OPERATIVECORONARY ANATOMY IN TAUSSIG BING HEART ANOMALY

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ABSTRACT

Objectives: This study was conducted to describe the anatomical morphologies of the coronary arteries in Taussig-Bing heart anomaly. **Methods:** From January 2010 to December 2018, 72 consecutive patients underwent total correction for the Taussig Bing heart anomaly at Vietnam National Children's Hospital. The coronary artery morphology of this patient's group was visually evaluated during arterial switch operations. **Results:** Consider usual coronary arteries were 1LCx2R (the left anterior descending and the circumflex originated from sinus 1, the right coronary artery from sinus 2). Unusual coronary arteries were observed in 50 of the 72 cases, providing a frequency of 69.5%. They were the circumflex originating from the sinus 2 (1L2RCx: 25%); the left anterior descending, the right coronary artery, and the circumflex from a single sinus (1LRCx: 5.6%; 2LRCx: 19.4%); right artery coronary from sinus 1 (1R2LCx: 11.1%). The coronary with intramural course presented in 5 patients (7%). The hospital death after arterial switch operation for total repair of the Taussig Bing heart anomaly was 13.9%. **Conclusion:** Patients with the Taussig Bing Heart anomaly have a high frequency of unusual coronary arteries. The congenital cardiac surgeons should consider this frequency for better management of the patients while the preoperative assessment has not much information of the coronary arteries anatomy.

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I. INTRODUCTION

Taussig Bing Heart Anomaly is a rare congenital heart defect first described in 1949 by two doctors: cardiologists Helen B. Taussig and cardiovascular surgeon Richard J. Bing [1]. Since 2000, according to the international nomenclature, this anomaly has been classified in the group of double outlet right ventricle and transposed great arteries [2].

Arterial switch operation (ASO) has become the first choice in the treatment of this heart defect in many cardiovascular centers around the world [1]. At our institution, since the first case was successfully repaired in 2010, ASO has been routinely performed to treat this anomaly. In Vietnam, an anatomical variant of coronary arteries remains one of the risk factors for mortality after ASO [3]. We retrospectively reviewed 72 consecutive cases who underwent ASO for total repair of Taussig Bing Heart Anomalyat Vietnam National Children's Hospital. This article aims to describe the frequency of intraoperative coronary patterns. Hopefully, this can be considered one of the reference sources for congenital heart surgeons in the evaluation and surgery's strategyand the selection of appropriate coronary reimplantation techniques.

II. RESEARCH SUBJECTS AND METHODS

1.1. Study population

The study included 72 patients (56 males, 16 females) who underwent total repair of Taussig Bing Heart anomaly by ASO at Vietnam National Children's Hospital, from January 2010 to December 2018.

1.2. Classification of coronary arteries anatomy

The Leiden classification was applied to identify the origin sinus of the coronary arteries ostia. The classification's principle was described as the surgeon standing in the non-coronary sinus of the aorta and looking towards the pulmonary artery. The surgeon's right hand is sinus number 1 (left coronary sinus) and the surgeon's left hand is sinus number 2 (right coronary sinus) [4]. Consider normal coronary anatomy is that the sinus 1 gives riseto the left main artery [including left anterior descending (LAD) and the circumflex (Cx)], while sinus 2 rises the right coronary artery (R) denoted as 1LCx 2R. Other changes are considered anatomical coronary abnormalities and the symbols for these changes depend on the origin sinus of the coronary ostia.

1.3. Research Methods

A retrospective descriptive study was conducted on 72 consecutive cases. The coronary anatomy was described as intraoperative coronary anatomy without any preoperative description in the echo cardiography report. Data were collected from medical records, information from medical check-upsand analyzed by SPSS 20.0 software. The study was approved by the ethics committee of the Research Institute Children's Health, National Children's Hospital. Due to the nature of the retrospective study, informed consent was not necessarily in need.

III. RESULTS

Table 1. Demographicinformation

Patient characteristics	**n (% or min-max) or X ± SD**
Gender	
Male	56 (78)
Female	16 (22)
Mean age (days)	81 ± 64 (7-294)
Mean weight (kg)	3.9 ± 0.9 (2.5-6.7)
Mean height (cm)	56 ± 5 (47-68)
Mean BSA (m^2)	0.24 ± 0.04 (0.17-0.34)

In this study, male patients predominate with the ratio Male: Female ≈ 3.5: 1. The mean age at thesurgery was 81 days, the youngest patient was 7 days of age while the oldest was 294 days of age. With a mean weight, height and BSA were 3.9kg, 56cm, and 0.24m^2, respectively.

Table 2. Great Arteries Relationship and Anatomy of Coronary Arteries

	Anatomy of the coronary arteries		**Total**	**%**
Relationship	Abnormal	Normal		
Rightward	8	6	14	19.4
Antero-posterior	16	10	26	36.1
Side-by-side	25	4	29	40.3
Leftward	1	2	3	4.2
Total	50	22	72	100

The frequent relationship of the great arteries in the group of Taussig Bing patients are side by side (40.3%), antero - posterior (36.1%). The rightward relationship accounts for 19.4%, the left ward relationship is rare which accounts for 4.2%.

