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ORIGIN, COURSE AND DISTRIBUTION OF THE VENAE CORDIS IN THE DONKEY. (EQUAS ASINUS)

(With One Table and 7 Figures).

By

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منشأ ومسار وتوزيع الأوردة القلبية في الحمير

زين العابدين أنور يادم

أجريت هذه الدراسة على عشرين من قلوب الحمير البالغة من مختلف الأعمار ومن كلا الجنسين بوقد تمت معالجتها بالطرق التشريحية التقليدية وحقنها بمادة المطاط السائل من خلال نهايات كل من الوريد القلبي الكبير والوريد القلبي الأوسط.

وقد تم تقسيم الأوردة القلبية طبقاً لحجمها وكفاية توزيعها خلال عضلة القلب إلى قسمين:-

١- الأوردة القلبية العظمى ، وتشمل الوريد القلبي الكبير والوريد القلبي الأوسط.

٢- الأوردة القلبية الصغرى وتشمل الأوردة القلبية اليمنى والأوردة القلبية الدقيقة.

وقد أوضحت الدراسة أن الوريدان الكبير والأوسط يفتحان معا في البهو الأيمن من خلال فتحه بدون صمام بينما يوجد صمام لكل منهما يبعد مسافة قصيرة عن المنشأ. هذا وقد تبين أن الوريد القلبي الكبير يقوم أساساً بالتصريف الوريدي لكل من البطين الأيسر والبهو الأيسر، بينما يختص الوريد القلبي الأوسط بتصريف كلا البطينين. هذا ويوجد تفاعل ملحوظ بين تفرعات كلا الوريدين. ولقد أثبتت الدراسة أيضاً أن الأوردة القلبية اليمنى تتمثل بوريدين ينشأان من البهو الأيمن ويتم من خلالهما التصريف الوريدي للبطين الأيمن والبهو الأيمن. هذا ويوجد أيضاً تفاعل ملحوظ بين تفرعات الأوردة القلبية اليمنى ونظيرتها من الوريد القلبي الكبير. كما أوضحت الدراسة أيضاً أن الأوردة القلبية الدقيقة تكون ممثلة بتفرعات صغيرة جداً، تنتشر خلال عضلة القلب وتصب منفردة في كل من البطين الأيمن والبهو الأيمن. هذا وقد نوقشت هذه النتائج مع مثيلاتها في الحيوانات الأخرى.

SUMMARY

The venae cordis in the donkey can be classified in the current study as major (V.cordis magna and V.cordis media) and minor (Vv.cordis dextrae and Vv.cordis minimae) vessels. The major ones open via a valveless orifice in the Atrium dextrum. The V.cordis magna possesses a well developed valve, and the V.cordis media, has an ill-developed one near their origins. The former vessels, drains mainly the Ventriculus sinister and the Atrium sinistrum, as well as the Conus arteriosus. The V.cordis media, on the other hand, drains chiefly the two ventricles. An obvious intervenous anastomoses can be demonstrated between the terminal branches of the two major vessels. Collectively, the vessels co-operate to drain the Septum interventriculare via 8 to 10 small Rr. septales. The Vv.cordis dextrae are represented by two considerable branches which drain the Atrium dextrum as well as the Ventriculus dexter. Furthermore, an anastomoses between these branches and those of the V.cordis magna, can be traced. The Vv.cordis minimae were represented by several minute vessels being interposed within the myocardium and emptied into the Atrium dextrum as well as the Ventriculus dexter.

INTRODUCTION

The recent surgical techniques have established the necessity for the precise anatomic knowledge on the cardiovascular architecture of some domestic animals. The study of the venae cordis in the donkey was requisite to obtain a clear picture about the coronary circulation, which is beneficial to justify some cardiac defects in such animal.

MATERIAL and METHODS

The current study was carried out on twenty hearts of apparently normal donkeys of both sexes and of different ages. The specimens were injected with normal saline followed by coloured Gum milk in a retrograde manner via the V.cordis magna and V.cordis media. They were preserved in 10% formaline solution for 24 hours before dissection was performed. The use of a magnifying lens during dissection was of great help to persuade the fine ramifications particularly those of the Vv.cordis minimae. The nomenclature used was that adopted by

N.A.V. (1983) as well as HEMMODA and AMIN (1989) as possible.

