ANATOMICAL STUDY OF TRIANGLE OF BROCQ AND MOUCHET IN HUMAN CADAVERIC HEART

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ABSTRACT

Right and left coronary arteries maintain the nutritional supply of heart. The left coronary artery (LCA) bifurcates into Anterior Interventricular Artery (AIA) and Circumflex Artery (CA). Triangle of Brocq and Mouchet is an arterio-venous triangle formed by AIA and CA of left coronary artery and great cardiac vein (GCV) that lies between conus aretriosus and left auricle. This study aims to determine frequency of Brocq and Mouchet triangle and its anatomical details. This study was conducted in thirty formalin fixed cadaveric hearts collectively available in the Department of Anatomy, Nepal Medical College from November 2019 till April 2020. The incidence of heart showing the triangle was 93.3% with the most common type being closed which is followed by inferiorly opened, superiorly opened, and completely opened. Most frequent content of the triangle was median artery followed by diagonal branches of AIA and CA. the mean area of the triangle was 218.84mm^2(527.97 mm^2-57.26 mm^2). The branches of LCA varied from bifurcation to pentafurcation. Relationship of GCV with AIA and CA was found to be either superficial or deep. The anatomical knowledge of the Brocq and Mouchet triangle regarding arterio-venous relationship will be required for angiographic procedures. Also, the triangle is a potential epicardial access route to mitral valve annulus thus detailed anatomical knowledge of the triangle will help cardiologist to achieve successful cardiological procedures with minimal complications.

KEYWORDS

Arterio-venous triangle, Brocq and Mouchet triangle, left coronary artery

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INTRODUCTION

Nutritional supply of heart is maintained through the right and left coronary artery and their branches. Right coronary artery arises from anterior aortic sinus and left coronary artery from left posterior aortic sinus of ascending aorta. These arteries and its major branches are usually subepicardial but in atrioventricular and interventricular groove they are often embedded within the myocardium.[1] Left Coronary Artery (LCA) on reaching the atrioventricular groove, bifurcate into Anterior Interventricular Artery (AIA) and Circumflex Artery (CA). But in some cases, LCA may trifurcates or quadrifurcates resulting diagonal arteries directly from the trunk of LCA.[2]

Triangle of Brocq and Mouchet is an arterio-venous triangle formed by AIA and CA of left coronary artery and great cardiac vein (GCV).[3] Topographic region of the triangle is located between conus aretriosus and left auricle.[4] The left coronary artery after its short course bifurcates into AIA and CA forming the apex of the triangle. Base of the triangle is formed by GCV when it leaves the anterior interventricular groove and terminates into left end of coronary sinus.[5] Lateral boundaries of the triangle are formed by AIA and CA of left coronary artery.

According to disposition of the structures forming its boundary, the triangle can be divided into four types; inferiorly open, close, superiorly open, and completely open. The triangle can even be absent in some individuals.[6] The triangle, when present has diagonal artery as its content.[2]
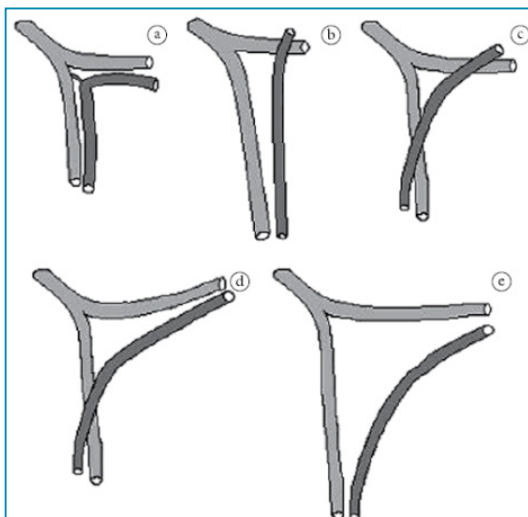

Fig. 1: Classification of triangle of Brocq and Mouchet. a) absence of triangle, b) Inferiorly opened, c) completely closed, d) superiorly opened, e) completely opened[5]

The apex of the triangle of Brocq and Mouchet is the area frequently subjected to surgical procedures where numbers of small blood vessels coexist, so there is high risk of injury.[6] The GCV, if present deep to the rigid arteries may be compressed, hindering venous return and also, anatomical knowledge regarding arterio-venous relationship will be required for angiographic procedures. The triangle is a potential epicardial access route to mitral valve annulus.[7] The present study aimed to determine the frequency and morphology of the Brocq and Mouchet triangle in Nepalese cadaveric heart.

