**Name of Journal: *World Journal of Cardiology***

**ESPS Manuscript NO: 24871**

**Manuscript Type: Original Article**

***Retrospective Study***

**Congenital coronary artery fistulas complicated with pulmonary hypertension: Analysis of 211 cases**

Said SAM. Coronary artery fistulas and pulmonary hypertension

**Salah AM Said**

**Salah AM Said**,Department of Cardiology, Hospital Group Twente, Almelo-Hengelo, 7555 DL Hengelo, the Netherlands

**Author contributions:** SaidSAMhas solely contributed to conception, design, drafting and final approval of the manuscript.

**Institutional review board statement:** The data of this manuscript are obtained from internet, so it should be excepted from approval of institutional review board.

**Conflict-of-interest statement**: Author has no conflict of interest in connection with the submitted article. No funding has been obtained.

**Data sharing statement**: Technical appendix, statistical code, and dataset available from the corresponding author at salah.said@gmail.com.

**Open-Access:** This article is an open-access article which was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

**Manuscript source:** Unsolicited manuscript

**Correspondence to:** **Salah AM Said, MD, PhD, FESC,** Department of Cardiology, Hospital Group Twente, Almelo-Hengelo, Geerdinksweg 141, 7555 DL Hengelo, the Netherlands. salah.said@gmail.com

**Telephone:** +31-88-7085286

**Fax:** +31-88-7085289

**Received:** February 12, 2016

**Peer-review started:** February 16, 2016

**First decision:** March 23, 2016

**Revised:** July 26, 2016

**Accepted:** August 6, 2016

**Article in press:**

**Published online:**

**Abstract**

**AIM:** To compare the behavior of pulmonary hypertension (PHT) associated with coronary artery fistulas (CAFs) between the Asian and Caucasian subjects.

**METHODS:** CAFs may be complicated with PHT secondary to left-to-right shunt. Literature review limited to the English language. A total of 211 reviewed patients were collected. Of those, 111 were of Asian and 100 were of Caucasian ethnic origin. The mean age of the Asian and the Caucasian groups of patients were 48.9 (range 19-83) and 49.9 years (range 16-85), respectively. In both groups, right heart catheterization was the most commonly (95%) used method for determining pulmonary artery pressure.

**RESULTS:** From all of the reviewed subjects, PHT was found in 49 patients (23%), of which 15 were Asian and 34 were Caucasian. In 75% of PHT subjects, mild to moderate PHT was reported and 76% of the fistulas had a vascular mode of termination. Treatment was surgical in 61%, followed by percutaneous therapeutic embolization (27%) and finally conservative medical management in 12% of PHT subjects. PHT was associated with a slight female gender predominance. The majority demonstrated mild to moderate PHT. PHT was reported more frequent in the Caucasian compared with the Asian ethnicity group. The majority of fistulas in patients with PHT had a vascular mode of termination. The results of this review are intended to be indicative and require cautious interpretation.

**CONCLUSION:** The likelihood for a CAF patient to develop PHT is presented when possessing the following features, with a Caucasian female having a fistula with a vascular mode of termination.

**Key words**: Congenital coronary artery fistulas; Congenital anomaly; Pulmonary hypertension; Asian population; Caucasian population

**© The Author(s) 2016.** Published by Baishideng Publishing Group Inc. All rights reserved.

**Core tip:** Congenital coronary artery fistulas (CAFs) are infrequent but hemodynamically important anomalies which may evolve a myriad of complications, such as myocardial infarction, congestive heart failure, infective endocarditis, aneurysm, rupture, pericardial effusion, arrhythmias and sudden death. In addition, secondary pulmonary hypertension (PHT) may complicate the course of CAFs. Moreover, when monitoring CAF patients, the clinicians responsible for the management of patients with congenital CAFs should be aware of the development of PHT during the course of the disease.

Said SAM. Congenital coronary artery fistulas complicated with pulmonary hypertension: Analysis of 211 cases. *World J Cardiol* 2016; In press

**INTRODUCTION**

Congenital coronary artery fistulas (CAFs) are uncommon anomalies. Most CAFs are small and hemodynamically inconsequential with a negligible shunt. However, some can be sizeable and lead to shunting of blood from the coronary circulation to low-pressure pulmonary vascular bed, resulting in pulmonary hypertension (PHT)[1]. CAFs may be associated with normal[2-4] pulmonary artery pressure (PAP) in unilateral[5-8] or bilateral[9,10] fistulas, or may sometimes be accompanied with elevated PAP[11-14]. Rarely, in octogenarians with bilateral CAFs, PAP may remain normal[15].

The hemodynamic consequences of CAFs varies, depending on their magnitude and the cardiac chamber or vascular site involved. Fistulas terminating into the right heart chambers may produce left-to-right shunt and volume overload of the pulmonary circulation, whereas fistulas to the left heart side cause left ventricular volume overload.

In a literature review, 211 subjects were included and a comparison was made between the Asian (*n =* 111) and Caucasian (*n =* 100) subjects regarding the behavior of PAP associated with CAFs.

**MATERIALS AND METHODS**

The data source was based on an extensive literature review of the English literature in the PubMed database regarding congenital CAFs and PAP. The search was conducted using the terms "congenital coronary artery fistulas" and "pulmonary artery pressure". Inclusion of a paper occurred when full data on PAP either using right heart catheterization (RHC) (direct measurement) or Doppler echocardiography (calculation of estimated PAP based on TR peak velocity) were provided.

This retrieval resulted in a collection of 133 papers which included 49 of Asian (*n =* 111 patients) and 84 of Caucasian (*n =* 100 patients) reports. Three were excluded because of duplication. Reference lists from selected papers were manually searched for potentially relevant publications. Whenever available, the most recent data were included. Another seven papers were therefore added, meaning that the final retrieval result was 137 papers. Congenital multiple micro-fistulas were not included and patients with acquired fistulas were excluded.

***Definition of PHT[16-18]***

**Invasive method:** PHT is defined as the systolic PAP (sPAP) or mean PAP, exceeding 35 mmHg or 25 mmHg, respectively. Furthermore, the mean PAP rises above 30 mmHg with exercise, occurring secondary to either a pulmonary or a cardiac disorder[16].

**Non-invasive method:** In accordance with the European Society of Cardiology criteria for detecting the presence of PHT, based on the tricuspid regurgitation (TR) peak velocity and Doppler-calculated sPAP at rest (assuming a normal right atrial pressure of 5 mmHg), additional echocardiographic variables suggestive of PHT were used to determine the sPAP[19,20]. PHT was defined by an estimate of right ventricular systolic pressure of greater than 40 mm Hg. sPAP is estimated using TR jet velocity based on the simplified Bernoulli's equation [4 × (TRV)2 + RA pressure][19,21,22] (TRV: TR velocity; RA: Right atrium).PHT was classified into three categories: Mild (40-49 mmHg), moderate (50-59 mmHg) and severe (> 59 mmHg).

***Statistical analysis***

Values were expressed as means, averages, and percentages.

**RESULTS**

***Total group (Table 1)***

A total of 211 (M 87 = 41% and F 124 = 59%) reviewed patients were collected from the world literature. The mean age was 49.4 years (range 16-85). The reported method of assessment of PAP was RHC (*n =* 201, Caucasian *n =* 94 and Asian *n =* 107) and Doppler echocardiography (*n =* 10, Caucasian *n =* 6 and Asian *n =* 4) in 95% and 5% of the subjects, respectively. The congenital CAFs were unilateral in 118 (56%), bilateral in 87 (41%) and multilateral in 6 (3%) of the subjects. The CAFs arose from the right (133/268 = 49.6%) and left (135/268 = 50.4%) coronary artery, respectively. The mode of termination was either vascular (90/211 = 43%) or cameral (121/211 = 57%).

Among the applied therapeutic modalities, surgical ligation (SL) was performed in 124 (59%), conservative medical management (CMM) in 38 (18%), percutaneous therapeutic embolization (PTE) in 29 (13%) and watchful waiting in 2 (1%). There were 2 mortalities (1%) and treatment options were not mentioned in 16 (8%) of the subjects. Among the whole group, 23% (49/211)were found to have elevatedPAP.

***Asian population*: *n = 111***

The reviewed patients of Asian ethnicity [*n =* 111, Male *n =* 48 (43%) and Female *n =* 63 (57%)] had a mean age of 48.9 years (range 19-83).

Between 1986 and 2014, papers published describing Asian population with congenital CAFS and reported data on PAP were included: from 1986-1993[23-28], 1994-1999[29-33], 2001-2004[34-39], 2005[40-42], 2006[43-49], 2007[50-55], 2009-2011[56-61] and 2012-2014[62-69]. PAP was measured by RHC in 107 and by Doppler echocardiography in 4.

