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Original Article

A STUDY ON VASCULATURE OF THE SUPRARENAL GLANDS

M. Venkateshwara Reddy [1], Mohammed Meraj Ahmed [*2], P. Praveen kumar [3], G. Raghuramaiah [4].

[1,*2, 3] Assistant Professor, Dept. of Anatomy, SVS MEDICAL COLLEGE, Mahaboobnagar, Andhra Pradesh, India.

[4] Tutor, Dept. of Anatomy, SVS MEDICAL COLLEGE, Mahaboobnagar, Andhra Pradesh, India.

ABSTRACT

Introduction: Suprarenal glands are among the most vascular organs in the body and they are richly supplied by the vasculature from the various sources. Suprarenal gland vasculature and its course characterized by the many unique features. Adrenal vascular studies are performed in order to identify benign or malignant, functioning or non-functioning lesions of the adrenal gland. However the vascular supply of adrenal gland is subject to a lot of variations and adequate knowledge of the arterial and venous vascularisation is of considerable importance in angiographic studies.

Materials and Methods: Total number of specimens studied in the present work is 75. Number of foetal specimens studied in dissection is 50 and Numbers of adult specimens studied in dissection is 25. All specimens were preserved in 4% formaldehyde solution. **Dissection method:** The present study is done only by direct dissection method. All the specimens are cleaned with water to remove the clots. The aorta and inferior vena cava are injected with acetone and then cleaned with distilled water to remove the clots. Specimens kept in 5% formalin.

Observations: Detailed study of vasculature of suprarenal glands along with the origin, course, branching pattern and point of entry into the gland were tabulated accordingly.

Conclusion: The usual pattern of origin of superior, middle and inferior suprarenal arteries from inferior phrenic, aorta and renal arteries is found in the present study. A few variations in the origin of the superior suprarenal, middle and inferior suprarenal arteries are also found along with the few variations in the termination of the supra renal veins.

KEYWORDS: Adrenal Glands; Vasculature; Inferior Vena cava; Abdominal Aorta; Supra Renal Veins.

Address for Correspondence: Dr. Mohammed Meraj Ahmed, Asst. Professor, Dept. of Anatomy, SVS MEDICAL COLLEGE, Mahaboobnagar, Andhra Pradesh, India. M.No +919849626775.
E-Mail: getdrmeraj@rediffmail.com

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INTRODUCTION

Adrenal gland is a pyramidal structure lying immediately above the kidney, hence the name (**ad, "near" or "at" + renes, "kidneys"**). The term adrenal has more general application than suprarenal. The anatomy of the adrenal glands was described almost 450 years ago by Bartholomeo Eustacius and the Suprarenal glands are among the most vascular organs in the body and they are richly supplied by the vasculature from the various sources [1].

Suprarenal gland vasculature and its course characterized by the following unique features:

a) Unlike those in other organs, the arteries and veins do not usually run together.

b) The arterial supply is abundant. As many as fifty to sixty terminal small arterioles have been counted in some glands.

c) The venous blood is channelled almost completely through a large single venous trunk easily identified.

d) The suprarenal glands receive a more abundant blood supply per gram of weight than any other organ in the body.

e) Adrenal vascular studies are performed in order to identify benign or malignant, functioning or non-functioning lesions of the adrenal gland.

However the vascular supply of adrenal gland is subject to a lot of variations.

Adequate knowledge of the arterial and venous vascularisation is of considerable importance in angiographic studies.

Adrenal vascular studies are performed in order to identify benign or malignant, functioning or non-functioning lesions of the adrenal gland. A non-selective abdominal aortogram may be sufficient to show large suprarenal tumours, but selective catheterisation of three main blood vessels that supply the gland may be needed to show small tumours. The cortex of the suprarenal gland usually shows as a dense blush about 2mm wide on angiography with a less opaque medulla. The three main tumours diagnosed by arteriography are carcinomas, neuroblastomas and pheochromocytomas[2]. Successful surgery of the suprarenal gland includes familiarity of gross morphology as well as vascular anomalies of the gland. The arteries which are arranged like the teeth of a comb at its superior, middle and inferior borders – has to be secured and ligated carefully, because they are the sources of bleeding during surgery and in the post-operative period. Suprarenal veins should be divided after controlling the arterial blood supply – in order to minimise the bleeding if suprarenal gland is opened [2,3,4,5].