MATERIALS AND METHODS

This observational and descriptive study was carried out in Department of Anatomy of Nepal Medical College (NMC) from November 2019 till April 2020 after obtaining ethical approval from Research and institutional review committee (IRC) of NMC. Thirty intact cadaveric hearts, fixed in 10% fromalin collected in the Department of Anatomy since 2012 till the end of 2019 were included. Sample size has been calculated using the formula,[8]

$$n = \frac{z^2\, p\, (100 - p)}{d^2}$$

where Z= 1.96 for 95% reliability, P; given proportion (93.3% Roy et al.) and d; maximum tolerable error (10% of p).

Procedure:

The epicardial fats on the heart were cleared along the course of LCA from left posterior aortic sinus. The trunk of LCA was carefully traced until its terminal branches. GCV was traced from its formation at the apex of heart till its termination into CS. The arteriovenous triangle of Brocq and Mouchet was delineated and classified into different types. The relationship of the vessels forming its boundaries and content of the triangle were observed.

An electronic digital vernier caliper was used to measure the extensions of vessels that formed the boundaries of the trigone. Knowing the length of its sides, its area was calculated, using the Heron's formula,[9]

$$A = \sqrt{P\,(P - a)\,.\,(P - b)\,.\,(P - c)}$$

where P represents the semi-perimeter (sum of the sides divided by two) a, b, c the extensions of the sides of the trigone.

RESULTS

Thirty cadaveric hearts were observed for the presence of Brocq and Mouchet triangle. The triangle was found in 28 hearts (93.3%) and in remaining two (6.7%) heart; triangle was absent (Fig. 2).
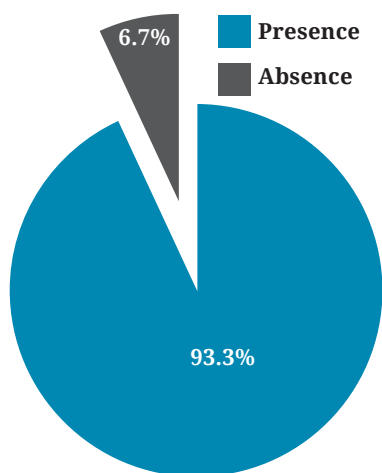

Fig. 2: Pie chart showing frequency of Brocq and Mouchet triangle

Regarding classification of the triangle, the patterns of distribution were found to be; closed in 24 (85.7%) hearts, inferiorly opened in three (10.7%) and superiorly open in one (3.6%) hearts (Fig. 3).

Among the specimens where triangle was present, the content of the triangle was found to be third branch of LCA (Median artery) in 11(39.3%) hearts, diagonal branch of CA in eight (28.6%) hearts, and diagonal branches of both AIA and CA in eight (28.6%) hearts. Remaining one heart showing the triangle had tributary of GCV as its content instead of artery. The mean area of the triangle was found to be 218.8mm^2 ranging from maximum 527.9mm^2 and minimum 57.3mm^2.

The LCA was found to bifurcate in 12 (40.0%), trifurcates in 13 (43.0%), quadrifurcates in four (13.3%) and pentafurcates in one (3.3%) heart. The relationship of GCV with AIA was found to be superficial in 11 (40.7%) and deep in 16 (59.3%) hearts. Similarly GCV was found to be superficial to CA in 21 (72.4%) and deep to CA in eight (27.6%) hearts.