Ninety-six subjects (86%) had normal PAP. Among the CAFs, 42 were unilateral (38%), 63 bilateral (57%) and 6 multilateral (5%). The treatment modalities were SL [82 = (74%)], CMM [20 = (18%)] and PTE [9 = (8%)]. No watchful waiting strategy was conducted and death did not occur in any of the subjects.

PHT was found in 15 Asian (14**%**) (M, *n =* 3; F, *n =* 12) subjects with a mean age 54.4 years (range 24-77). Among the 15 subjects, mild, moderate and severe PHT was detected in 8, 2 and 5, respectively.

***Caucasian population: n = 100***

The mean age (*n* = 100, Male 39 and Female 61) was 49.9 years (range 18-85). Published papers on Caucasian population regarding CAFs and PAP between 1955 and 2014 were included for evaluation: 1955-1961[70-75], 1964-1967[5,76-78], 1971-1976[2,79-82], 1981-1989[11,83-85], 1990-1991[3,6,10,86,87], 1992-1994[88-92], 1995-1997[4,9,31,93-95], 2000-2002[12,13,96-101], 2003-2004[102-106], 2005-2006[7,15,107-113], 2007-2009[14,114-124], 2010-2012[8,125-130], and 2013-2014[131-134]. PAP was evaluated by RHC in 94% (*n* = 94) and in 6 by Doppler echocardiography method. The CAFs were unilateral in 76 (76%) and bilateral in 24 (24%) of the subjects. No multilateral fistulas were reported. Sixty-six subjects (66%) had normal PAP.

Treatment modalities included SL (42), PTE (20), CMM (18), and watchful waiting (2), and were not mentioned in 16 cases. There were 2 mortalities (2). PHT was found in 34 subjects (34%) [M *n* = 12 (35%) and F *n* = 22 (65%)], with a mean age of 56.8 years (range 16-80).

***PHT population: n = 49 (Table 2)***

PHT was found in 49 patients (49/211=23**%**), with a mean age of 56 years (range 16-80). There were 34 females (69%) and 15 males (31%), with 15 Asian (mean age 54.4, range 24-77 years) and 34 (mean age 56.8, range 16-80 years) of Caucasian patients. The fistulas were unilateral in 37 (76%) and bilateral in 12 (24%) of the subjects.Measurement of PAP was achieved by RHC in 43 subjects (13 Asian and 30 Caucasian) and by Doppler echocardiography in 6 (2 Asian and 4 Caucasian) subjects. Mild, moderate and severe PHT was reported in 26 (53%), 11 (23%) and 12 (24%) subjects, respectively.

***The following features were detected among PHT group of patients:*** A female predominance (34/49 = 69%), unilateral origin (37/49 = 76%) from the left coronary artery (30/49 = 61%) and termination into the right heart side (45/49 = 92%) were the major findings of the PHT group of patients.

The percentage of unilateral and CVFs was higher in the Caucasian group (82% and 82%) compared to the Asian group (60% and 60%), respectively (Table 3).

**DISCUSSION**

CAFs may remain silent, co-existing with longevity for years and emerging as a coincidental finding during non-invasive or invasive[135] investigation for the analysis of suspected cardiac disorder.

CAFs are an uncommon congenital anomaly which may be associated with several complications (Table 4). These complications may have coronary vascular, pericardial or myocardial origin. Furthermore, they may have a valvular source or may originate from an atrial or ventricular arrhythmic substrate. Such complications may include myocardial infarction (MI) (4%)[136,137], congestive heart failure (CHF) (20%)[136], infective endocarditis (IE) (reported in 4%-12% in different series)[81,136], atrial[138] and ventricular[139] arrhythmias, aneurysm (reported in 20% of cases)[96,140], rarely ruptured aneurysm with hemopericardium[141] and unruptured aneurysm[139,142], pericardial effusion[143], syncope[142,144] and sudden death[145]. It has been postulated that fistula-related complications increase with age[136]. Secondary PHT is an infrequent complication of congenital CAFs. As early as 1955, Davison reported PHT in patients with CAFs[70].

Most CAFs are small and hemodynamically inconsequential with a negligible left-to-right shunt. However, some can be sizeable and lead to shunting of blood from the coronary circulation to low-pressure pulmonary vascular bed, resulting in PHT[1].

In congenital CAFs, although PHT may occur when sizeable left-to-right shunt exists; in the current review, the mean Qp:Qs was modest, with moderate magnitude 1.9:1.0.

It has been stated that severe PHT is not frequently observed in isolated CAFs[87]. Mild to moderate PHT[5] has sporadically been reported in unilateral[39,45,107,124,146,147] and bilateral fistulas[42,103,112,118]. Indeed,in the current literature review, only 25% were found to have severe PHT, with the majority (75%) having mild or moderate PHT.No reports of multilateral CAFs associated with PHT were found. It is noteworthy that CAFs may be associated with longevity[96] and PHT has been reported in septuagenarians[11] and octogenarians[107].

Although PAP can be measured on Doppler echocardiography, the gold standard for diagnosis is RHC. In the current review, 95% were direct calculation of PAP using RHC and only 5% as an estimate of right ventricular systolic pressure by Doppler echocardiography using TR jet velocity based on the simplified Bernoulli's equation (Figure 1). It is widely accepted that pulmonary artery systolic pressure (sPAP) can be considered normal until 40 mmHg in the elderly and obese subjects. Moreover, tricuspid regurgitant jet velocity is a parameter that has been widely applied to estimate sPAP[22].

In comparison with the Caucasian group of patients (65%) with PHT, female gender accounted for 80% in the Asian group and was almost equally associated (35% versus 33%) with concomitant congenital and acquired coronary and valvular heart defects.

In the total group of patients (*n* = 49) with PHT, female gender accounted for (69%), unilateral fistulas was present in (76%) and mild to moderate PHT (75%) was predominant. RHC was performed in 88% of patients and in 12% Doppler echocardiography was used for estimation of the sPAP. Coronary vascular fistulas as a mode of termination were found in the overwhelming majority (76%) of patients. SL was performed in 61% of patients with PHT.

In the present review of all 49 subjects, possible common features of CAFs associated with PHT were unilateral fistula (37/49 = 76%) originating from the left coronary artery (30/49 = 61%) with a vascular termination (76%) into the right heart side (45/49 = 92%). These findings have to be investigated in a future international survey or prospective study.

A significant difference was noted in the percentages of coronary-cameral fistulas between Asian (40%) and Caucasian (18%) groups of patients with PHT. There was no difference in associated cardiac defects, congenital or acquired, in both the Asian and Caucasian groups (33% and 35%, respectively).

***Limitations of the study***

Among the Asian population reported by Cheung et al. in 2001, among the 41 subjects, there were children included in their study[35]. The time span for data collection spread from 1955 to 2014 due to period collection bias.

Publication bias, only subjects with abnormal findings are accepted for publication. Although the data were of high quality and were collected from the world literature, the results of this review are intended to be indicative and require cautious interpretation.

It is clear that more research and studies are warranted for the identification and registration of congenital CAFs associated with PHT; the cause seems to be more multi-factorial (gender, fistula origin and outflow) and dependent on the fistula characteristics itself. We are encouraged to initiate an international survey on CAFs (Euro-CAF.care).

In conclusion, among the whole population, 23% were found to have elevated PAP. In the Asian group of patients 14% demonstrated PHT compared to 34% among the Caucasian group. Among the patients (*n* = 49) with PHT, 69% were female. The majority of fistulas (76%) in patients (*n* = 49) with PHT were of CVFs type in contrast to CCFs who accounted for 24% of subjects. The likelihood for a CAF patient to develop PHT is presented when possessing the following features, with a Caucasian female having a fistula with a vascular mode of termination. The findings of this review need to be confirmed in a larger multicenter international registry, preferably with a longer follow-up.

**ACKNOWLEDGEMENTS**

With gratitude the author wishes to thank the librarians of Hospital Group Twente, Mrs. A. Geerdink and Mrs. L. Gerritsen for their assistance during the preparation of the manuscript.

**COMMENTS**

***Background***

Congenital coronary artery fistulas (CAFs) are uncommon anomalies. Most CAFs are small and hemodynamically inconsequential with a negligible shunt. However, some can be sizeable and lead to shunting of blood from the coronary circulation to low-pressure pulmonary vascular bed, resulting in pulmonary hypertension (PHT).

***Research frontiers***

CAFs may be associated with normal pulmonary artery pressure (PAP) in unilateral or bilateral fistulas, or may sometimes be accompanied with elevated PAP. Rarely, in octogenarians with bilateral CAFs, PAP may remain normal.

