Prevalence of Third Coronary Artery: Variation or Constant Coronary Artery?

Prevalencia de la Tercera Arteria Coronaria: ¿Variación o Arteria Coronaria Constante?

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MARIC, D. L.; COLIC, B.; MIROVIC, B.; ERIC, M.; RADOSEVIC, D.; KNEZI, N. & MARIC, D. M. Prevalence of third coronary artery: Variation or constant coronary artery? Int. J. Morphol., 36 (4):1241-1245, 2018.

SUMMARY: Third coronary artery or supernumerary coronary artery is a direct branch from right aortic sinus and it supplies pulmonary conus and upper part of right ventricle. Third coronary artery is an important bridge for collateral circulation between right and left coronary system. The aim of this study was to determine the number of arteries that origin from right aortic sinus, their frequency and position. The study included 55 adult human hearts collected from Department of Anatomy. The hearts were morphologically studied by gross dissection for the prevalence and topographical anatomy of supernumerary coronary arteries. Out of 55 hearts, 26 (47.3 %) had one right coronary artery, 23 (41.8 %) had two right coronary arteries, and 6 (10.9 %) had three coronary arteries. The supernumerary arteries arises from the right aortic sinus. Right supernumerary coronary arteries may be present in about 52.7 % of the Serbian population. Interpretation of signs and symptoms of coronary occlusion should therefore consider possible contribution of this blood vessels.

KEY WORDS: Supernumerary coronary artery; Third coronary artery; Right coronary artery.

INTRODUCTION

The arterial supply of heart is provided by right and left coronary arteries. The levels and number of coronary ostia are occasionally variable. Variation of coronary artery is usually related to the length, branches quantity, origin and irrigated territories (Ballesteros et al. 2011).

The high incidence of supernumerary arteries on right is in marked contrast to the rare occurrence of accessory vessels to left coronary artery system (Schlesinger et al. 1949).

Conus artery is the first branch of right coronary artery (RCA). Immediately after its origin, it ramifies anteriorly on the lowest part of pulmonary conus and upper part of right ventricle. When conus artery arises independently from the anterior aortic sinus it is called as third coronary artery (TCA) (Schlesinger et al.; Udayasankari & Jain, 2014). It is also known as preinfundibulbar or right Vieuussens's artery, adipose or accessory artery, and supernumerary coronary artery (Schlesinger et al.; Lujinovic et al., 2008). Fourth coronary artery (FCA) can be present when two conus arteries, each with independent aortic origin, are present (Fiss, 2007).

Although its distribution is relatively unexplored, TCA may supply variable parts of the anterior wall of the right ventricle and the interventricular septum (Sahni & Jit, 1990; Ben-Gal et al., 1997; von Lüdinghausen & Ohmachi, 2001).

The reported prevalence of the TCA ranges from 33 to 51 % with evidence of age and ethnic variability (Schlesinger et al.; Miyazaki & Kato, 1988; Stankovic & Jesic, 2004; Standring, 2016).

Various authors have suggested that TCA provides a collateral connection between the right and left coronary arteries, and the anastomosis is known in the literature as Vieuussens ring which is formed around the pulmonary trunk. This ring represents a significant path of collateral circulation under conditions of coronary insufficiency (Sankari et al., 2011).

Understanding variations of coronary artery is important in the diagnosis of unexplained clinical signs and symptoms as well as surgical procedures.

TCA may be a benefit for the person having it (Sankari et al.). Collateral circulation is a key factor in the
pathophysiology of coronary artery disease. Symptoms and prognosis among patients with advanced coronary artery disease depend largely on the degree of collateral circulation (Gouda et al., 2009).

This study was undertaken with the purpose of estimating the number of arteries that origin from right aortic sinus, their frequency and position.

MATERIAL AND METHOD

The study was carried out in 55 formalin fixed normal adult human hearts obtained from the collection of Department of Anatomy, Faculty of Medicine, University of Novi Sad, Serbia. Specimens with observable cardiac defects or congenital anomalies were excluded from the study. Approval from the Institutional Ethics committee was taken for the study.

The hearts were dissected to prove the origins of right supernumerary coronary arteries. With the aid of dissecting lenses, the branches of the supernumerary coronary artery were displayed and traced distally to confirm the course, branching and termination. Next the aorta was longitudinally opened at the level of right posterior aortic sinus to enable the visualization and analysis of coronary ostia. The most representative specimens were photographed with the camera "Olympus" (18x optical zoom). We analyzed the macroscopic appearance, location and relationship of right coronary artery with supernumerary arteries and divided them into basic groups. The external diameters at the starting points of these branches were measured using 0.01 mm sensitive digital calipers. To determine the dominant circulation, the artery that supplies the posterior interventricular sulcus was investigated.

The incidence of supernumerary coronary artery and type of arterial vascularization of the heart is statistically analyzed.

RESULTS

Out of 55 dissected hearts, 26 (47.3 %) had one right coronary artery, 23 (41.8 %) had two coronary arteries, and 6 (10.9 %) had three coronary arteries.

The supernumerary arteries arises from the right anterior aortic sinus, close to the origin of RCA (Fig. 1).

The orifice, in all cases, was in front of and right from the orifice of RCA. Radius of the orifice of TCA was 1-2 mm, and its distance from the orifice of RCA was 1.5-4.5 mm. In all cases TCA supply conus arteriosus, anterior wall of the right ventricle, interventricular septum and the apex of the heart. TCA was found to arise independently from the anterior aortic sinus. TCA had subepicardial course without any myocardial bridges and noticeable anastomosis, and distance...
from the orifice of RCA was 1.5-4.5 mm. In these hearts
ostium of TCA was located at the same level and to the left
of the ostium of RCA.