Appreciation of the multiplicity of arteries is essential for haemostasis during dissection of the gland, and knowledge of the usually constant venous drainage enables mobilisation of the pedicle – like vein for final clamping and ligation in removal of the gland. All post-adrenalectomy patients should receive specific hormone replacement. Replacement therapy should correct both glucocorticoid and mineralocorticoid deficiencies. Patients should also be instructed to maintain an ample intake of sodium (3–4 g/d) [6].

MATERIALS AND METHODS

MATERIALS

1: Total number of specimens studied in the present work is 75.

a) Number of foetal specimens studied in dissection is 50.

b) Numbers of adult specimens studied in dissection is 25.

2: Chemicals used for this study.

a) Quick –fix.

b) Glycerine

c) Red and blue colour paper

All specimens were preserved in 4% formaldehyde solution.

METHODS

Dissection method: The previous workers studied the suprarenal vessels either by dissection or by injection method or by angiography.

The present study is done only by direct dissection method .As the dissection was carried out variation of vessels were noted sketches were drawn then and there only and then photographs were taken.

All the specimens are cleaned with water to remove the clots. The aorta and inferior vena cava are injected with acetone and then cleaned with distilled water to remove the clots. Specimens kept in 5% formalin.

After the dissection of veins –sketches are drawn photographs are taken, distance of suprarenal vein in relation to inferior vena cava, renal vein and gonadal vein are measured. After this inferior venacava, suprarenal vein and gonadal veins are excised, and removed from all the specimens.

Suprarenal arteries are dissected, separating them from the posterior abdominal wall. Sketches are drawn –during the dissection.

In the 15 of the adult specimens, suprarenal arteries are applied with Quick fix and allowed to dry it completely. After the specimen is completely dried up coloured paper were kept below the vessels and all of them were photographed.

Collection of specimens:

From adult cadavers: Anterior abdominal wall was studied after taking the transverse incision at T9 and L3 level. Peritoneum is opened and reflected .Present specimens collected after removal of stomach, duodeneum, small and large intestine up to sigmoid colon, liver, pancreas and spleen.

A transverse incision is taken below the lower pole of kidney by resecting the inferior venacava and aorta .Upper incision is taken posterior to xiphoid process –separating the diaphragm from it [5]. Fibres of the diaphragm separated from ribs and bodies of vertebra. Inferior venacava excised at the entrance of diaphragm. Diaphragm, suprarenal gland and kidney along with inferior venacava and aorta are removed en block –and preserved in 5% formalin.

From the foetus: Specimen is removed en block including diaphragm up to the level of inferior pole kidney,

Stomach, liver, and large intestine are removed carefully and specimen is preserved in 5% formalin.

OBSERVATIONS

ARTERIES

For the present study 75 specimens were used viz.., 50 foetuses and 25 adult cadavers. Detailed study of vasculature of suprarenal glands along with the origin, course, branching pattern and point of entry into the gland were tabulated accordingly.

VEINS

Study of suprarenal vein is important as its:

Constant venous drainage of suprarenal gland enables mobilisation of the pedicle –like vein for final clamping ligation, in removal of the gland .It is important to know the course of suprarenal veins, as selective venous sampling for hormone assay is useful in localising functional adrenal lesions. Venous sampling is also done for localisation of aldosterone producing adenomas. Adrenal venous sampling is significant in cases of congenital adrenal hyperplasia and bilateral testicular tumors. Ovarian adrenal vein catheterisation is also useful to locate androgen producing tumor in hyperandrogenism.

In the present study following details about the suprarenal vein are studied:-

1) Point of exit from the gland
2) Its course
3) Tributaries
4) Its termination
5) Length of vein from its exit to its termination
6) Distance of left suprarenal vein entering into left renal vein from Inferior vena cava

DISCUSSION

In the present study of Arterial supply and venous drainage of suprarenal gland, observations were made on 50 foetuses and 25 adult specimens during routine dissection. Incidence of variations of arterial supply in the present study was 60% and venous drainage was 0% in adults and incidence of arterial variation is 4% and venous drainage is 6% in foetuses. Higher incidence was noted in adults as against foetuses. Literature is showing varying figures.

Present work is mainly concerned with the origin, course, branches, number and point of entry of branches into the gland of the suprarenal arteries.

Supernumerary arteries are about twice as common as supernumerary veins – which usually arise at the level of kidney.

