, hepatic, superior
mesenteric and rarely from spermatic and from contra lateral IPA [5].

Gurses et al., studied the origin of inferior phrenic artery with special reference to their branches with clinical importance in twenty six cadavers and found that both RIPA and LIPA originated as common trunk from abdominal aorta in five cadavers. They also stated that RIPA arose from RA in two sides, from CA in one side and from left gastric artery in one side. The LIPA arose from CA in six sides [9].

Petrella et al., conducted a vast study on origin of inferior phrenic artery on eighty nine cadavers and reported that IPA arose from CA in 31 cadavers and among these in 19 (21.35 %) cadavers from LIPA arose from the left contour of CA which was similar to the results obtained by Pick and Anson, who reported 34(17%) out of 200 cadavers [10].

[Table /Fig-9] show, the various origins of IPA in our study and in various other studies.

The RIPA is the major collateral blood supply to HCC second only to hepatic arteries. Inferior phrenic arteries were found to have varied origin. These arteries are of small caliber and surgeons must be cautious to avoid unintentional sectioning of small caliber arteries, as it may occur during celiac artery decompression in compression syndrome of celiac trunk by median arcuate ligament [11]. Inferior phrenic arteries also supply adrenal gland, hence are important in angiographic examination of adrenal lesion [12].

Gwon et al., performed interventional procedures related to IPA and observed in 346 HCC cases which had extrahepatic collateral supply from IPA. The importance of IPA is not only to hepatic arteries. Inferior phrenic arteries were found to have varied origin. These arteries are of small caliber and surgeons must be cautious to avoid unintentional sectioning of small caliber arteries, as it may occur during celiac artery decompression in compression syndrome of celiac trunk by median arcuate ligament [11]. Inferior phrenic arteries also supply adrenal gland, hence are important in angiographic examination of adrenal lesion [12].

The LIPA and its branches supply the left dome of diaphragm and also gastroesophageal junction. The LIPA supplies collateral arterial supply to stomach in case of gastric artery occlusion. During Transcatheter Arterial Chemo-Embolization (TACE) esophageal and gastric damage can occur if non target vessels are embolized [5,13].

Knowledge of variations in origin of IPA is useful in evaluating the efficacy and safety of TACE through IPA, and for treatment of hepatic, suprarenal and diaphragmatic lesions [14].

When IPA arises from RA or in common with RA, suprarenal arteries are always derived from RA, hence are important in angiographic examination of adrenal lesions and it is important to keep in mind while clamping the renal artery during nephrectomy [15]. [Table/Fig-9] tabulated the overview of previous studies which investigated the anatomy of the inferior phrenic arteries.

**EMBRYOLOGICAL BASIS**

The diaphragm is developed from four embryonic components: septum transversum, pleuroperitoneal membranes, dorsal mesentery of oesophagus and muscular ingrowths from lateral body wall [19]. The dorsal aorta in the thorax and lumbar region, gives thirty pair of arteries, which passes in between the successive somites. These are termed as dorsal intersegmental arteries. So the diaphragm which is developed from muscular ingrowths from lateral body wall is supplied by the dorsal branches of abdominal aorta through inferior phrenic artery [20].

The intestinal /vitelline arteries are connected by longitudinal anterior anastomosis and are four in number among which the proximal part of the 2nd and 3rd root disappears and distal portion joins with the first root to form classical three branches.
of celiac artery [21]. The celiac axis and the inferior phrenic artery are derived from 6th pair of ventral splanchnic vessels. During foetal development, these arteries span and disappear, but if this longitudinal channels between the primitive vessels persists may lead to vascular variations [22].

CONCLUSION

Inferior phrenic artery commonly takes origin from abdominal aorta, but other source of origin, like coeliac axis, renal artery and accessory renal artery were also observed. Right inferior phrenic artery is the commonest extrahaepatic feeding artery supplying hepatocellular carcinoma. Any unresectable inferior phrenic artery is the commonest extrahepatic feeding artery and accessory renal artery were also observed. Right aorta, but other source of origin, like coeliac axis, renal artery and clinical importance. Knowledge of all possible variations of inferior phrenic artery origin is essential for researchers, anatomists, interventional radiologist, oncologists and surgeons working in the area of inferior phrenic artery and while performing angiographic examination of adrenal lesions and during nephrectomy.

REFERENCES

[22] Jyothi Krishnarajanagar Chandrachari et al., A Study of Variations in the Origin of Inferior Phrenic Artery

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FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Online Ahead of Print: Jun 3, 2016