RESULTS

According to the diameter as well as the sufficiency of distribution within the myocardium, the venae cordis of the donkey, could conceivably be classed as major and minor vessels. The former comprised the V.cordis magna and V.cordis media, however, the minor ones implied the Vv.cordis dextrae and Vv.cordis minimae.

I- V.cordis magna, (Figs. 1 & 3/1 and 2 & 4/7):

It was relatively a large main vessel, emanated with the V.cordis media by a valveless orifice at the caudo-ventral aspect of the Atrium dextrum, just ventral to the termination of the V.cava caudalis. The Sinus coronarius could not be traced in the dissected specimens. A well developed valve, on the other hand, could be observed about 1.5 cm from its origin. The V.cordis magna pursued within the Sulcus coronarius around the left ventricular border, accompanied with the R.circumflexus of the A.coronaria sinistra (Fig. 3/9). It traversed the preceding artery to gain the Sulcus interventricularis paraconalis where it continued caudal to the comparable artery.

Along its course, it detached the following tributaries:

1- Rr.intermedius, [Rr.margines ventriculares sinistri], (Fig. 2 & 4/6): They were represented by three relatively short branches, about 2.5 - 3 cm apart from each other. They proceeded distally to drain the proximal third of the atrial surface as well as the caudal aspect of the Ventriculus sinister via 6 to 8 small branches.

2- V.obliqua atrii sinister: It was represented by a considerable vessel, departed from the atrial aspect of the parent one, opposite to the preceding branches. It passed dorsally to gain the caudal aspect of the Atrium sinistrum where it split into 2 slender branches.

3- R.proximalis atrii sinister (Fig. 1 & 3/2): It was a weak vessel, directed craniomedially to drain the auricular part of the Atrium sinistrum.

4- R.proximalis ventricularis sinister (Fig. 1 & 3/3): It was a relatively long branch, departed from the ventricular aspect of the chief vessel. It sloped gently caudo - ventrad to drain the proximal third of the auricular surface of the Ventriculus sinister.

5- R.angularis (Fig. 1 & 3/4): It was a feeble branch, detached from the main vessel, just before it gained the Sulcus

VENAE CORDIS & DONKEY

interventricularis paraconalis. It contributed the preceding branch in the drainage of the Ventriculus sinister.

6- R.interventricularis paraconalis (Fig. 1 & 3/5): Constituted the direct continuation of the V.cordis magna within the Sulcus interventricularis paraconalis. It descended caudal to the corresponding artery up to the middle of this groove whereas it behaved a spiral course around the artery, to terminate approximately 5 cm above the apex of the heart.

Along its course, the R.interventricularis paraconalis gave off the following branches:

1- Rr.coni arteriosi *Fig. 1 & 3/6): It was a single slender branch, released from the cranial aspect of the chief vessel. It ran cranio-dorsally to drain the Conus arteriosus as well as the initial part of the Truncus pulmonalis.

2- Rr.collaterales proximalis et distalis (Fig. 1 & 3/7): They were represented by five small branches. Three of them emanated from the caudal aspect of the parent vessel, ran caudo-ventrally to drain the middle and distal thirds of the auricular surface of the Ventriculus sinister. The other two branches, on the other hand, were smaller and were released from the cranial aspect of the main vessel to drain the counterparts of the Ventriculus dexter. About 4-5 cm above the apex of the heart, an anastomosis could conspicuously be traced between the extreme distal branches and the corresponding ones of the V.cordis media.

3- Rr.septales: They were 4 to 5 offshoots, were departed from the deep aspect of the R.interventricularis paraconalis to participate in the drainage of the Septum interventriculare in common with those of the V.cordis media. In only two examined cases, the V.cordis magna (Fig. 6/1), was bifurcated into R.cranialis (Fig. 6/3) and R.caudalis (Fig. 6/4). The former continued within the Sulcus interventricularis paraconalis and issued 4 to 5 short tributaries to drain the middle and distal thirds of the two ventricles. The R.caudalis, on the other hand, passed caudally to drain the middle third of the Ventriculus sinister via two small branches.