Persistence of some of the mesonephric arteries account for the variations of origin of the adult segmental arteries from the aorta [7].

Suprarenal gland is often supplied by intercostals bilaterally [Williams, 1974 gray's anatomy 2005]. In the present study 3 cases were found with suprarenal gland supplied by intercostal arteries accounting to 12%.

Spermatic or ovarian arteries may arise from supernumerary renal artery [8]. Sometime a branch from testicular artery may supply as an inferior suprarenal artery [10].no such variation was found in the present study.

Frequently the gland receives one or more twigs from ureteric or gonadal arteries. Inferior suprarenal artery may arise from accessory renal artery [11].

Superior Suprarenal Artery

Usually arise from the posterior division of

inferior phrenic artery [12, 13]and Nichols 1958 [14] have worked extensively on the suprarenal arteries and their work also coincides with this.

Present work also reveals that out of 70 cases in 65 cases on the right side the origin of superior suprarenal artery is from the inferior phrenic artery which is arising either above the celiac trunk, at the level of celiac trunk or just below the celiac trunk accounts for 90%.

In one specimen left suprarenal gland and kidney was discarded because of decomposition.

On the left side the superior suprarenal is from the inferior phrenic artery in 73 cases and this accounts for about 97.33% one from the aorta (1.33%) and another from proximal part of inferior phrenic artery (1.33%).

Merklin and Michel, Gagnon, studies have shown that superior suprarenal is arising directly from aorta, celiac trunk, and superior polar artery. The present studies also show that in two specimens (11, 5) the superior suprarenal is arising from aorta [12].

Middle Suprarenal Artery

In the present study, the origin of left middle suprarenal artery is from aorta in 34 specimens (45%).

Gagnon and Robert et al have shown that the origin is from the proximal part of inferior phrenic artery. In the present study it is seen in 2 specimens (13 and 25) that inferior phrenic artery before it divides into anterior and posterior division gives branches to the medial border of the gland(2.66%) [15, 16].

Gagnon, Merklin and Michels and Robert Merklin have shown the origin from the renal artery.In the present study this variation is seen in three specimen (7, 14, 17) accounts for 4% agreeing with work of above authors [16, 17].

Merklin and Michel have mentioned about the origin of middle suprarenal artery from superior polar artery. In the present study we have traced the middle suprarenal artery arising from superior polar artery in 1 specimen (1) accounts for 1.33% [12].

Normally middle suprarenal artery is single in most. But Gagnon, Merklin and Michel, Woodburne, Cunningham have mentioned about the multiple middle suprarenal arteries.

In the present study it is observed, it is single in 23 specimens on the right side (30.66%) and in 23 specimens on the left side (30.66%). Double in 1 specimen (14) on the right side (1.33%) and 1 specimen (2) on left side (1.33%) Triple on left side in 1specimen (11) (1.33%), on the right side 2 specimens showed multiple middle suprarenal arteries (7, 17) accounts for 2.66% [12].

Hollinshed and Cunningham have observed that the middle suprarenal is absent in some cases. In the present study also it is absent in 1 specimen (9)(1.33%) on the right side and in 2 (23, 25) specimens on the left side(2.66%) [5, 11].

Here we have also seen in three specimens (2.66%) (7, 17) that middle suprarenal arteries are four (multiple) in number and arising, one from the proximal part of inferior phrenic artery, one from the junction between the inferior phrenic and renal, two directly from renal artery. No such variation was mentioned in previous studies.

The middle suprarenal is usually a single branch and is distributed to anteromedial surface of the gland. In some instances it arises from the proximal part of inferior phrenic or from first part of renal.

In some instances the artery is double. In some it is absent [12, 13]. Present study also shows origin of middle suprarenal from proximal part of inferior phrenic in 3 (4%) cases, from first part of renal artery in 3 cases (4%), double in 2(2,14) cases (2.66%) or multiple in 2 (7,17) (2.66%) and absent in 3 cases (4%).

Inferior suprarenal artery

Gerard Piersol Fowler, Morris, Barry et al, Cunningham, Gagnon, Robert Merklin, Woodburne have shown that it normally arises from the renal artery. In the present study it is shown that in 65 (86.66%) specimens on the right and 66 (88%) specimens on the left side the origin is from the renal artery [12, 13].

In the present study specimen no: 14 showed the origin of inferior suprarenal artery from accessory renal artery on the right side in 2 cases accounting for 2.66% agreeing with the study of Hollinshed with presentations but not with percentage.

