Available online at: http://www.iajps.com   *Research Article*

PREVALENCE OF CORONARY ARTERIES ANOMALIES DETECTED IN GENERAL POPULATION IN XINJIANG WITH CT-ANGIOGRAPHY

[1]**Sanawar Abbas, [1]Liu Wenya.**
[1]Imaging Center, the First Affiliated Hospital of Xinjiang Medical University, Urumqi 830054, China

Abstract:

Background: The coronary arteries are subject to congenital anomalies of varying degree. Most of the coronary artery anomalies are congenital in origin. Objectives: The aim of this study is to determine angiographically the detail account of the prevalence of different forms and types of coronary anomalies among male and female population in xinjiang.

Materials and Methods: The CT angiographic data of 6678 consecutive patients undergoing CT angiography in first affiliated hospital of xinjiang medical university from 1st June 2012 to 1st September 2018 were analyzed. This study is one center study, and its conducted in First Affiliated Hospital of Xinjiang Medical University, Urumqi, Xinjiang, China.

Results: The total population under study was 6678 cases with anomalous coronary arteries are 187 cases with an incidence rate of 2.80%. Among these cases 149 of them (79.67%) had anomalies of origin and distribution, and 5 (2.67%) had coronary artery fistulae. while the in 33(17.65%) patient's coronary arteries are absent, (24 cases (12.83%) in LMA and 9 cases (4.81%) in LCX). The incidence was highest for the origin of RCA from the left coronary sinus 45 cases (24.06%) .The incidence of coronary artery anomalies in male and female is $X^2=8.047$, P=0.005 .The occurrence of coronary artery anomalies in male and female has significant difference ($X^2=15.243$ P=0.000).

Conclusion: The aim of this study to conclude CT angiographically the anatomical patterns and frequency of occurrence of congenital coronary anomalies in xinjiang among male and female population , this study is carried out to evaluate the difference in anomalies in both groups and to recommend these results to clinicians for the better treatment of patients in respective category and to pave a pathway for further work and research in this field.

Corresponding author:

Liu Wenya,
Imaging Center, the First Affiliated Hospital of Xinjiang Medical University,
Urumqi 830054, China. email: sanawarabbas1@yahoo.com

QR code

INTRODUCTION:

Computed tomography angiography (CTA) is an advanced non-invasive imaging modality and it is a golden standard for evaluation and diagnosis of coronary arteries, its variants and anomalies[1]. Coronary artery anomalies are rare yet diagnosed incidentally on CCA and CTA [2], but the incidence of coronary anomalies varies from 0.2% to 1.6 %, but figures between 0.3 to 5.6% have been mentioned in the literature [20-23].In past recent years the advancement of CT based angiography (CTA) for coronary arteries not only provides greater evaluation of coronary artery disease (CAD) but also serves as diagnostic tool for many non-coronary cardiac pathologies [1, 3],and few conditions in which there is high prevalence of coronary artery anomalies as of in turner syndrome[4]. Majority of the anomalies of coronary arteries are benign anatomic variants, only a modest number of anomalies are malignant [25]. some literature has concluded that malignant anomalies coronary arteries are related to almost 33% of all sudden cardiac deaths especially in the youth[5][26], even some of the benign anomalies are of clinical and diagnostic significance, as higher location of coronary arteries, clamping of the aorta below the artery during surgery may cause cardiac ischemia, lead to fatal consequences .Girish, M.P., et al.,in their study even reported a non-coronary sinus origin and atresia of left circumflex coronary artery[6]. Congenital coronary anomalies are isolated primary lesions, they had no association for development coronary atherosclerosis and coronary stenosis. [33] CTA is first line imaging support to delineate coronary arteries for major interventional procedures such as guiding catheter and the guide wire for coronary anomalies which lead to considerably reduce the dispensability of invasive catheterization [1, 7]. Primary congenital anomalies are owed to changes during early embryonic life [24]. Cardiologists, surgeons, and anatomists have been interested in coronary artery anomalies for many years. The recognition of these anomalies is of particular significance when a patient requires percutaneous therapeutic coronary intervention coronary angioplasties, or cardiac surgery.

The purpose of this study was to establish the prevalence and anatomical patterns of coronary artery anomalies and to determine its frequency in the general population of xinjiang.