***Innovations and breakthroughs***

The likelihood for a CAF patient to develop PHT is presented when possessing the following features, with a Caucasian female having a fistula with a vascular mode of termination.

***Applications***

The findings of this review need to be confirmed in a larger multicenter international registry, preferably with a longer follow-up.

***Peer-review***

This paper is interesting review concerning association PAH and CAF. Therefore, this article should be published.

**REFERENCES**

1. **Sharma UM**, Aslam AF, Tak T. Diagnosis of coronary artery fistulas: clinical aspects and brief review of the literature. *Int J Angiol* 2013; **22**: 189-192 [PMID: 24436610 DOI: 10.1055/s-0033-1349166]
2. **Bishop JO**, Mathur VS, Guinn GA. Letter: Congenital coronary artery fistula with myocardial infarction. *Chest* 1974; **65**: 233-234 [PMID: 4810692 DOI: 10.1378/chest.65.2.233]
3. **Brack MJ**, Hubner PJ, Firmin RK. Successful operation on a coronary arteriovenous fistula in a 74 year old woman. *Br Heart J* 1991; **65**: 107-108 [PMID: 1867943 DOI: 10.1136/hrt.65.2.107]
4. **Bitar SR**, Aguirre FV, McBride L, Munroe C, Kern MJ. Characterization of intra-arterial flow velocity within left coronary to pulmonary artery fistula. *Cathet Cardiovasc Diagn* 1997; **41**: 208-212 [PMID: 9184298 DOI: 10.1002/(SICI)1097-0304(199706)41: 2<208: : AID-CCD22>3.0.CO; 2-K]
5. **Dedichen H**, Skalleberg L, Cappelen C. Congenital coronary artery fistula. *Thorax* 1966; **21**: 121-128 [PMID: 5935838 DOI: 10.1136/thx.21.2.121]
6. **Doorey AJ**, Sullivan KL, Levin DC. Successful percutaneous closure of a complex coronary-to-pulmonary artery fistula using a detachable balloon: benefits of intra-procedural physiologic and angiographic assessment. *Cathet Cardiovasc Diagn* 1991; **23**: 23-27 [PMID: 1863956 DOI: 10.1002/ccd.1810230107]
7. **Behera SK**, Danon S, Levi DS, Moore JW. Transcatheter closure of coronary artery fistulae using the Amplatzer Duct Occluder. *Catheter Cardiovasc Interv* 2006; **68**: 242-248 [PMID: 16819766 DOI: 10.1002/ccd.20811]
8. **Abusaid GH**, Hughes D, Khalife WI, Parto P, Gilani SA, Fujise K. Congenital coronary artery fistula presenting later in life. *JC Cases* 2011; **4**: e43-e46 [DOI: 10.1016/j.jccase.2011.05.008]
9. **Van Dam DW**, Noyez L, Skotnicki SH, Lacquet LK. Multiple fistulas between coronary and pulmonary arteries. *Eur J Cardiothorac Surg* 1995; **9**: 707-708 [PMID: 8703493 DOI: 10.1016/S1010-7940(05)80130-7]
10. **Strunk BL**, Hieshima GB, Shafton EP. Treatment of congenital coronary arteriovenous malformations with micro-particle embolization. *Cathet Cardiovasc Diagn* 1991; **22**: 133-136 [PMID: 2009563 DOI: 10.1002/ccd.1810220214]
11. **Baim DS**, Kline H, Silverman JF. Bilateral coronary artery--pulmonary artery fistulas. Report of five cases and review of the literature. *Circulation* 1982; **65**: 810-815 [PMID: 7060261 DOI: 10.1161/01.CIR.65.4.810]
12. **Ahmed J**, Edelstein Y, Rose M, Lichstein E, Connolly MW. Coronary arteriovenous fistula with papillary muscle rupture. *South Med J* 2000; **93**: 627-628 [PMID: 10881787 DOI: 10.1097/00007611-200006000-00021]
13. **Cijan A**, Zorc-Pleskovic R, Zorc M, Klokocovnik T. Local pulmonary malformation caused by bilateral coronary artery and bronchial artery fistulae to the left pulmonary artery in a patient with coronary artery disease. *Tex Heart Inst J* 2000; **27**: 390-394 [PMID: 11198313]
14. **Brown MA**, Balzer D, Lasala J. Multiple coronary artery fistulae treated with a single Amplatzer vascular plug: check the back door when the front is locked. *Catheter Cardiovasc Interv* 2009; **73**: 390-394 [PMID: 19133675 DOI: 10.1002/ccd.21860]
15. **Phillips MB**, Oken KR. Embryology in the elderly: Bilateral coronary artery fistulae. *Southern Med J* 2005; **98**: S45 [DOI: 10.1097/00007611-200510001-00121]
16. **Barst RJ**, McGoon M, Torbicki A, Sitbon O, Krowka MJ, Olschewski H, Gaine S. Diagnosis and differential assessment of pulmonary arterial hypertension. *J Am Coll Cardiol* 2004; **43**: 40S-47S [PMID: 15194177 DOI: 10.1016/j.jacc.2004.02.032]
17. **Fisher MR**, Forfia PR, Chamera E, Housten-Harris T, Champion HC, Girgis RE, Corretti MC, Hassoun PM. Accuracy of Doppler echocardiography in the hemodynamic assessment of pulmonary hypertension. *Am J Respir Crit Care Med* 2009; **179**: 615-621 [PMID: 19164700 DOI: 10.1164/rccm.200811-1691OC]
18. **Arcasoy SM**, Christie JD, Ferrari VA, Sutton MS, Zisman DA, Blumenthal NP, Pochettino A, Kotloff RM. Echocardiographic assessment of pulmonary hypertension in patients with advanced lung disease. *Am J Respir Crit Care Med* 2003; **167**: 735-740 [PMID: 12480614 DOI: 10.1164/rccm.200210-1130OC]
19. **Galiè N**, Hoeper MM, Humbert M, Torbicki A, Vachiery JL, Barbera JA, Beghetti M, Corris P, Gaine S, Gibbs JS, Gomez-Sanchez MA, Jondeau G, Klepetko W, Opitz C, Peacock A, Rubin L, Zellweger M, Simonneau G. Guidelines for the diagnosis and treatment of pulmonary hypertension: the Task Force for the Diagnosis and Treatment of Pulmonary Hypertension of the European Society of Cardiology (ESC) and the European Respiratory Society (ERS), endorsed by the International Society of Heart and Lung Transplantation (ISHLT). *Eur Heart J* 2009; **30**: 2493-2537 [PMID: 19713419 DOI: 10.1093/eurheartj/ehp297]
20. **Gaine SP**, Rubin LJ. Primary pulmonary hypertension. *Lancet* 1998; **352**: 719-725 [PMID: 9729004 DOI: 10.1016/S0140-6736(98)02111-4]
21. **Badesch DB**, Champion HC, Sanchez MA, Hoeper MM, Loyd JE, Manes A, McGoon M, Naeije R, Olschewski H, Oudiz RJ, Torbicki A. Diagnosis and assessment of pulmonary arterial hypertension. *J Am Coll Cardiol* 2009; **54**: S55-S66 [PMID: 19555859 DOI: 10.1016/j.jacc.2009.04.011]
22. **McQuillan BM**, Picard MH, Leavitt M, Weyman AE. Clinical correlates and reference intervals for pulmonary artery systolic pressure among echocardiographically normal subjects. *Circulation* 2001; **104**: 2797-2802 [PMID: 11733397 DOI: 10.1161/hc4801.100076]
23. **Bhandari S**, Kanojia A, Kasliwal RR, Kler TS, Seth A, Trehan N, Bhatia ML. Coronary artery fistulae without audible murmur in adults. *Cardiovasc Intervent Radiol* 1993; **16**: 219-223 [PMID: 8402783 DOI: 10.1007/BF02602964]
24. **Doi YL**, Takata J, Hamashige N, Yonezawa Y, Odawara H, Ozawa T. Congenital coronary arteriovenous fistula associated with dilated cardiomyopathy. *Chest* 1987; **91**: 464-466 [PMID: 3816326 DOI: 10.1378/chest.91.3.464]
25. **Fujiwara R**, Kutsumi Y, Yamamura I, Nakai T, Miyabo S. Bilateral coronary arteriovenous fistulas associated with idiopathic hypertrophic cardiomyopathy. *Am Heart J* 1986; **111**: 1207-1208 [PMID: 3716996 DOI: 10.1016/0002-8703(86)90030-X]
26. **Ishikura Y**, Odagiri S, Shimazu A, Hirao D, Watanabe H, Yano K. Surgical management of the coronary artery to pulmonary artery fistulas; a case of a large ruptured aneurysm. *Surg Today* 1992; **22**: 176-179 [PMID: 1498500 DOI: 10.1007/BF00311346]
27. **Nakatani S**, Nanto S, Masuyama T, Tamai J, Kodama K. Spontaneous near disappearance of bilateral coronary artery-pulmonary artery fistulas. *Chest* 1991; **99**: 1288-1289 [PMID: 2019198 DOI: 10.1378/chest.99.5.1288]