Merklin and Michels states that inferior supra -

renal artery may also arises from the aorta just below or above the origin of renal artery. In present study in one (1.33%) specimen (1) the origin is from the posterior aspect of the aorta below the level of renal artery on left side. In two (2.66%) specimen (11, 5) the origin is from the junction between aorta and renal artery on both the sides [12].

In 23% of cases the inferior suprarenal artery is double, one arising from aorta and other from the renal artery near the hilus of the kidney [Gerard 1913]. In present study two (2.66%) cases (5,14) of double inferior suprarenal artery and one case (1.33) specimen (13) multiple inferior suprarenal arteries were found.

The observation made by Gerard, Merklin and Michels, Robert Merklin and Hollinshed, F.T.Graves was that inferior suprarenal artery may arise from the accessory renal artery. In the present study in one (1.33) specimen (14) such observation is seen [12].

In the present study inferior suprarenal artery is found to be absent in one (1.33%) specimen (23) on the right side and one (1.33%) specimen (9) on the left side.

In the specimens where the present study shows that there is no branch given by the renal artery to the gland – requires further study by radiographic observation whether the superior polar artery in these cases supplies the gland because of the absence of inferior suprarenal artery has not been mentioned by any other author previously.

Inferior suprarenal artery normally arises as a single artery found by Gerard, Piersol. Fowler, Barry et al, Gagnon, Robert Merklin [12]. In the present study this artery is found to be single in 62 (82.66%) on the right side and 69 (92%) on the left side.

It is observed by Gerard, Robert Merklin, Hollinshed and F.T.Graves that it is double. In the present study it is found to be double in 3 (4%) specimens (7, 14, 17) on the right side, and in 3 (4%) specimens (5, 12, 23) on the left side [12] .

The artery was found to be multiple according to Gagnon, Hollinshed, and Cunningham. In our study it is found in 2 (2.66%) specimen (9, 13) on right side [11, 16].

Inferior suprarenal artery can arise from aorta [Robert j merklin and Nicholas 1958, S Dutta 2010]. Present study also shows the origin of inferior suprarenal artery from aorta in 2 (2.66%) cases(41, 43).

In the foetal specimen it is seen that the superior and middle suprarenal arteries are more constant than the inferior suprarenal arteries.

In foetal specimens the variations are more in inferior suprarenal artery. The inferior suprarenal artery is arising from aorta in 12 specimens.

Suprarenal vein

Supernumerary veins are as common as supernumerary arteries**,** at the level of suprarenal gland and kidney, because of the development of subcardinal, supracardinal, azygos venous line and their intercommunications with each other and with the posterior cardinal vein. So variations occur as a result of persistence and regression of embryonic vessels.

Cunningham's Text Book of Anatomy describes that the suprarenal gland is drained by a single large central vein which emerges through the hilus –on the right side, after a very short course, joins the inferior venacava; the left enters the left renal vein behind the body of pancreas, after receiving the inferior phrenic vein. This same description also correlates with the description of Gray's Anatomy 2005 [5].

Anatomy for Surgeons by Hollinshed – states about the single central vein emerging through hilus. The right vein runs medially to open into inferior venacava, or at the junction between inferior venacava and right renal vein or rarely in the right renal vein. The left vein runs downwards, joins with the inferior phrenic vein and opens into left renal vein [11].

In the present study the length of the right suprarenal vein varies from no extra glandular course i.e., 0 to 1.2 cm and the length of the left suprarenal vein from 0.2 to 2.3 cm.

F.R.C. Johnstone who has studied the suprarenal veins in fresh autopsy material with latex – in 8 out of 10 subjects he found to have a single right suprarenal vein – and 5 of them have joined the inferior vena cava and the remaining 3 of them have joined the right hepatic vein close to the

junction of hepatic vein with inferior venacava. In 1 specimen (6) there were 2 suprarenal veins on left side 3 suprarenal veins on right side – all opened into inferior vena cava(2.66%) [18].

In the present study out of 75 specimens, 71 specimens where found to have a single right suprarenal vein, all of them draining into the inferior vena cava(94.66%). In 2 specimens there are two suprarenal venison left side(2.66%) and in 1 specimen there are three suprarenal veins on right side(1.33%).

Fig. 1: Showing the Middle suprarenal arteries are four (multiple) in number and arising from the proximal part of inferior phrenic artery (17th Specimen).