II- V.cordis media, (Fig. 2 & 4/1):

Approximately 0.5 cm from its origin, caudoventral to the Atrium dextrum, an ill-developed valve could be distinguished. It descended within the Sulcus interventricularis subsinuus, caudal to the homonymous artery. About the middle of this groove, the vessel split into R.cranialis (Fig. 2 & 4/2) and R.caudalis (Fig. 2 & 4/3). The former descend cranial to the satellite artery, curved cranio-dorsally, about 1 cm dorsal to the apex, to gain the Sulcus interventricularis paraconalis

whereas it released 5 to 6 small branches to drain the distal portion of both ventricles. The R. caudalis, on the other hand, was relatively shorter, proceeded caudal to the same artery and inclined caudodorsally to break up into 2 to 3 small branches, draining the distal third of the Ventriculus sinister. In only one dissected specimen, the V. cordis media arose from the Atrium dextrum by a separate orifice distal to that of the V. cordis magna.

Along its course, the V. cordis media detached the following tributaries:

1- Rr. collaterales proximales et distales dexter, (Fig. 2 & 4/4): They were four considerable branches, diverged from the cranial aspect of the main vessel, cranioventrally to drain the proximal and middle thirds of the atrial surface of the Ventriculus dexter.

2- R. colateralis ventricularis sinister (Fig. 2 & 4/5): It was and obviously short vessel, originated from the chief one, immediately before its bifurcation. It passed caudoventrally to vascularize the middle third of the atrial surface of the Ventriculus sinister.

III- Vv. cordis dextrae (Fig. 1 & 3/8 and 5/1 & 2):

They were represented by two considerable vessels arose from the ventral aspect of the Atrium dextrum, an interval about 1 - 1.5 cm between their origins. The first vessel (Fig. 5/1), directed towards the Conus arteriosus, deep to the A. coronaria dextra (Fig. 5/4) and ramified into 4 to 5 considerable tributaries to drain the Conus arteriosus as well as the auricular surface of the Ventriculus dexter. An anastomosis could evidently be detected between these branches and those of the V. cordis magna. The second V. cordis dextra (Fig. 5/2) traversed the deep aspect of the A. coronaria dextra to gain the right ventricular border where it ramified. A feeble Ramus anastomoticus (Fig. 5/3), could be observed between the initial portion of the two Vv. cordis dextrae. It is worth to mention that, each V. cordis dextra released 1 to 2 fine twigs to drain the deep aspect of the Atrium dextrum. In only two examined cases, the Vv. cordis dextrae were represented by a single, apparantly short vessel (Fig. 7/1), which promptly split into a circumflex (Fig. 7/2) and a descending (Fig. 7/3) branch. The former traversed above the A. coronaria dextra (Fig. 7/5) towards the Conus arteriosus to drain the latter as well as the Atrium dextrum. The descending branch, was longer, bridged over the same artery and issued 4 to 5 small tributaries on the cranial aspect of the Ventriculus dexter. Furthermore, the V. cordis dextra also branched off a slender

VENAE CORDIS & DONKEY

atriale branch (Fig. (7/4) to drain the Atrium dextrum as well as its auricle.

IV- Vv.cordis minimae:

These group of veins were represented by numerous minute vessels, insinuated within the myocardium. Those drained the ventricular walls opened into the cavity of the Ventriculus dexter. However, those of the atria were less numerous and emptied into the cavity of the Atrium dextrum between the Mm. pectinati.

As a conclusion for the venous pattern presented, which explained lately in the table (1), the Ventriculus sinister was sufficiently drained (by seven branches) than the right one (via only four tributaries) which may be rendered to the thicker myocardium of the former.

DISCUSSION

Regarding the Sinus coronarius, in the donkey, the current study could not trace it in all dissected specimens. In the horse, on the other hand, it was either absent in most cases (CHRISTENSEN, 1958 & McKIBBEN and CHRISTENSEN, 1964) or represented by a short trunk (GHOSHAL; KOCH and POPESKO, 1981). However, in the ox, sheep and pig, it was relatively long (McKIBBEN and CHRISTENSEN, 1964).