28. **Ogino K**, Hisatome I, Kotake H, Furuse T, Mashiba H, Kuroda H, Mori T. A case of four coronary artery fistulae originating from three vessels associated with aneurysm. *Eur Heart J* 1987; **8**: 1260-1263 [PMID: 3691563]
29. **Hirose H**, Amano A, Yoshida S, Nagao T, Sunami H, Takahashi A, Nagano N. Coronary artery aneurysm associated with fistula in adults: collective review and a case report. *Ann Thorac Cardiovasc Surg* 1999; **5**: 258-264 [PMID: 10508953]
30. **Ho YL**, Chen WJ, Wu CC, Lee YT. Acute myocardial infarction in a case of myelofibrosis with patent coronary arteries and arteriovenous fistulae draining into the main pulmonary artery. *Int J Cardiol* 1994; **46**: 49-51 [PMID: 7960275 DOI: 10.1016/0167-5273(94)90116-3]
31. **Kanda Y**, Takahashi T, Yokoyama I, Momomura S, Serizawa T. Coronary artery-coronary sinus fistulae associated with a large hepatic hemangioma. A case report. *Vasc Endovascular Surg* 1995; **29**: 65-69 [DOI: 10.1177/153857449502900110]
32. **Katoh T**, Zempo N, Minami Y, Suzuki K, Fujimura Y, Tsuboi H, Esato K, Gondo T. Coronary arteriovenous fistulas with giant aneurysm: two case reports. *Cardiovasc Surg* 1999; **7**: 470-472 [PMID: 10430533 DOI: 10.1016/S0967-2109(98)00102-1]
33. **Sunder KR**, Balakrishnan KG, Tharakan JA, Titus T, Pillai VR, Francis B, Kumar A, Bhat A, Shankaran S. Coronary artery fistula in children and adults: a review of 25 cases with long-term observations. *Int J Cardiol* 1997; **58**: 47-53 [PMID: 9021427 DOI: 10.1016/S0167-5273(96)02792-1]
34. **Atmaca Y**, Altin T, Ozdöl C, Pamir G, Cağlar N, Oral D. Coronary-pulmonary artery fistula associated with right heart failure: successful closure of fistula with a graft stent. *Angiology* 2002; **53**: 613-616 [PMID: 12365873 DOI: 10.1177/000331970205300519]
35. **Cheung DL**, Au WK, Cheung HH, Chiu CS, Lee WT. Coronary artery fistulas: long-term results of surgical correction. *Ann Thorac Surg* 2001; **71**: 190-195 [PMID: 11216744 DOI: 10.1016/S0003-4975(00)01862-2]
36. **Hong GJ**, Lin CY, Lee CY, Loh SH, Yang HS, Liu KY, Tsai YT, Tsai CS. Congenital coronary artery fistulas: clinical considerations and surgical treatment. *ANZ J Surg* 2004; **74**: 350-355 [PMID: 15144256 DOI: 10.1111/j.1445-1433.2004.02980.x]
37. **Murata N**, Yamamoto N. A case of ruptured coronary artery aneurysm associated with coronary artery fistulas. *Jpn J Cardiovasc Surg* 2001; **30**: 305-307 [DOI: 10.4326/jjcvs.30.305]
38. **Sugihara M**, Yamamoto H, Matsushita H, Tadehara F, Gomyo Y, Mochizuki T, Marui A. Multiple coronary artery fistulas with a huge right coronary artery showing exacerbation during 16 years of follow-up. *Circ J* 2004; **68**: 85-87 [PMID: 14695472 DOI: 10.1253/circj.68.85]
39. **Wu YJ**, Chan YC, Hung CL, Hou CJ. Congestive heart failure in a patient with giant aneurysm-like right coronary AV fistula. *Acta Cardiol Sin* 2004; **20**: 105-109
40. **Mohanty SK**, Ramanathan KR, Banakal S, Muralidhar K, Kumar P. An interesting case of coronary cameral fistula. *Ann Card Anaesth* 2005; **8**: 152-154 [PMID: 17762067]
41. **Sato F**, Koishizawa T. Stress/Rest (99m)Tc-MIBI SPECT and 123I-BMIPP scintigraphy for indication of surgery with coronary artery to pulmonary artery fistula. *Int Heart J* 2005; **46**: 355-361 [PMID: 15876821 DOI: 10.1536/ihj.46.355]
42. **Sun S**, Li JY, Hu PY, Wu SJ. Starfish-assisted off-pump obliteration of massive coronary arteriovenous fistulae. *Tex Heart Inst J* 2005; **32**: 595-597 [PMID: 16429913]
43. **Aoyagi S**, Fukunaga S, Ishihara K, Egawa N, Hosokawa Y, Nakamura E. Coronary artery fistula from the left circumflex to the coronary sinus. *Int Heart J* 2006; **47**: 147-152 [PMID: 16479050 DOI: 10.1536/ihj.47.147]
44. **Guo H**, You B, Lee JD. Dilated cardiomyopathy caused by a coronary-pulmonary fistula treated successfully with coil embolization. *Circ J* 2006; **70**: 1223-1225 [PMID: 16936441 DOI: 10.1253/circj.70.1223]
45. **Izgi A**, Kirma C, Türkmen M, Tanalp AC. Successful coil embolization of a large coronary artery fistula in a patient with congestive heart failure. *Arch Turk Soc Cardiol* 2006; **34**: 47-50
46. **Okamoto M**, Makita Y, Fujii Y, Kajihara K, Yamasaki S, Iwamoto A, Hashimoto M, Sueda T. Successful coil embolization with assistance of coronary stenting in an adult patient with a huge coronary arterial-right atrial fistula. *Intern Med* 2006; **45**: 865-870 [PMID: 16908944 DOI: 10.2169/internalmedicine.45.1774]
47. **Okwuosa TM**, Gundeck EL, Ward RP. Coronary to pulmonary artery fistula--diagnosis by transesophageal echocardiography. *Echocardiography* 2006; **23**: 62-64 [PMID: 16412187 DOI: 10.1111/j.1540-8175.2006.00116.x]
48. **Vijayvergiya R**, Singh TP, Grover A. Large left coronary artery to coronary sinus fistula. *Int J Cardiol* 2006; **108**: 132-134 [PMID: 15916820 DOI: 10.1016/j.ijcard.2005.03.013]
49. **Zhou T**, Shen XQ, Fang ZF, Zhou SH, Qi SS, Lü XL. Transcatheter closure of a giant coronary artery fistula with patent duct occluder. *Chin Med J* (Engl) 2006; **119**: 779-781 [PMID: 16701021]
50. **Cheon WS**, Kim EJ, Kim SH, Choi YJ, Rhim CY. Bilateral coronary artery fistulas communicating with main pulmonary artery and left ventricle: case report. *Angiology* 2007; **58**: 118-121 [PMID: 17351168 DOI: 10.1177/0003319706292572]
51. **Hatakeyama Y**, Doi T, Shirasawa K, Sasaki Y, Inenaga K, Takeda S, Takeoka R, Hwang MW, Nomura Y, Park CH, Sawada Y, Kawai C. Four coronary to pulmonary artery fistulas originating from the left main trunk and each of three coronary arteries (LAD, LCX and RCA) detected by the combination of coronary angiography and multislice computed tomography. *Int J Cardiol* 2007; **121**: 227-228 [PMID: 17157939 DOI: 10.1016/j.ijcard.2006.08.117]
52. **Kassaian SE**, Mahmoodian M, Salarifar M, Alidoosti M, Abbasi SH, Rasekh A. Stent-graft exclusion of multiple symptomatic coronary artery fistulae. *Tex Heart Inst J* 2007; **34**: 199-202 [PMID: 17622368]
53. **Sethuratnam R**, Srinivasan B, Menon A, [Anbarasu](https://www.researchgate.net/profile/Mohanraj_Anbarasu) M, Pillai RS, Dhruv T, Davidson Y. Unusual presentation of a coronary cameral fistula. *Ind J Thorac Cardiovasc Surg* 2007; **23**: 28-30 [DOI: 10.1007/s12055-007-0006-9]
54. **Vaidyanathan KR**, Theodore SA, Sankar MN, Cherian KM. Coronary artery to pulmonary artery fistula with dual origin--embryological, clinical and surgical significance. *Eur J Cardiothorac Surg* 2007; **31**: 318-319 [PMID: 17161953 DOI: 10.1016/j.ejcts.2006.11.018]
55. **Esmaeilzadeh M**, Khaledifar A, Usefi A, Omrani Gh. Right coronary artery-to-pulmonary artery fistula, the role of echocardiography. *Iranian Cardiovascular Research Journal* 2007; **1**: 50-52. Available from: URL: http://ircrj.com/?page=article&article\_id=9744
56. **Goda M**, Arakawa K, Yano H, Himeno H, Yamazaki I, Suzuki S, Masuda M. Congenital aortopulmonary artery fistulas combined with bilateral coronary artery fistulas. *Ann Thorac Surg* 2011; **92**: 1524-1526 [PMID: 21958813 DOI: 10.1016/j.athoracsur.2011.04.046]