Key words: Coronary Artery, Computed Tomography Angiography, Anomalies, Fistulas, Prevalence

Abbreviations: Coronary Artery Disease (CAD), Coronary postmortem computed tomography angiography (coronary PMCTA), acute myocardial infarction (AMI), coronary artery anomalies (CAAs), coronary computed tomography (CCT), left coronary artery (LCA)

MATERIALS AND METHOD:

This study was carried out at The First Affiliated Hospital of Xinjiang Medical University Urumqi, China. Before performing CT, all adult patients undergoing CT coronary angiography at this center are recorded on a dedicated database. Basic biodata including age, gender, family history (cardiac disease), smoking habits, admission diagnosis, any Co-morbidities were properly reviewed. Furthermore, laboratory findings, ECG, cardiac angiographic tests and any previous treatment histories were all documented. CT angiographic procedures are performed by Consultant radiologists, including several Visiting radiologists, and doctors-in-training under the supervision of the concerned technical Consultant staff. After the angiograms has been performed, all diagnostic findings on a separate diagnostic form. We analyzed the data between the period 1st June 2012 to 1st September 2018. Patients with known congenital heart disease were excluded. The reports were analyzed, and those with anomalous coronary arteries were selected for further assessment.8024 CT angiographies were performed during this period; the diagnostic information was completed in 6678 patients. Those patients recorded as having a congenital coronary anomalies were retrieved and reviewed by four consultant radiologists from our hospital and four independent observers from other affiliated hospitals of Xinjiang Medical University. In case of any difference of opinion, a consensus was reached after discussion on different aspects of the case. The number of male and female patients under this study were 4745 (71.054%), and 1933 (28.945%) respectively. The anomalies of coronary arteries found in both male and female population is analyzed by systematic anatomic approaches developed by Angelini and later by Khatami, et al, [27] are probably the most valid classification for coronary artery anomalies.

STATISTICAL ANALYSIS:

Statistical analysis was performed with commercially available software (SPSS 13.0 version, Chicago, IL, USA). Chi-square test was used to assess any significant difference of anomalous origin of coronary arteries between male and female patients. The incidence of coronary artery anomalies of male and female population were different in the following: the incidence of coronary artery anomalies (X^2=8.047, P=0.005). The occurrence of coronary artery anomalies in male and female has significant difference of X^2=15.243, P=0.000). P-values < 0.05

were considered significant between two groups. There were significant differences of the morbidity between male and female is X2=15.243, P=0.000 and the morbidity of male is 2.3%, female is 4.0%.

RESULTS:

Patient population: The study included 6678 patients who underwent diagnostic CTA during the study period. The presence of congenital coronary anomalies was confirmed in 187 patients 109 males, 78 females. The male and female ratio is (M: F) (58.2 %), 78(41.8 %) respectively, with estimated prevalence is 2.80%,

the details of anomalies are summarized in the tables below.

Incidence: The incidence of congenital anomalies was 2.80% (187 out of 6678 patients) of whom 149 (79.67%) had anomalies of origin and distribution, and 5 (2.67%)had coronary artery fistulae. while the in 33 (17.64%) patient's coronary arteries are absent, (24 (12.83%) cases in LMA and 9 cases in LCX (4.81% respectively). The incidence was the highest for the origin of RCA from the left coronary sinus 45 (24.06%), with angiographic incidence of 0.67%.

Table-1. Shows the incidence of Anomalies in Total Population.

Prevalence	Population	Anomalies	incidence %
Total prevalence	7470	203	2.72
Prevalence in male & female population	6678	187	2.80

Table-2. Incidence of Coronary Artery Anomalies. The angiographically detected coronary artery anomalies, according to the systematic analysis scheme proposed by Angelini and Khatami.

Classification	Number of patients	Angiographic incidence (%)	Anomaly-incidence(%)
Total coronary arteriograms.	6687		
Total coronary anomalies.	187	2.80%	
Anomalies of origin and distribution.	149	2.23%	79.7%
Coronary arteries communications and fistulae.	5	0.07%	2.7%
Congenital coronary arteries atresia (absent).	33	0.49%	17.6%

Table-3. Total Male and Female population.

Population	Total
Male population	4745
Female population	1933
Total population	6678

Table-4. Comparison of Anomalies in Male and Female population.