The pattern of distribution of the V.cordis magna presented in this work showed a great resemblance to the findings of HEMMODA and AMIN (1989) in the buffalo. The latter authors, observed that the Rr.intermedius (Rr.marginis ventriculares sinistri) of the preceding vessel, were represented by two long branches being anastomosed with the adjoining ones of the R.interventricularis paraconalis. The present study, on the other hand, achieved that these tributaries were three, short ones, showing no anastomoses with the contiguous branches. Furthermore, HEGAZI (1962) in the camel, described a single vessel which was referred to as the V.cordis caudalis. The spiral course of the R.interventricularis paraconalis presented in the current study, could not be demonstrated by the preceding authors in camel and buffalo. It was relevant to point out that the initial portion of the two major vessels (V.cordis magna and V.cordis media) possessed a well-developed and an ill-developed valves respectively. Such a result was convenient to the findings of HEMMODA and AMIN (1989) in the buffalo. It was established that the branches of the R.interventricularis paraconalis anastomosed with those of the V.cordis media near the apex of the heart. This simulated what has been previously recorded by

HEMMODA and AMIN (1989) in the buffalo. They added that V.cordis media performed a complete ring around the spex. In the donkey, the V. cordis media was represented by a single vessel. However, in the dog (McKIBBEN and CHRISTENSEN, 1964), it was represented by two main vessels.

Concerning the Vv. cordis dextrae, the present study demonstrated two considerable branches, however, GHOSHAL *et al.* (1981) in the horse, described 4 to 6 small ones. Their origin from the Atrium dextrum and their drainage for the latter as well as the Ventriculus dexter simulated the present findings as well as those of CHRISTENSEN and CAMPETI (1959) in the dog and pig and SMUTS and BEZUIDENHOUT (1987) in the camel. The intervenous anastomoses between these branches and those of the V.cordis magna, presented in the current study, was ascertained by the findings of CHRISTENSEN and CAMPETI (1959) in the pig. However, the Ramus anastomoticus between the two Vv.cordis dextrae, presented in this work, could not be traced by the preceding authors. CHRISTENSEN and CAMPETI (1959) revealed that the left side of the heart of the dog and pig (including both atria and ventricles) was greatly vascularized than the right one. On the other hand, the present study, achieved that the Ventriculus sinister was sufficiently drained than the Ventriculus dexter which may be rendered to the thicker myocardium of the former.

LEGENDS

Fig. 1: Diagramatic representation showing the pattern of distribution of the V.cordis magna and Vv.cordis dextrae in the heart of the donkey, left side: 1-V.cordis magna. 2-R.proximalis atrii sinister. 3-R.proximalis ventricularis sinister. 4-R.angularis. 5-R.interventricularis paraconalis. 6-R.conus arteriosus. 7-Rr.collaterales proximales et distales. 8-Vv.cordis dextrae. 9-A.coronaria sinistra. (A) Truncus pulmonalis. (B) Auricula dextra. (C) Auricula sinistra. (D) Arcus aortae. (E) Ventriculus dexter. (F) Ventriculus sinister.

Fig. 2: Diagramatic representation showing the pattern of distribution of the V.cordis media in the heart of the donkey, right side: 1-V.cordis media. 2-R.cranialis of (1). 3-R.caudalis of (1). 4-Rr.collaterales proximales et distales dexter. 5-R.collateralis ventricularis sinister. 6-Rr.intermedia. 7-V.cordis magna. 8-A.coronaria dextra. 9-V.cava cranialis. 10-V.cava caudalis. 11-Arcus aortae. (A) Atrium dextrum. (B) Atrium sinistrum. (C) Ventriculus dexter. (D) Ventriculus sinister.

Fig. 3: Photographic representation showing the pattern of distribution of the V.cordis magna in the heart of the donkey, left side : 1-V.cordis magna. 2-R.proximalis atrii sinister.

VENAE CORDIS & DONKEY

3-R.proximalis ventricularis sinister. 4-R.angularis.
 5-R.interventricularis paraconalis. 6-R.conus arteriosus.
 7-Rr.collaterales proximales et distales. 8-Vv.cordis dextrae.
 9-R.circumflexus of A.coronaria sinistra. A-Truncus pulmonalis.
 (B) Auricula dextra. (C) Auricula sinistra. (D) Arcus aortae.
 (E) Ventriculus dexter. (F) Ventriculus sinister.