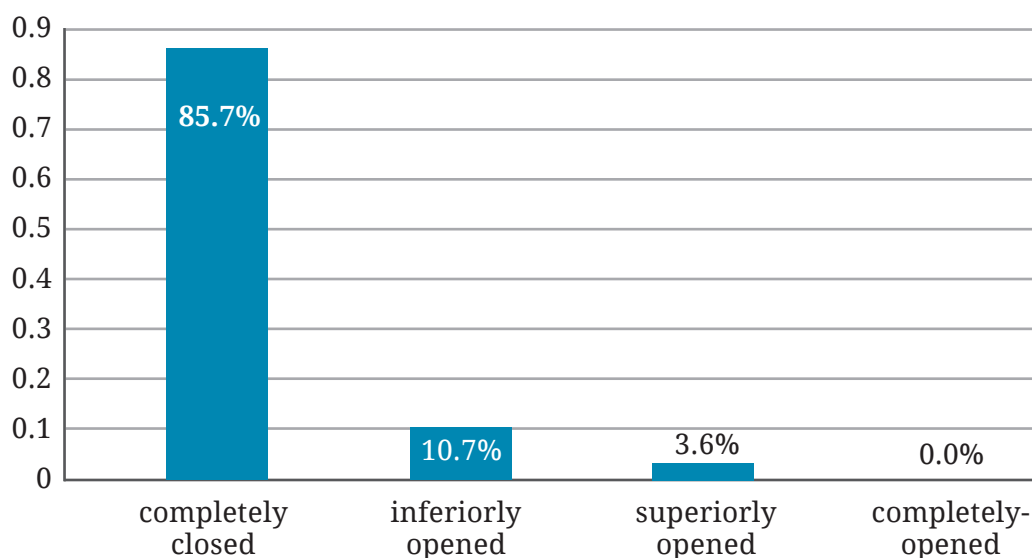| Table 1: Relationship of GCV with AIA and CA				
	AIA	**Percentage n(%)**	**CA**	**Percentage n(%)**
Relationship of GCV with;	Superficial	11(40.7)	Superficial	21(72.4)
	Deep	16(59.3)	Deep	8(27.6)
	*Total 27, excluding 3 inferiorly opened		*Total 29, excluding 1 superiorly opened	

Fig. 3: Classification and distribution of Brocq and Mouchet triangle

Fig. 4: Left view of the heart; Completely closed,
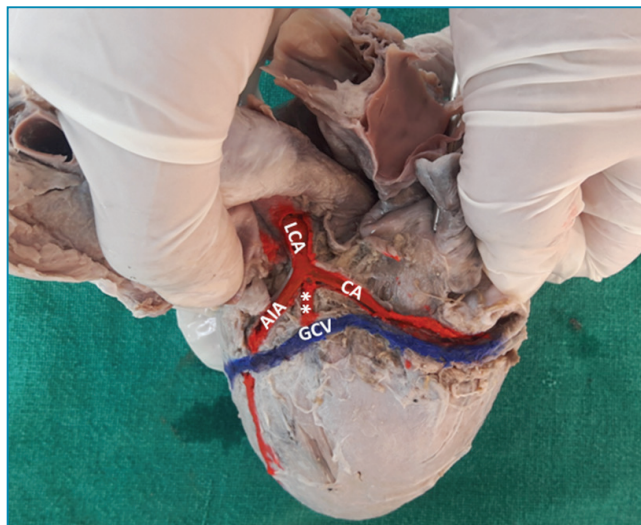Asterisk – diagonal arteries of CA

Fig. 7: Left view of the heart; Superiorly opened,
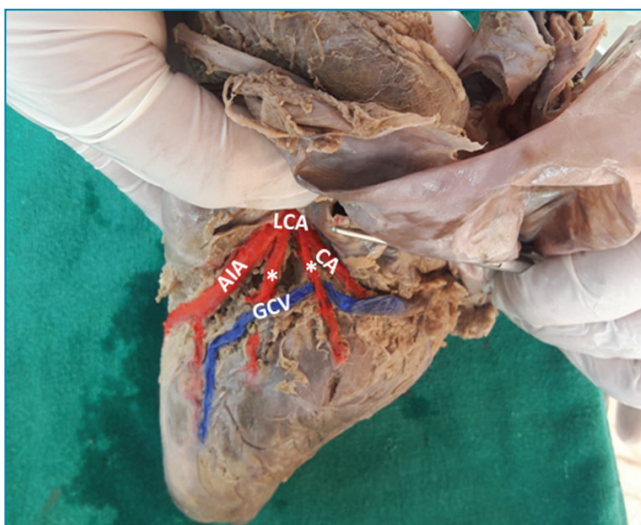Double asterisk– 3rd branch of LCA