57. **Huang HC**, Liu CY, Lu TM, Hsu CP. Applying preoperative multidetector computed tomography to bilateral coronary artery fistulas. *J Chin Med Assoc* 2010; **73**: 431-434 [PMID: 20728855 DOI: 10.1016/S1726-4901(10)70092-7]
58. **Izumi K**, Hisata Y, Hazam S. Surgical repair for a coronary-pulmonary artery fistula with a saccular aneurysm of the coronary artery. *Ann Thorac Cardiovasc Surg* 2009; **15**: 194-197 [PMID: 19597399]
59. **Noda Y**, Matsutera R, Yasuoka Y, Abe H, Adachi H, Hattori S, Araki R, Imanaka T, Kosugi M, Sasaki T. Noninvasive demonstration of dual coronary artery fistulas to main pulmonary artery with 64-slice multidetector-computed tomography: a case report. *Cardiol Res Pract* 2010; **2010**: pii 861068 [PMID: 20721283 DOI: 10.4061/2010/861068]
60. **Osawa H**, Sakurada T, Sasaki J, Araki E. Successful surgical repair of a bilateral coronary-to-pulmonary artery fistula. *Ann Thorac Cardiovasc Surg* 2009; **15**: 50-52 [PMID: 19262451]
61. **Tseng WC**, Chen YS, Chiu SN. Coronary artery fistula as major source of right lung circulation in a patient with isolated right pulmonary artery agenesis. *Eur Heart J* 2010; **31**: 891 [PMID: 20008337 DOI: 10.1093/eurheartj/ehp559]
62. **Alipourparsa S**, Khaheshi I, Eslami V, Bozorgmanesh M, Haybar H. Accidental left circumflex artery to right lung fistula in a suspected case of pulmonary hypertension. *Case Rep Cardiol* 2014; **2014**: 427045 [PMID: 25143836 DOI: 10.1155/2014/427045]
63. **Almansori M**, Tamim M. Giant coronary artery fistula. *Asian Cardiovasc Thorac Ann* 2013; **22**: 595-597 [PMID: 24867037 DOI: 10.1177/0218492313478627]
64. **Jiang Z**, Chen H, Wang J. Right coronary artery fistula to left ventricle treated by transcatheter coil embolization: a case report and literature review. *Intern Med* 2012; **51**: 1351-1353 [PMID: 22687840 DOI: 10.2169/internalmedicine.51.6787]
65. **Komatsu T**, Katada Y, Sakai Y. Transbrachial coil embolization of a giant coronary artery fistula. *J Invasive Cardiol* 2012; **24**: E159-E160 [PMID: 22865315]
66. **Sayin MR**, Akpinar I, Ceetiner MA, Büyükateş M, Demirtaş AO, Yavuz N. Coronary artery fistula concomitant with bicuspid aortic valve stenosis. *Kosuyolu Kalp Derg* 2013; **16**: 237-239 [DOI: 10.5578/kkd.4444]
67. **Tachibana M**, Mukouhara N, Hirami R, Fujio H, Yumoto A, Watanuki Y, Hayashi A, Suminoe I, Koudani H. Double congenital fistulae with aneurysm diagnosed by combining imaging modalities. *Acta Med Okayama* 2013; **67**: 305-309 [PMID: 24145730]
68. **Wang H**, Luo X, Wang W, Wang X, Yang C, Zeng C. Successful transcatheter patent ductus arteriosus occluder embolization of a congenital left coronary artery aneurysm and fistulas draining into the right atrium. *Ann Thorac Cardiovasc Surg* 2012; **18**: 540-543 [PMID: 22673605 DOI: 0.5761/atcs.cr.11.01786]
69. **Alizadeh Ghavidel A**, Kyavar M, Ojaghi Z, Mirmesdagh Y. Huge arteriovenous fistula between a giant aneurismal right coronary artery and coronary sinus. *Arch Iran Med* 2012; **15**: 113-114 [PMID: 22292585]
70. **Davison PH**, McCracken BH, McIlveen DJ. Congenital coronary arteriovenous aneurysm. *Br Heart J* 1955; **17**: 569-572 [PMID: 13269618 DOI: 10.1136/hrt.17.4.569]
71. **Gasul BM**, Arcilla RA, Fell EH, Lynfield J, Bicoff JP, Luan LL. Congenital coronary arteriovenous fistula. Clinical, phonocardiographic, angiocardiographic and hemodynamic studies in five patients. *Pediatrics* 1960; **25**: 531-560 [PMID: 13826815]
72. **McIntosh HD**, Sleeper JC, Thompson HK, Sealy WC, Glenn Youn W. Preoperative evaluation of a continuous murmur in the chest. *Arch Surg* 1961; **82**: 74-87 [DOI: 10.1001/archsurg.1961.01300070078011]
73. **Neill C**, Mounsey P. Auscultation in patent ductus arteriosus; with a description of two fistulae simulating patent ductus. *Br Heart J* 1958; **20**: 61-75 [PMID: 13499770]
74. **Neufeld HN,** Lester RG, Adams P, Jr., [Anderson](http://circ.ahajournals.org/search?author1=RAY+C.+ANDERSON&sortspec=date&submit=Submit) RC, [Walton Lillehei](http://circ.ahajournals.org/search?author1=C.+WALTON+LILLEHEI&sortspec=date&submit=Submit) C, [Edwards](http://circ.ahajournals.org/search?author1=JESSE+E.+EDWARDS&sortspec=date&submit=Submit) JE. Congenital communication of a coronary artery with a cardiac chamber or the pulmonary trunk ("coronary arterial fistula"). *Circulation* 1961; **24**: 171-179 [DOI: 10.1161/01.CIR.24.2.171]
75. **Sanger PW**, Taylor FH, Robicsek F. The diagnosis and treatment of coronary arteriovenous fistula. *Surgery* 1959; **45**: 344-351 [PMID: 13625013]
76. **Honey M**. Coronary arterial fistula. *Br Heart J* 1964; **26**: 719-722 [PMID: 14213035 DOI: 10.1136/hrt.26.5.719]
77. **Meyer MH**, Stephenson HE, Keats TE, Martt JM. Coronary artery resection for giant aneurysmal enlargement and arteriovenous fistula. A five-year follow-up. *Am Heart J* 1967; **74**: 603-613 [PMID: 6055697 DOI: 10.1016/0002-8703(67)90500-5]
78. **Newcombe CP**, Whitaker W, KeateS PG. Coronary arterio-venous fistulae. *Thorax* 1964; **19**: 16-21 [PMID: 14105878 DOI: 10.1136/thx.19.1.16]
79. **Kourouclis C**, Viskos D, Papadopoulos P, Augoustakis D. Multiple coronary arteriovenous fistulae. *Acta Cardiol* 1976; **31**: 333-338 [PMID: 1088042]
80. **Morgan JR**, Forker AD, O'Sullivan MJ, Fosburg RG. Coronary arterial fistulas: seven cases with unusual features. *Am J Cardiol* 1972; **30**: 432-436 [PMID: 5056854 DOI: 10.1016/0002-9149(72)90578-4]
81. **Ogden JA**, Stansel HC. Coronary arterial fistulas terminating in the coronary venous system. *J Thorac Cardiovasc Surg* 1972; **63**: 172-182 [PMID: 5009726]
82. **Querimit AS**, Rowe GG. Localization of coronary arteriovenous fistula by indicator-dilution curves. *Am J Cardiol* 1971; **27**: 114-119 [PMID: 4922950 DOI: 10.1016/0002-9149(71)90089-0]
83. **Theman TE**, Crosby DR. Coronary artery steal secondary to coronary arteriovenous fistula. *Can J Surg* 1981; **24**: 231-23, 236 [PMID: 7237295]
84. **Rodgers DM**, Wolf NM, Barrett MJ, Zuckerman GL, Meister SG. Two-dimensional echocardiographic features of coronary arteriovenous fistula. *Am Heart J* 1982; **104**: 872-874 [PMID: 7124602 DOI: 10.1016/0002-8703(82)90026-6]
85. **Nguyen K**, Myler RK, Hieshima G, Ashraf M, Stertzer SH. Treatment of coronary artery stenosis and coronary arteriovenous fistula by interventional cardiology techniques. *Cathet Cardiovasc Diagn* 1989; **18**: 240-243 [PMID: 2605627 DOI: 10.1002/ccd.1810180410]
86. **Muthusamy R**, Gupta G, Ahmed RA, de Giovanni J, Singh SP. Fistula between a branch of left anterior descending coronary artery and pulmonary artery with spontaneous closure. *Eur Heart J* 1990; **11**: 954-956 [PMID: 2265645]
87. **Sapin P**, Frantz E, Jain A, Nichols TC, Dehmer GJ. Coronary artery fistula: an abnormality affecting all age groups. *Medicine* (Baltimore) 1990; **69**: 101-113 [PMID: 2319939 DOI: 10.1097/00005792-199003000-00004]
88. **Ashraf SS**, Shaukat N, Fisher M, Clarke B, Keenan DJ. Bicoronary-pulmonary fistulae with coexistent mitral valve prolapse: a case report and literature review of coronary-pulmonary fistula. *Eur Heart J* 1994; **15**: 571-574 [PMID: 8070486]