Table 3. Operative Coronary Anatomy

Origin of the coronary artery ostium	**n (%)**
Two difference ostia from 2 sinus	22 (30.5)
1LCx-2R	18 (25)
1L-2RCx	8 (11.1)
1RL-2Cx	4 (5.6)
1RCx-2L	1 (1.4)
1Cx-2RL	1 (1.4)
Single ostium	18 (25)
1LCxR	4 (5.6)
2RLCx	14 (19.4)
Intramural course	5 (7)

We used the Leiden classification for all patients undergoing ASO including those with Taussig-Bing anomaly and patients with transposition of great arteries. There were 18 patients (25%) have single coronary anatomy in our cohort, and 5 patients (7%) had an intramural coronary artery.

IV. DISCUSSION

In our study, the coronary anatomy was all described intraoperatively. In the echo cardiography report, the coronary anatomy was not noticed. The recent development of multislice computed tomography (ms-CT) with high resolution is a useful tool to evaluate the precise preoperative coronary anatomy. We recommend using the ms-CT 256 slides to evaluate the coronary anatomy of all patients with TGA or Taussig-Bing anomaly for preoperative planning and for the safety of intraoperative coronary transfer.

In a study of 715 patients undergoing ASO in 2017, Moll et al showed that the most frequent relationship between two great arteries was rightward accounted for 44.9%; anteroposterior accounted for 34.4%, side by side accounted only for 11.6%, and leftward accounted for 9.1% [5]. Although their group of patients was mainly patients with transposition of great arteries, this difference suggests that in patients with Taussig Bing heart anomaly, the relationship of great arteries is more abnormal. In our study group, the frequency of coronary abnormalities in patients with side-by-side relationships was also higher than in other relationships ($p<0.05$). Others also agree that ASO for patients with Taussig Bing heart anomaly introduces more challenges than the usual case of transposition of great arteries. The side-by-side relationship of the great arteries remains a real difficulty for surgeons[6],[7].

According to the sinus origin of the coronary ostium, the coronary anatomy was easily denoted, which could be an advantage of this classification. However, this method only pays attention to the ostium origin of the coronary artery but does not emphasize the course or loops of the coronary artery [4]. According to our study, normal coronary anatomy (1LCx2R) was found in 22 patients,

accounting for 30.5%, other coronary abnormalities were common, accounting for 69.5%. Most common to be the circumflex branch originating from the right coronary artery from sinus 2 (1L2RCx: 25%); or a single coronary artery originating from a single sinus 1 or 2 (1LCxR: 5.6%; 2RLCx: 19.4%); or inverted coronary morphology (1R2LCx: 11.1%); frequency of intramural coronary accounting for 7%. According to Wang et al in 2015 of 1078 patients with transposition of great arteries and Taussig Bing anomaly, there were 248 patients with coronary abnormalities. The most common coronary anomalies were the right coronary artery originating from the sinus 1 while the circumflex branch originating from the sinus 2(1RL2Cx: 26.5%); the circumflex branch comes from sinus 2 (1L2RCx: 21.36%); and a single common coronary artery from sinus 2 (2RLCx: 13.24%) [8].

The meta-analysis of Pasquali et al in 2002 including 1942 ASO patients from 9 studies showed that coronary abnormalities nearly doubled the risk of mortality compared to the group of normal coronary anatomy (OR=1.7; 95%CI 1.3 - 2.4). Also, according to the author, coronary anatomical factors had less influence on the outcome since 1992 [4]. At Vietnam National Children's Hospital, 10 patients died during hospital stay after ASO for the total repair of the Taussig-Bing anomaly. The early survival rate reached 86.1%. Among the patients who died during the hospital stay, 6 patients died early on a postoperative day 2nd or 3rd in the period 2010 to 2014. The early mortality etiology was all due to arrhythmias or cardiovascular collapse very early after surgery, and the cause could be related to myocardial perfusion. From 2015 to 2018, 4 patients died during the hospital stay, all related to prolonged mechanical ventilation and sepsis with bacterial etiology were identified. This also partly reflects that, when surgeons are still inexperienced in assessing and managing coronary anatomical changes, the selection or practice of coronary reimplantation methods has not been successful. Over time, the technique refinement will help improve the treatment outcomes. Remain controversial, but the anatomical variations of the coronary arteries, especially intramural course remains a technical challenge for congenital heart surgeons[9]. According to our experiences, we unroofed totally the anterior wall of the intramural course, and we are all successfully divided the single coronary button by two individual coronary buttons and easily implant it into the neo-aorta. For single coronary anatomy, the neo-aorta was filling with blood to distended, after dissection of the coronary button, and we could easily choose the best appropriate position for coronary reimplantation.

V. CONCLUSION

Patients with Taussig Bing Heart Anomaly had a high incidence of abnormalities or anatomical variation of coronary arteries (69.5%). Therefore, focusing on accurate assessment of coronary artery anatomy will help congenital heart surgeons, especially junior and inexperienced surgeons, to have the right surgical strategy for the patient, hence improving outcomes of this complex heart defect.

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