Fig. 5: Left view of the heart; Inferiorly opened,
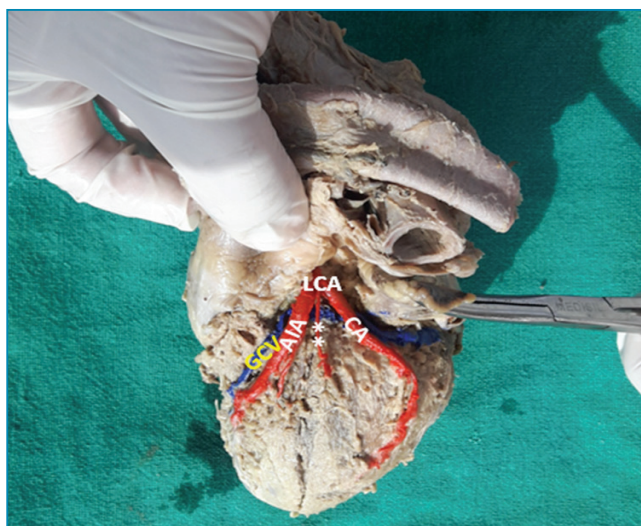Asterisk - diagonal arteries of AIA and CA

Fig. 6: Left view of the heart; Absence of triangle,
Double asterisk – 3rd branch of LCA

DISCUSSION

The present study was conducted to determine frequency of Brocq and Mouchet triangle, its classification, relationship of vessels forming it, content and area of the triangle. The triangle of Brocq and Mouchet was present in 28 (93.3%) hearts and absent in 2 (6.7%) hearts. Similar study was conducted by Roy *et al* in North Indian population with presence of triangle in 93.3% hearts and absence of triangle in 6.67% hearts.[10] In contrast to this study, authors observed slightly lower incidence (86.9%) of hearts containing the triangle in Brazilian cadaveric hearts[11] whereas, in a corrosion cast study conducted by Suma *et al* in South Indian heart found higher incidence (98%) of the triangle.[12]

Regarding frequency of types of the triangle, in this study closed triangle was the most common type found in 24 (85.7%) hearts, least common being superiorly open type in one (3.6%) and completely open type was not found in any of the hearts. Present study was comparable with the studies carried out by Roy *et al*. and Bharathi *et al* as having closed type the most common and completely open type the least common types of triangle however the frequency of closed type was comparatively lesser in both studies; 46.43% and 50% respectively while completely open type was higher being 10.71% and 6.7% respectively.[10,13] Unlike this study, the study carried by Andrade *et al* and Rodrigues *et al* concluded the sequence of most common type of triangle to be inferiorly opened type, closed type, completely opened type and superiorly opened type.[6,11] As almost all studies were cadaveric, the normal anatomy

in some specimens may not be clear or may be disrupted while dissecting which might explain the difference in frequency of each types of triangle in various studies.[12] Also, this variation in incidence of the triangle might be due to the difference in sample size of the studies.

was deep to CA. If the position of GCV lies deep to either of rigid wall AIA or CA, may cause compression to the vein resulting in altered venous return. Gerber *et al* suggested that percutaneous coronary artery bypass grafting is not suitable in individuals with crossing of

Table 2: Comparing the frequency of the triangle and its type from different studies

Authors	Population	Sample size (N)	Incidence of triangle	Frequency of types of triangle			
				Closed	SO	IO	CO
Suma *et al* (2019)	South India	104	98%	6.7%	0.9%	87.5%	1.9%
Kulkarni *et al* (2014)	South India	52	95.9%	38%	10%	37%	12%
Roy *et al* (2016)	North India	30	93.3%	46.4%	14.3%	28.6%	10.7%
Bharathi *et al* (2013)	South India	30	86.7%	50%	10%	20%	6.7%
Andrade *et al* (2010)	Brazil	23	86.9%	21.7%	8.7%	39.1%	17.4%
Rodrigues *et al* (2004)	Brazil	26	88%	35%	4%	52%	9%
Present study	Kathmandu, Nepal	30	28 (93.3%)	24 (85.7%)	1 (3.6%)	3 (10.7%)	0

Relationship of arteries and vein forming the triangle had been studied by many authors. Present study found GCV to be superficial to AIA in 11 (40.7%) hearts while deep to it in 16 (59.3%) hearts. Relationship of GCV with CA was superficial in 21 (72.4%) and deep in eight (27.6%) hearts which was similar to Ortale *et al* showing 73% of hearts to be superficial and 22% deep to CA.[5] However, Mehra *et al* found total 40 hearts were superficial to CA and