89. **Houghton JL**, Saxena R, Frank MJ. Angina and ischemic electrocardiographic changes secondary to coronary arteriovenous fistula with abnormal basal and reserve coronary blood flow. *Am Heart J* 1993; **125**: 886-889 [PMID: 8438722 DOI: 10.1016/0002-8703(93)90187-E]
90. **Kugelmass AD**, Manning WJ, Piana RN, Weintraub RM, Baim DS, Grossman W. Coronary arteriovenous fistula presenting as congestive heart failure. *Cathet Cardiovasc Diagn* 1992; **26**: 19-25 [PMID: 1499058 DOI: 10.1002/ccd.1810260106]
91. **Millaire A**, Goullard L, De Groote P, Ducloux G. Congenital high flow coronary cameral fistula in an 81-year-old woman: management problems. *Can J Cardiol* 1992; **8**: 917-920 [PMID: 1486542]
92. **Said SA**, Austermann-Kaper T, Bucx JJ. Congenital coronary arteriovenous fistula associated with atrioventricular valvular regurgitation in an octogenarian. *Int J Cardiol* 1993; **38**: 96-97 [PMID: 8444509 DOI: 10.1016/0167-5273(93)90210-8]
93. **Lemke P**, Urbanyi B, Wehr G, Hellberg K. Anomalous coronary artery fistula with simultaneous drainage to the left atrium and the coronary sinus. *Eur J Cardiothorac Surg* 1997; **11**: 793-795 [PMID: 9151059 DOI: 10.1016/S1010-7940(96)01137-2]
94. **Olsen LA**, Folke K, Kjaergard HK. Surgery of complex coronary arteriovenous fistula. *Scand Cardiovasc J* 1997; **31**: 169-171 [PMID: 9264167 DOI: 10.3109/14017439709058089]
95. **Boccalandro F**, Awadalla H, Smalling RW. Percutaneous transcatheter coil embolization of two coronary fistulas originating from the left main ostium and left anterior descending artery. *Catheter Cardiovasc Interv* 2002; **57**: 221-223 [PMID: 12357525 DOI: 0.1002/ccd.10280]
96. **Burns KE**, Ferguson KA, Spouge A, Brown JE. Massive congenital coronary arteriovenous malformation presenting with exertional dyspnea and desaturation in an adult: a case report and review of the literature. *Can J Cardiol* 2001; **17**: 85-89 [PMID: 11173319]
97. **Umaña E**, Massey CV, Painter JA. Myocardial ischemia secondary to a large coronary-pulmonary fistula--a case report. *Angiology* 2002; **53**: 353-357 [PMID: 12025925 DOI: 10.1177/000331970205300315]
98. **Yang Y**, Bartel T, Caspari G, Eggebrecht H, Baumgart D, Erbel R. Echocardiographic detection of coronary artery fistula into the pulmonary artery. *Eur J Echocardiogr* 2001; **2**: 292-294 [PMID: 11888824]
99. **Tousoulis D**, Brilli S, Aggelli K, Tentolouris C, Stefanadis C, Toutouzas K, Frogoudaki A, Toutouzas P. Left main coronary artery to left atrial fistula causing mild pulmonary hypertension. *Circulation* 2001; **103**: 2028-2029 [PMID: 11306534 DOI: 10.1161/01.CIR.103.15.2028]
100. **Tomaszewski A**, Brzozowski W. Right coronary artery-to-coronary sinus fistula diagnosed by echocardiography-A case report. *Kardiologia Polska* 2002; **56**: 83-86
101. **Ascoop AK**, Budts W. Percutaneous closure of a congenital coronary artery fistula complicated by an acute myocardial infarction. *Acta Cardiol* 2004; **59**: 67-69 [PMID: 15030137 DOI: 10.2143/AC.59.1.2005161]
102. **Dahiya R**, Copeland J, Butman SM. Myocardial ischemia and congestive heart failure from a left main to coronary sinus fistula. *Cardiol Rev* 2004; **12**: 59-62 [PMID: 14667267 DOI: 10.1097/01.crd.0000090892.82247.a8]
103. **Goldberg SL**, Makkar R, Duckwiler G. New strategies in the percutaneous management of coronary artery fistulae: A case report. *Catheter Cardiovasc Interv* 2004; **61**: 227-232 [PMID: 14755818 DOI: 10.1002/ccd.10758]
104. **Makaryus AN**, Orlando J, Katz S. Anomalous origin of the left coronary artery from the right coronary artery: a rare case of a single coronary artery originating from the right sinus of Valsalva in a man with suspected coronary artery disease. *J Invasive Cardiol* 2005; **17**: 56-58 [PMID: 15640543]
105. **Maleszka A**, Kleikamp G, Minami K, Peterschröder A, Körfer R. Giant coronary arteriovenous fistula. A case report and review of the literature. *Z Kardiol* 2005; **94**: 38-43 [PMID: 15668829 DOI: 10.1007/s00392-005-0161-1]
106. **Bonello L**, Com O, Gaubert JY, Sbraggia P, Paganelli F. Covered stent for closure of symptomatic plexus-like coronary fistula. *Int J Cardiol* 2006; **109**: 408-410 [PMID: 15982761 DOI: 10.1016/j.ijcard.2005.05.041]
107. **Koda M**, Hori T, Maeda N, Kato S, Murawaki Y, Horie Y, Kawasaki H, Hirayama C, Taketa K. Lectin-reactive patterns of markedly elevated serum alpha-fetoprotein in patients with chronic active hepatitis. *Am J Gastroenterol* 1991; **86**: 861-865 [PMID: 1711775 DOI: 10.2143/AC.61.5.2017774]
108. **Kalangos A**, Karaca S, Cikirikcioglu M, Vala D, Didier D. Aneurysmal circumflex coronary artery with fistulous connection to the coronary sinus. *J Thorac Cardiovasc Surg* 2005; **130**: 580-581 [PMID: 16077439 DOI: 10.1016/j.jtcvs.2005.02.045]
109. **Onorati F**, Mastroroberto P, Bilotta M, Cristodoro L, Esposito A, Pezzo F, Renzulli A. Surgical treatment of coronary-to-pulmonary fistula: how and when? *Heart Vessels* 2006; **21**: 321-324 [DOI: 10.1007/s00380-005-0892-y]
110. **Patsouras D**, Tsakas P, Korantzopoulos P, Siogas K. Dual coronary artery fistula in a patient with aortic valve stenosis. *Int J Cardiol* 2006; **108**: 397-398 [PMID: 16520126 DOI: 10.1016/j.ijcard.2005.03.022]
111. **Portela A**, Vale BP, Bastos R, Sousa JF, Costa I, Paiva J. [Large coronary-pulmonary artery fistulae: percutaneous embolization with microcoils and disposable balloons]. *Arq Bras Cardiol* 2005; **84**: 270-272 [PMID: 15868005 DOI: 10.1590/S0066-782X2005000300015]
112. **Rangasetty UC**, Ahmad M. Giant coronary artery fistula with aneurysm and multiple openings: a two-dimensional echocardiographic evaluation. *Echocardiography* 2006; **23**: 611-613 [PMID: 16911339 DOI: 10.1111/j.1540-8175.2006.00270.x]
113. **Abdelmoneim SS**, Mookadam F, Moustafa SE, Holmes DR. Coronary artery fistula with anomalous coronary artery origin: a case report. *J Am Soc Echocardiogr* 2007; **20**: 333.e1-333.e4 [PMID: 17336762 DOI: 10.1016/j.echo.2006.09.012]
114. **Androulakis A**, Chrysohoou C, Barbetseas J, Brili S, Kakavas A, Maragiannis D, Kallikazaros I, Stefanadis C. Arteriovenous connection between the aorta and the coronary sinus through a giant fistulous right coronary artery. *Hellenic J Cardiol* 2008; **49**: 48-51 [PMID: 18350782]
115. **de Doelder MS**, Hillers JA. Combination of imaging modalities in a coronary artery fistula. *Neth Heart J* 2008; **16**: 313-314 [PMID: 18827876 DOI: 10.1007/BF03086171]
116. **Dourado LO**, Góis AF, Hueb W, César LA. Large bilateral coronary artery fistula: the choice of clinical treatment. *Arq Bras Cardiol* 2009; **93**: e48-e49 [PMID: 19851641]
117. **Ramos Filho J**, Silva OA, Vilarinho DO, Guilherme FG, Ferreira JC, Souza AM. Pulmonary hypertension secondary to coronary-to-pulmonary artery fistula. *Arq Bras Cardiol* 2008; **91**: e19-e21 [PMID: 18709251]
118. **Hendry C**, Mahadevan V, Fath-Ordoubadi F. Successful percutaneous closure of coronary artery fistula with angiographic follow-up at 6 months. *Catheter Cardiovasc Interv* 2009; **73**: 581-583 [PMID: 19085916 DOI: 10.1002/ccd.21830]