Population	Total
Incidence in male	109
Incidence in female	78
Total	187

Table-5. Comparison of Anomalies in Male and Female, Angiographically detected Coronary Artery Anomalies, according to the systematic analysis scheme proposed by Angelini and Khatami.

Coronary Anomalies	Male	Female	Total
1. Anomalous pulmonary origin	1	0	1
2.Anamolous aortic origin	33	27	60
3.Congenital atresia/absent	18	15	33
4.Coronary AV-fistulas	3	2	5
5.High incidence of LCA	22	21	43
6.High incidence of RCA	26	11	37
7.High incidence of both LCA & RCA	6	2	8
Total	109	78	187

Anomalous Pulmonary origins of the Coronary Arteries: In our study, we had one case (0.53%) of anomalous origin of pulmonary artery. The left coronary artery (LCA) originating from right pulmonary artery (RPA) was reported in male. No cases were reported in female population.

Anomalous Aortic Origins of the Coronary Arteries: Total 60 case, estimated prevalence 32.08% was reported with anomalous aortic origin of coronary arteries, among these cases 33 (17.65%) were male and 27 (14.43%) were females. The Majority of the cases had different origins of the RCA, LCA and left anterior descending artery (LAD). Nine cases in which there is anomalous origination of LCA from the right coronary sinus. There were 4 left circumflex artery (LCX) origin and distribution anomalies, all of which originated from the RCS. There were 2 LAD origin and distribution anomalies. Both the cases of RCA originated from LAD, found in females. There were 45 cases of LCA origin and distribution anomalies, in those cases RCA arise from LCA, of whom 23 cases were found in male population and 22 cases were found in female population. The incidence of anomalies of RCA is the highest. Conclusively, the prevalence rate of aortic anomalies in male population is slightly higher than in female population.

Congenital absent /atresia of the Coronary Arteries: There were 33 case (17.65%)of coronary arteries atresia/absent, of whom 18 cases (9.63%) male and 15 cases (8.02%) female patients. In 24 cases, 14 male and 10 female patients had congenital atresia/absent LMA and in 9 cases 4 males and 5 female patients were diagnosed with absent LCX. The incidence of atresic anomalies were slighter more in male then in female population.

Coronary Artery Bridging: We detected no case of coronary artery bridging.

Coronary Arteriovenous Fistulas: Coronary artery fistulae were observed in 5 cases (2.67%) three in males and two female patients. Abnormal distal connections or terminations were included in this subgroup. The fistulae we found in our series were small and with one case of significant shunt circulation between LAD and left ventricle. These were between the LAD and PA, accessory coronary artery and PA and from LCA to PA. Majority of the fistulas lead to pulmonary artery, and the prevalence rate of arteriovenous fistulas is almost equal in both groups. The shunt between LAD and left ventricle was diagnosed in male population.

Coronary Artery Aneurysms and Stenosis: In both anomalous and normal coronaries, no significant association was found between the presence of stenotic/atherosclerotic lesion or aneurysms in male and female population.

The incidence of high location of coronary arteries were reported as well in this study. There were 43 case (23%) of high location of LCA, of whom 22 cases were reported in male and 21 cases were reported in female population. In both the groups the prevalence is almost same in both groups.

There were also 37 cases (19.79%) of high location of RCA, of whom 26 cases were reported in males and 11 cases were reported in female adult population. The incidence of high location of RCA is more in male population. we also found 8 cases (4.28%) with high location of both LCA and RCA with 2 cases in females and 6 cases were identified in male population.The incidence of high location of anomalous coronary arteries in male population was more than female population, with 54 cases of male and 34 cases female population.