AIA and GCV since the site of overlap can mask the calcification of artery.[15]

According to many authors, diagonal artery is the content of the triangle in 100% of cases with some minor left ventricular branches.[6,11,13] Similar was the case in present study with diagonal artery as the content in 27 (96.4%) hearts. Present study traced the origin of diagonal artery and found it to originate either

Table 3: Comparing the Branching pattern of LCA from different studies

Authors	N	Branching pattern of LCA			
		Bifurcation	Trifurcation	Tetrafurcation	Pentafurcation
Kulkarni (2014)	52	34.7%	53.06%	10.02%	2.04%
Miraz 2015	40	45%	42.5%	10%	-
Kalpana 2003	100	47%	40%	11%	1%
Julius 2014	208	54.8%	32.2%	9.6%	3.4%
Baptista 1990	150	54.7%	38.7%	6.7%	-
Present study	30	12(40%)	13(43%)	4(13.3%)	1(3.3%)

parallel to AIA without crossing between two.[14] The relation between GCV and both arterial branches (AIA and CA) in present study were; no crossing any arterial branches in 6.7% (absence of triangle), GCV superficial to both arteries in eight (33.3%), GCV deep to both arteries in four (16.7%), superficial to one of the artery and deep to another in 12 (50%), parallel to AIA and crossed CA in four (14.3%), parallel to CA and crossed AIA in one (3.6%). GCV was most commonly deep to AIA but in only one case it

directly from LCA or from AIA or CA. Diagonal branches of LCA in addition to AIA and CA is referred as median artery.[16] Diagonal artery in the form of median artery is present as the content of the triangle in 11(39.3%) hearts which was alike to Kalpana *et al* having 40% cases[17] contrast to kulkarni *et al* having median artery in 65.3% of cases.[18] Diagonal branches from CA was present in eight (28.6%) and diagonal branches from both AIA and CA in eight (28.6%) hearts varying in number from

1 to 2 diagonal branches from each. In most of the cases with diagonal arteries, GCV was deep to the artery. In contrast, tributary of GCV was found as content in one of the heart 3.3% which has also been mentioned to be present in a study made by Rodrigues *et al* in 70% of hearts.[6]

Branches of LCA was found to bifurcate in 40% (12) of hearts, trifurcates in 43% (13) hearts, quadrifurcates in 13.3% (4) and pentafurcates in 3.3% (1) of hearts similar to the study of Kulkarni *et al* with bifurcation in 34.7%, trifurcation in 53.06%, tetrafurcation in 10.02% and pentafurcation in 2.04%.[18] Similarly Miraz *et al* found LCA bifurcates in 45%, trifurcates in 42.5%, and quadrifurcates in 10% of hearts.[16] Present study is also comparable with the study of Kalpana *et al* who found the incidence of bifurcation as 47%, trifurcation 40%, quadrification 11% and pentafurcation 1%.[17] Pentafurcation is not so common as found by Bhimalli *et al* 1%, Surucu *et al* 2.5% and Julius *et al* 3.4%[19,20,21] alike to this case 3.3%.

The mean area of the triangle was found to be 218.84mm^2 with the range of 57.26 to 527.97mm^2. While Rodrigues *et al* found the area of the triangle varied between 147 to 762mm^2 with an average of 369mm^2 which was slightly higher than the present study findings.[6]

In conclusion, the incidence of heart showing the triangle was 93.3% with the most common type of triangle in an order of closed, inferiorly opened, superiorly opened and completely opened. Most frequent content of the triangle was median artery followed by diagonal branches of AIA and CA. the mean area of the triangle was 218.84mm^2 (527.97mm^2-57.26mm^2). The branches of LCA varied from bifurcation to pentafurcation. Relationship of GCV with AIA and CA was found to be either superficial or deep. The anatomical knowledge of the Brocq and Mouchet triangle regarding arterio-venous relationship will be required for angiographic procedures. Also, the triangle is a potential epicardial access route to mitral valve annulus thus detailed anatomical knowledge of the triangle will help cardiologist to achieve successful cardiological procedures with minimal complications.

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