Fig. 4: Photographic representation showing the pattern of distribution of the V.cordis media in the heart of the donkey, right side: 1-V.cordis media. 2-R.cranialis of (1). 3-R.caudalis of (1). 4-Rr.collaterales proximales et distales dexter. 5-R.collateralis ventricularis sinister. 6-Rr.intermedia of V. cordis magna (Rr.marginis ventricularis sinistri). 7-V.cordis magna. 8-A.coronaria dextra.

Fig. 5: Photographic representation showing the pattern of distribution of the Vv.cordis dextrae in the heart of the donkey, cranial view: 1-First V.cordis dextra. 2-Second V.cordis dextra. 3-R.anastomoticus. 4-A.coronaria dextra. (A) Atrium dextrum. (B) Ventriculus dexter. (C) Conus arteriosus.

Fig. 6: Photographic representation showing an exceptional pattern of distribution of the V.cordis magna in the heart of the donkey, left side: 1-V.cordis magna. 2-R.interventricularis paraconalis. 3-R.cranialis of (2). 4-R.caudalis of (2). 5-R.interventricularis paraconalis of A. coronaria sinistra. (A) Atrium sinistrum. (B) Ventriculus sinister. (C) Ventriculus dexter. (D) Truncus pulmonalis.

Fig. 7: Photographic representation showing an exceptional pattern of distribution of the Vv.cordis dextrae (represented by a single vessel), in the heart of the donkey, cranial view; 1-V.cordis dextra. 2-R.circumflexus of (1). 3-R.descendous of (1). 4-R.atrialis of (1). 5-A.coronaria dextra. (A) Atrium dextrum. (B) Ventriculus dexter. (C) Truncus pulmonalis.

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Table (1) : The veins draining the different parts of the heart of the donkey and their origin.

Part of the heart.	The vessel.	The origin of the vessel.
Atrium dextrum.	- Vv. cordis dextrae.	- from Atrium dextrum.
Ventriculus dexter.	1- Rt. collaterales proximales et distales.	- from R. interventricularis paracostalis.
	2- Rt. collaterales proximales et distales dexter.	- from V. cordis media.
	3- R. cranialis of V. cordis media.	- from V. cordis media.
	4- Vv. cordis dextrae.	- from Atrium dextrum.
Atrium sinister.	1- V. obliquus atrii sinister.	- from V. cordis magna.
	2- R. proximales atrii sinister.	- from V. cordis magna.
Ventriculus sinister.	1- Rt. intermedia.	- from V. cordis magna.
	2- R. proximales ventricularis sinister.	- from V. cordis magna.
	3- R. angularis.	- from V. cordis magna.
	4- Rt. collaterales proximales et distales.	- from R. interventricularis paracostalis.
	5- R. cranialis of V. cordis media.	- from V. cordis media.
	6- R. caudalis of V. cordis media.	- from V. cordis media.
	7- R. collaterales ventricularis sinister.	- from V. cordis media.
Septum interventriculare	- Rt. septales.	- from R. interventricularis paracostalis.
Conus arteriosus	- R. conus arteriosus.	- from V. cordis media.
	- V. cordis dextra.	- from R. interventricularis paracostalis.