119. **Klein LW**. A new hypothesis of the developmental origin of congenital left anterior descending coronary artery to pulmonary artery fistulas. *Catheter Cardiovasc Interv* 2008; **71**: 568-571 [PMID: 18307238 DOI: 10.1002/ccd.21408]
120. **Meerkin D**, Balkin J, Klutstein M. Rapid transcatheter occlusion of a coronary cameral fistula using a three-lobed vascular occlusion plug. *J Invasive Cardiol* 2009; **21**: E151-E153 [PMID: 19652265]
121. **Papadopoulos DP**, Perakis A, Votreas V, Anagnostopoulou S. Bilateral fistulas: a rare cause of chest pain. Case report with literature review. *Hellenic J Cardiol* 2008; **49**: 111-113 [PMID: 18459470]
122. **Raju MG**, Goyal SK, Punnam SR, Shah DO, Smith GF, Abela GS. Coronary artery fistula: a case series with review of the literature. *J Cardiol* 2009; **53**: 467-472 [PMID: 19477393 DOI: 10.1016/j.jjcc.2008.09.009]
123. **Said SA**, Schroeder-Tanka JM, Mulder BJ. Female gender and the risk of rupture of congenital aneurysmal fistula in adults. *Congenit Heart Dis* 2008; **3**: 63-68 [PMID: 18373752 DOI: 10.1111/j.1747-0803.2007.00144.x]
124. **Blaschke F**, Baur A, Roser M, Attanasio P, Ozcelik C, Haverkamp W, Boldt LH. Absent proximal right coronary artery with a fistula into the pulmonary vein. *Europace* 2012; **14**: 1369-1370 [PMID: 22628451 DOI: 10.1093/europace/eus090]
125. **Said SA**, van der Sluis A, Koster K, Sie H, Shahin GM. Congenital circumflex artery-coronary sinus fistula in an adult female associated with severe mitral regurgitation and myelodysplasy--case report and review of the literature. *Congenit Heart Dis* 2010; **5**: 599-606 [PMID: 21106021 DOI: 10.1111/j.1747-0803.2010.00381.x]
126. **Taleb MM**, Sheikh MA, Cooper CJ, Tinkel JL. Multiple coronary to pulmonary artery fistulas: a case report and review of the literature. *Cardiovasc Interv Ther* 2012; **27**: 127-130 [PMID: 22623009 DOI: 10.1007/s12928-012-0096-1]
127. **Kiefer TL**, Crowley AL, Jaggers J, Harrison JK. Coronary arteriovenous fistulae: the complexity of coronary artery-to-coronary sinus connections. *Tex Heart Inst J* 2012; **39**: 218-222 [PMID: 22740735]
128. **Kenny D**, Kavinsky C, Hijazi Z. Acute management of right coronary artery dissection following transcatheter occlusion of a congenital right coronary artery fistula-Benefits of a collaborative congenital and structural heart program. *Congenital Cardiology Today* 2011; **9**: 1-7
129. **Roscani MG**, Zanati SG, Salmazo PS, Carvalho FC, Magalhães CG, Borges VT, Bregagnollo EA, Matsubara BB, Hueb JC. Congenital aneurysmal circumflex coronary artery fistula in a pregnant woman. *Clinics* (Sao Paulo) 2012; **67**: 1523-1525 [PMID: 23295614 DOI: 10.6061/clinics/2012(12)30]
130. **Gribaa R**, Slim M, Ouali S, Neffati E, Boughzela E. Transcatheter closure of a congenital coronary artery to right ventricle fistula: a case report. *J Med Case Rep* 2014; **8**: 432 [PMID: 25511876 DOI: 10.1186/1752-1947-8-432]
131. **Kiefer TL**, Vavalle J, Halim S, Kaul P, Klein JL, Hurwitz LH, Gaca JG, Harrison JK. Anterograde percutaneous coronary-cameral fistula closure employing a guide-in-guide technique. *JACC Cardiovasc Interv* 2013; **6**: 1105-1107 [PMID: 24156972 DOI: 10.1016/j.jcin.2013.03.023]
132. **Villanueva PD**, Cebada FS, Ibañes EG, Sanz-Ruíz R, Elízaga-Corrales J, Fernández-Avilés F. Cardiac tamponade as a rare complication after giant coronary fistula percutaneous closure. *World Journal of Cardiovascular Diseases* 2013; **3**: 215-217 [DOI: [10.4236/wjcd.2013.32031](http://dx.doi.org/10.4236/wjcd.2013.32031%22%20%5Ct%20%22_blank)]
133. **Zanobini M**, Pontone G, Andreini D, Tessitore G, Bartorelli AL. Hybrid treatment of a giant coronary artery fistula between the left circumflex coronary artery and the coronary sinus. *Eur Heart J Cardiovasc Imaging* 2013; **14**: 200 [PMID: 23015031 DOI: 10.1093/ehjci/jes191]
134. **Said SA**, Koomen EM, Bos JS. Gender-related differences in octogenarians with congenital coronary artery fistula: a report of two cases and a review. *Neth Heart J* 2011; **19**: 523-530 [PMID: 21960176 DOI: 10.1007/s12471-011-0199-9]
135. **Liberthson RR**, Sagar K, Berkoben JP, Weintraub RM, Levine FH. Congenital coronary arteriovenous fistula. Report of 13 patients, review of the literature and delineation of management. *Circulation* 1979; **59**: 849-854 [PMID: 428095 DOI: 10.1161/01.CIR.59.5.849]
136. **Smettei OA**, Abazid RM. A rare case of coronary artery fistula presented with acute myocardial infarction. *Avicenna J Med* 2015; **5**: 49-51 [PMID: 25878968 DOI: 10.4103/2231-0770.154200]
137. **Rämö OJ**, Tötterman KJ, Harjula AL. Thrombosed coronary artery fistula as a cause of paroxysmal atrial fibrillation and ventricular arrhythmia. *Cardiovasc Surg* 1994; **2**: 720-722 [PMID: 7532088]
138. **Cao H**, Ye L, Chan P, Fan H, Liu Z. Giant coronary artery aneurysm with fistula to the pulmonary artery complicated by frequent ventricular premature contractions: a case report. *Medicine* (Baltimore) 2015; **94**: e530 [PMID: 25700316 DOI: 10.1097/MD.0000000000000530]
139. **Said SA**, el Gamal MI. Coronary angiographic morphology of congenital coronary arteriovenous fistulas in adults: report of four new cases and review of angiograms of fifteen reported cases. *Cathet Cardiovasc Diagn* 1995; **35**: 29-35 [PMID: 7614537]
140. **Urrutia-S CO**, Falaschi G, Ott DA, Cooley DA. Surgical management of 56 patients with congenital coronary artery fistulas. *Ann Thorac Surg* 1983; **35**: 300-307 [PMID: 6830365 DOI: 10.1016/S0003-4975(10)61563-9]
141. **Bauer HH**, Allmendinger PD, Flaherty J, Owlia D, Rossi MA, Chen C. Congenital coronary arteriovenous fistula: spontaneous rupture and cardiac tamponade. *Ann Thorac Surg* 1996; **62**: 1521-1523 [PMID: 8893601 DOI: 10.1016/0003-4975(96)00757-6]
142. **Liu M**, Hou Q, Guo X, Wang S, Ma Z. Dual-source CT coronary angiographic evaluation of coronary artery fistulas. *Exp Ther Med* 2014; **7**: 1155-1159 [PMID: 24940403 DOI: 10.3892/etm.2014.1602]
143. **Ozeki S**, Utsunomiya T, Kishi T, Tokushima T, Tsuji S, Matsuo S, Natsuaki M, Ito T, Yano K. Coronary arteriovenous fistula presenting as chronic pericardial effusion. *Circ J* 2002; **66**: 779-782 [PMID: 12197607 DOI: 10.1253/circj.66.779]
144. **Kisko AS**, Dernarova L, Kmec J, Vereb M, Hudakova A, Jakubikova M, Kishko N. An unusual presentation of coronary artery fistula in athlete-Case report. *Clinical Medicine and Diagnostics* 2012; **2**: 33-36 [DOI: [10.5923/j.cmd.20120204.03](http://dx.doi.org/10.5923/j.cmd.20120204.03%22%20%5Ct%20%22_blank)]
145. **Lau G**. Sudden death arising from a congenital coronary artery fistula. *Forensic Sci Int* 1995; **73**: 125-130 [PMID: 7797185 DOI: 10.1016/0379-0738(95)01721-T]
146. **McNamara JJ**, Gross RE. Congenital coronary artery fistula. *Surgery* 1969; **65**: 59-69 [PMID: 5762418]
147. **Makaryus AN**, Kort S, Rosman D, Vatsia S, Mangion JR. Successful surgical repair of a giant left main coronary artery aneurysm with arteriovenous fistula draining into a persistent left superior vena cava and coronary sinus: role of intraoperative transesophageal echocardiography. *J Am Soc Echocardiogr* 2003; **16**: 1322-1325 [PMID: 14652614 DOI: 10.1067/j.echo.2003.08.007]