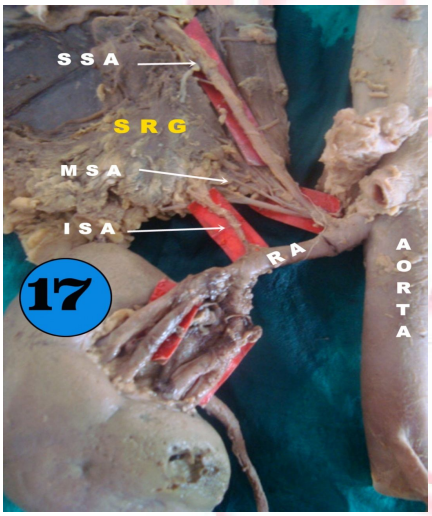


Fig. 2: Showing the Absence of middle suprarenal Artery on left side (23rd Specimen).

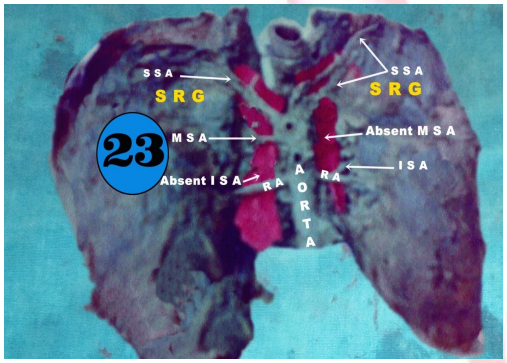


Fig. 3: Showing Inferior suprarenal artery arising from aorta (41st Specimen).

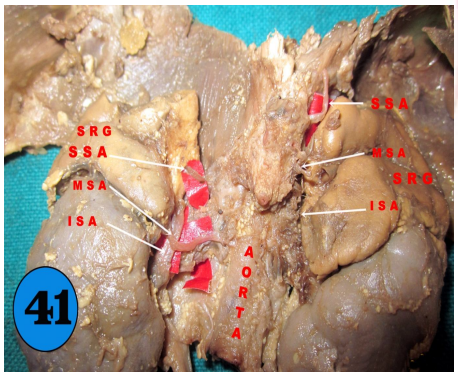
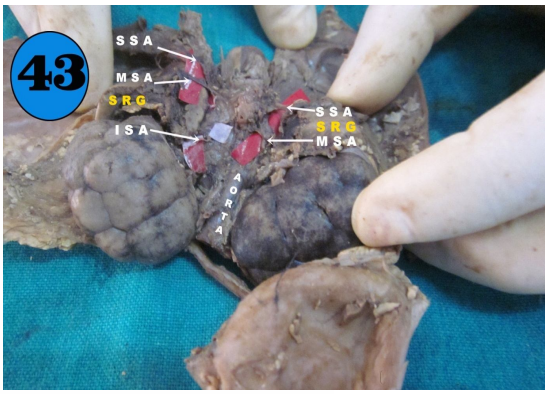


Fig. 4: Showing Inferior suprarenal artery arising from aorta (43rd Specimen).



SUMMARY AND CONCLUSION

The present study was undertaken to investigate the source of origin and number of arteries supplying the suprarenal gland and also mode of termination of suprarenal veins – its length and relation to inferior venacava, renal vein and gonadal veins.

The usual pattern of origin of superior, middle and inferior suprarenal arteries from inferior phrenic, aorta and renal arteries is found in the present study. A few variations in the origin of the superior suprarenal, middle and inferior suprarenal arteries are also found.

Multiplicity of the origin of superior, middle and inferior suprarenal arteries are also found in the present study.

In the case of suprarenal veins normally right vein drains into inferior venacava and left vein drains into renal vein. Present study also shows the same termination of suprarenal veins on the right and left side. Number of veins on the left side as well as on the right side in few specimens it is found to be double and in some multiple and all of them drain into inferior venacava.

Mode of termination of left suprarenal vein into the renal vein as well as into the inferior venacava is also noted.

Abbreviations :

S.S.A - Superior suprarenal artery
M.S.A - Middle suprarenal artery
I.S.A - Inferior suprarenal artery
I.P.A - Inferior phrenic artery
I.V.C - Inferior venacava
R.A - Renal artery
S.P.A - Superior polar artery
A.R.A - Accessory renal artery

Conflicts of Interests: None

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