FCA was present in 6 hearts (10.9 %) (Fig. 3). These
6 hearts showed 3 ostia in anterior aortic sinus (for RCA,
TCA and FCA). Ostium of FCA was located at the same
level and right of the ostium of TCA. FCA originated from
separate right aortic sinus with orifice radius from 0.5 to 0.8
mm, and distance from the orifice of RCA was 2.5-4.5 mm.
All these FCA were short, single vessels which supplied the
pulmonary cone.

We found that at 54 of hearts (93.33 %) was
represented the right type of arterial vascularization while
only 1 heart (6.67 %) was represented the left type.

discussion

Morphological analysis of 55 hearts has revealed a
prevalence of 47.3 % of RCA, 41.8 % of TCA, while FCA
is the rarest artery (10.9 %). Other dissection studies have
reported various incidence which are shown in Table I.

These findings suggest ethnic variability and appear
to support the suggestion by Garg et al. (2000) that there are
geographical differences in coronary artery variations, which
may have a genetic background. Ballesteros et al. and Apsara
(2014) results did not prove any statistically relation between
the prevalence of TCA and sex.

Different methodologies used for the study may also
contribute to the observed variations. Coronary angiograms
frequently are unsuccessful to visualize TCA (Jyothi
Lakshmi et al., 2017) or FCA.

Earlier embryologists confirmed that coronary
arteries developed by angiogenesis (i.e. growing from aortic
root). The recent studies have shown that the coronary
arteries develop from a complex capillary network derived
from epicardial mesenchyme. The significant positive
correlation between the lengths of RCA with the fetal age
indicated that there are significant changes in the
development of the coronary vasculature with fetal heart
development. The separate orifices for TCA and RCA had
been explained by inadequate unification of these two
vessels, during their growth towards the ascending aorta
(Reese et al., 2002; Singh et al., 2017). Olabu et al. (2007)
noticed three types of origin of TCA depending on the
number of orifices (common orifice with the RCA, single
orifice separate from that of the RCA, and two orifices).

Since the right conus artery did not arise from the
RCA always, the study of level of ostium gains importance
for angiographic dye injection. The ostium of TCA may be
to the left of and superior to the ostium of RCA as reported
by Stankovic & Jesic. According to Apsara the most
common position of TCA ostium is at the same level and to
the left of the ostium of RCA. In the study of Sankari et al.
the level of ostia below the level at sinotubular junction
was 73.34 %.

One question that could be asked today is: What is
normal incidence of RCA or TCA? The area of perfusion
of the TCA is variable and may be more extensive than usual

| Author                 | Population | TCA   | FCA   |
|------------------------|------------|-------|-------|
| Kurjia et al. (1986)   | Iraqi      | 8 %   | -     |
| Miyazaki & Kato (1988) | Japanese   | 36.8% | -     |
| Wolloeschek et al. (2001) | Germans     | 60%   | -     |
| Saidi et al. (2002)    | Kenyan     | 17%   | 2%    |
| Kalpana (2003)         | Indians    | 24%   | -     |
| Stankovic & Jesic (2004) | Serbian    | 34.8% | -     |
| Lujinovic et al. (2008) | Bosnian   | 32%   | 4%    |
| Fazliogullari et al. (2010) | Turks     | 68%   | -     |
| Sankari et al. (2011)  | Indians    | 16.67%| 6.66% |
| Present study (2018)   | Serbian    | 41.8% | 10.9% |

Fig. 3. Human heart (dissection preparation). 1. Orifice of right coronary artery 2. Orifice of third coronary artery 3. Orifice of fourth coronary artery.
in some individuals. About 10% of clinical malpractice is due to the ignorance of the anatomical variations (Ajayi et al., 2013). The size of the coronary arteries typically determines the treatment options in the management of coronary artery disease as small arteries may cause anastomotic difficulties during bypass grafting and can influence the outcome in procedures such as stenting and balloon angioplasty. The possibility of large TCA and myocardial bridges over it should be thought of during various surgical procedures to avoid damage.

We can conclude based on our results, that supernumerary right coronary artery is not rare as previously thought. More than 52.7% of heart in our sample had supernumerary coronary artery. Detecting the number of supernumerary coronary arteries, quantity and place of opening the aortic sinus on the findings of coronary angiography, as well as correct interpretation, certainly affect the preoperative preparation and the type of cardiac intervention.

Medicolegal importance of TCA was pointed out by Gouda et al. as it might help in establishment of partial identity of an individual if ante mortem record of third coronary artery was available. Since this study is based on an autopsy, more researches on the third coronary artery are needed in living individuals.

CONCLUSIONS

Morphological analysis of 55 hearts showed that the front of the right aortic sinus usually leaves only the right coronary artery (47.3%), followed by a third coronary artery (41.8%), while the least represented the fourth coronary arteries (10.9%). More than 52.7% of the heart has a right supernumerary coronary artery. TCA and FCA is commonly located at the same level and to the left of the ostium of RCA. We noticed right type of arterial vascularization at 93.33% and left type at 6.67% in hearts that have TCA and FCA. Knowledge of individual and racial variations in coronary arteries is essential for the diagnosis and treatment of coronary artery patients.

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Received: 15-05-2018
Accepted: 06-08-2018