**P-Reviewer:** Cebi N, Kettering K, Peteiro J **S-Editor:** Kong JX **L-Editor: E-Editor:**



**Figure 1** **Continuous wave Doppler demonstrating blood flow velocity (3.66 m/c) across the tricuspid valve.**

**Table 1 Reviewed Asian (*n =* 111) and Caucasian (*n =* 100) group of patients**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Total reviewed subjects** | **Asian group** | **Caucasian group** |
| *n* | 211 | 111 (53%) | 100 (47%) |
| Gender | F 124(59%) M 87(41%) | F 63(57%) M 48(43%) | F 61(61%) M 39(39%) |
| Mean age (range)1, yr | 49.4 (16-85) | 48.9 (19-83) | 49.9 (16-85) |
| CAF characteristics UnilateralBilateralMultilateralMode of terminationCVFsCCFs | 118 (56%)87 (41%)6 (3%)90 (43%)121 (57%) | 42 (38%)63 (57%)6 (5%)43 (39%)68 (61%) | 76 (76%)24 (24%)-47 (47%)53 (53%) |
| RHCsPAP/RVSP | 201 (95%)10 (5%) | 107 (96%)4 (4%) | 94 (94%)6 (6%) |
| ManagementCMMPTE2SLWWDeathNot mentioned | 3829124 (59%)2216 | 209 (8%)82 (74%)--- | 1820 (20%)42 (42%)2216 |

1Subjects (*n =* 41) from ref. [35] were not included in calculation of mean age (*n =* 170, 70 Asian and 100 Caucasian). 2In one patient, PTE failed followed by SL treatment (ref. [149]) and another treated with hybrid procedures (ref. [135]). CAF: Coronary artery fistula; CCFs: Coronary-cameral fistulas; CVFs: Coronary-vascular fistulas; CMM: Conservative medical management; F: Female; M: Male; PTE: Percutaneous therapeutic embolization; RHC: Right heart catheterization; SL: Surgical ligation; sPAP: Systolic pulmonary artery pressure; RVSP: Right ventricular systolic pressure.

**Table 2 Asian and Caucasian group of patients (*n =* 49) with pulmonary hypertension**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Total group** | **Asian group** | **Caucasian group** |
| *n* | 49 | 15 (31%) | 34 (69%) |
| Age1 | 56 (16-80) | 54.4 (24-77) | 56.8 (16-80) |
| Gender | F 34 (69%) M 15 (31%) | F 12 (80%) M 3 (20%) | F 22 (65%) M 12(35%) |
| CAF |  |  |  |
| Unilateral | 37 (76%) | 9 (60%) | 28 (82%) |
| Bilateral | 12 (24%) | 6 (40%) | 6 (18%) |
| PHT |  |  |  |
| Mild | 26 (53%) | 8/15 (53%) | 18/34 (53%) |
| Moderate | 11 (22%) | 2/15 (13%) | 9/34 (26%) |
| Severe | 12 (25%) | 5/15 (33%) | 7/34 (21%) |
| Mean PAP (mmHg) | 35.6 (range 26-60) | 36.9 (range 27-49) | 34.3 (range 26-60) |
| Mean Qp:Qs ratio | 1.9 (range 1.13-2.75) | 1.9 (range 1.13-2.75) | 1.9 (range 1,3-2.7) |
| RHC | 43 (88%) | 13 (87%) | 30 (88%) |
| Doppler (sPAP) | 6 (12%) | 2 (13%) | 4 (12%) |
| CAF characteristics |  |  |  |
| Origin  | R 8, L 30, bilateral 11 | R 2, L 8, bilateral 5 | R 6, L 22, bilateral 6 |
| Termination | RH side 45 LH side 4 | RH side 13 LH side 2 | RH side 32 LH side 2 |
| Mode of termination |  |  |  |
| CVFs | 37 (76%) | 9/15 (60%) | 28/34 (82%) |
| CCFs | 12 (24%) | 6/15 (40%) | 6/34 (18%) |
| Associated disorders | 17/49 (35%) | 5/15 (33%) | 12/34 (35%) |
| Management |  |  |  |
| SL | 30 (61%) | 9 | 21 |
| PTE | 13 (27%) | 4 | 92 |
| CMM | 6 (12%) | 2 | 4 |

1Subjects from ref. [35] were not included in calculation of mean age. Mean age was calculated from 170 (70 Asian and 100 Caucasian) subjects. 2One PTE failed (from ref. [149]) followed by SL treatment and another treated with hybrid procedures (from ref. [135]). CAF: Coronary artery fistula; CCFs: Coronary-cameral fistulas; CVFs: Coronary-vascular fistulas; CMM: Conservative medical management; F: Female; R: Right coronary artery; L: Left coronary artery; LH: Left heart side; M: Male; PAP: Pulmonary artery pressure; PHT: Pulmonary hypertension; PTE: Percutaneous therapeutic embolization; RH: Right heart side; RHC: Right heart catheterization; SL: Surgical ligation; sPAP: Systolic pulmonary artery pressure.

 **Table 3 Mode of termination coronary-vascular fistulas *vs* coronary-cameral fistulas in the pulmonary hypertension (*n =* 49) and all reviewed (*n =* 211) subjects**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **CVFs** | **CCFs** | **Mean age and range (yr)** |
| Total *n =* 211  | 90/211 (43%) | 121/211(57%) | 38.3 (26-67) |
| Asian 15/111 (14%) | 9/15 (60%) | 6/15 (40%) | 39.7 (27-67) |
| Caucasian 34/100 (34%) | 28/34 (82%) | 6/34 (18%) | 36.8 (26-60) |

CCFs: Coronary-cameral fistulas; CVFs: Coronary-vascular fistulas.

**Table 4 Possible complications of coronary artery fistulas**

|  |  |
| --- | --- |
| **Complication** | **Features** |
| Cardiovascular  | Myocardial infarction, stroke, aneurysm, rupture |
| Infectious  | Bacterial endocarditis, septic pulmonary and septic renal embolism |
| Valvular  | Incompetence, dysfunction, perforation |
| Pericardial  | Hemopericardium, pericardial effusion, tamponade) |
| Myocardial  | Congestive heart failure |
| Arrhythmic  | Supraventricular arrhythmias, ventricular arrhythmias and sudden death |