VENAE CORDIS & DONKEY

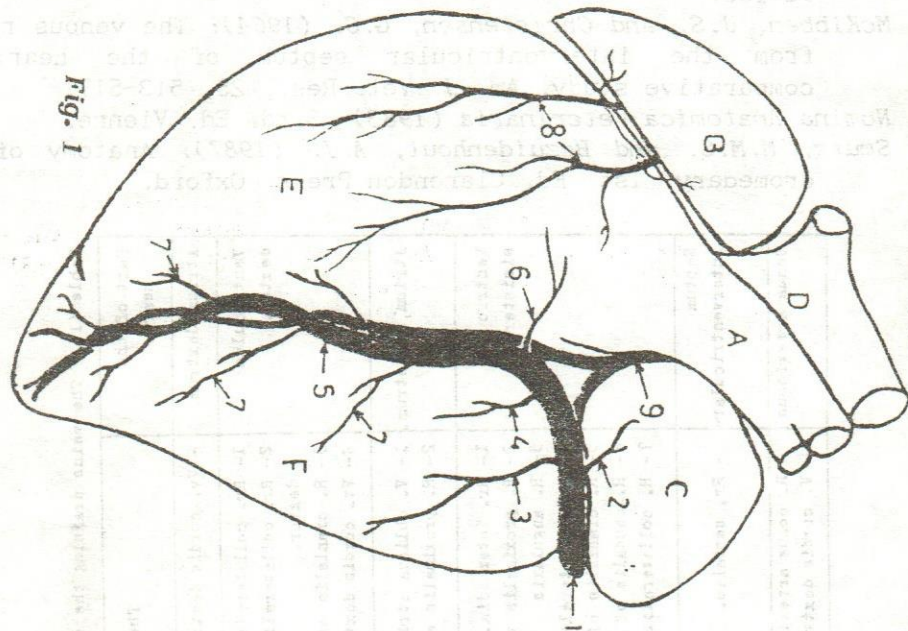


Fig. 1

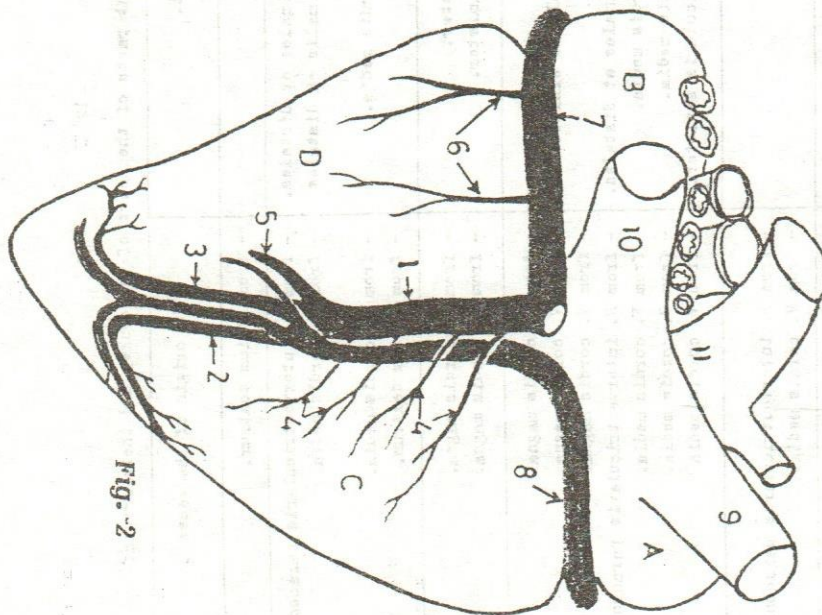


Fig. 2

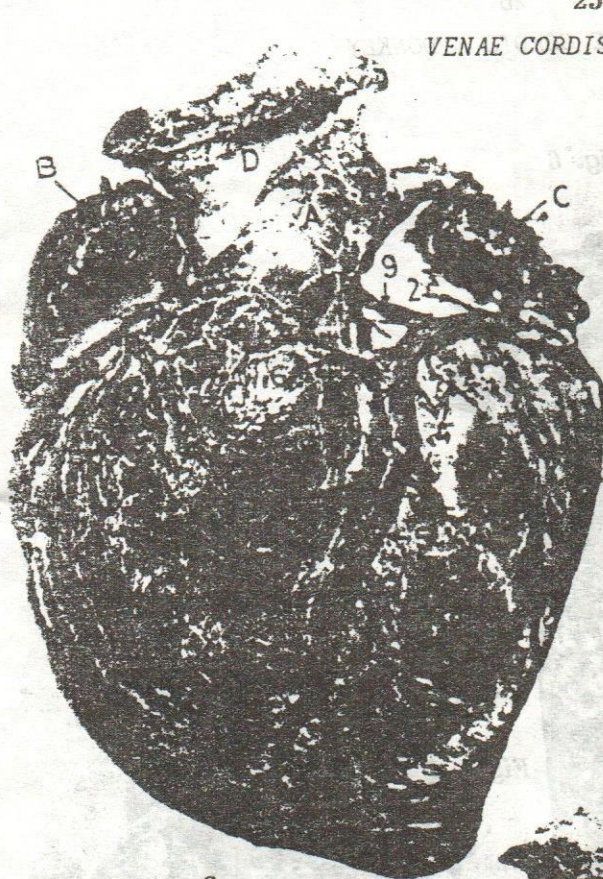


Fig. 3



Fig. 5

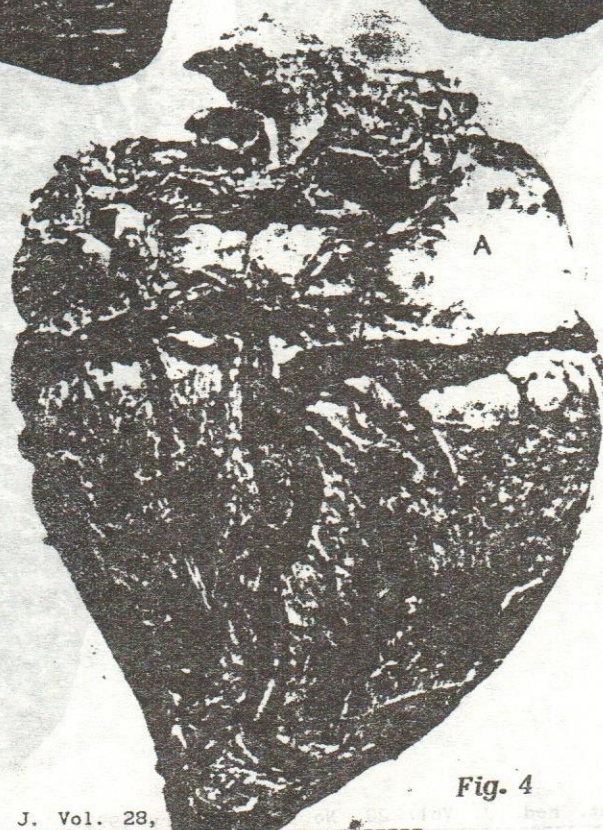


Fig. 4

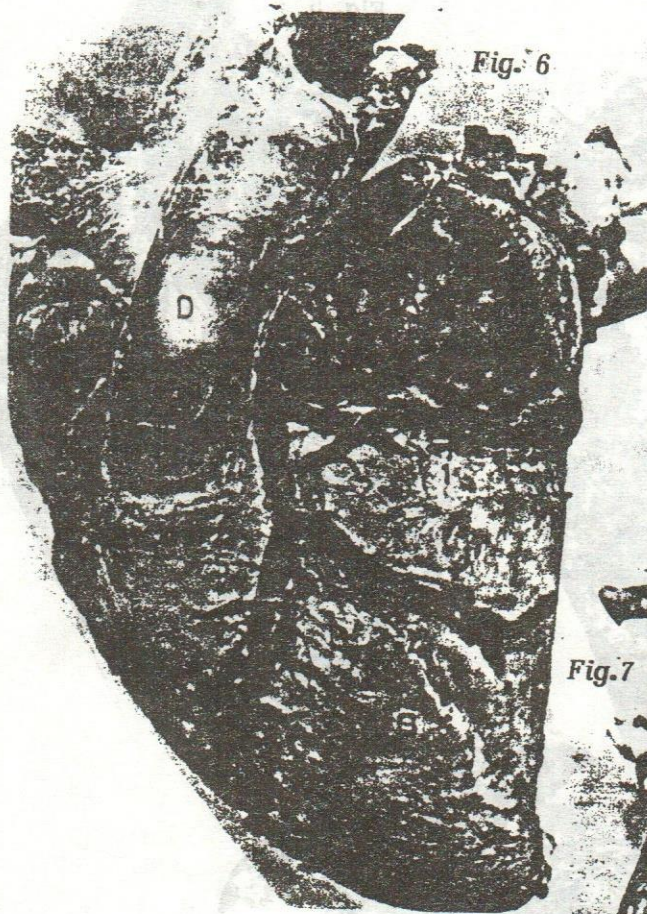


Fig. 6



Fig. 7