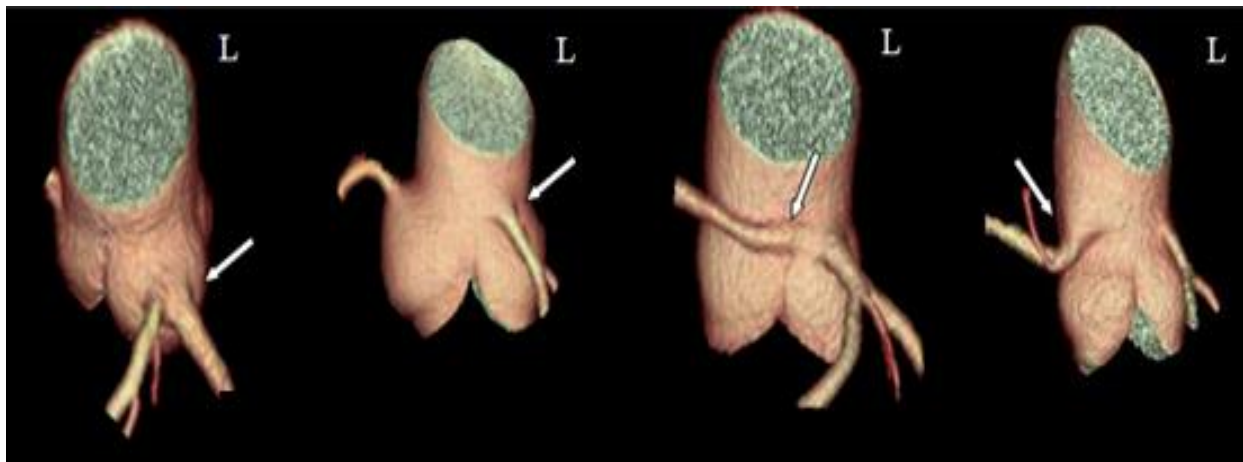**Figure-1- Shows Different Anomalies of Coronary Arteries.**

Figure-1 1. Absent LMA 2. LCA High location 3. RCA Originate from left Coronary sinus 4. RCA High location respectively

DISCUSSION:
The overall incidence of Coronary artery anomalies was 2.80%, which in agreement with incidence reported previously in different Studies of the coronary angiograms described in the literature [20-23]. In our study we had one case (0.53%) of a coronary artery originating from the pulmonary artery. It is a rare congenital anomaly occurring in 0.26% of patients with congenital heart disease. In 1933 Bland, White and Garland described the clinical syndrome in a 3-month old infant who died from it. Nearly 90% of patients with these anomalies die during infancy. If the patient survives, the anomalous artery fills retrogradely through collaterals and drains into the pulmonary artery (left to right shunt). This condition

may cause symptoms as arrhythmias, angina, infarction(MI), and heart failure, yet exhibit very few morbidity and mortality rates[8]. LCA originating from the pulmonary artery is not rare in congenital lesions, and is associated with a high death rate in infants and children if surgery is not performed. 32.08% of cases were reported with anomalous aortic origin of coronary arteries, among these cases 33 were male and 27 were females. 33 (17.65%) cases had absent/atresia coronary artery in our patients. Among 24 cases,14 males and 10 female patients had congenital atresia/absent LMA and 9 cases 4 male and 5 female patients were found with absent LCX. Congenital hypoplastic, stenotic, or atretic LMCA are

rare anomalies and have been found to be related to myocardial infarction but not sudden death. [28] Coronary fistulas were observed in 5 (2.67%) patients. The fistulae were reported less than 0.002-1% in some studies[9]. It is a congenital or either acquired rare condition, patients are mostly asymptomatic and hemodynamically stable, fistulas are also known as coronary arteriovenous malformation, usually found on routine checkup as accidental findings.[10] we found in our series were small and with one case of significant shunt circulation between LAD and left ventricle. A coronary artery fistula is an abnormal connection between a cardiac chamber ("coronary-cameral fistula") or other structures in systemic and pulmonary circulation,[9] commonly on the right side of the heart from coronary artery to pulmonary artery,[11] and less common drain into left atrium, or left ventricle. These shunts are generally very small, However, if the shunt is large pulmonary hypertension, congestive heart failure, bacterial endocarditis, and myocardial ischemia in the terminal portion of the involved coronary artery can occur, it may also cause "coronary steal syndrome"[9] but the majority of coronary arterial fistulas are asymptomatic in the early years. The advancement of CTA,MRI and echocardiography has better equipped us with rite tools to delineate anomalous coronary arteries.[11, 12]

The prevalence of high location of coronary arteries were reported as well, there were 43 case (23%) of high location of LCA, 37 cases (19.79%) of high location of RCA and 8 cases (4.28%) with high location of both LCA and RCA. The incidence of high location of anomalous coronary arteries in male population was more than female population with 54 cases of male and 34 cases of female population. The benign anomalies of high location of coronary arteries can have clinical significance, clamping of aorta during surgery may cause cardiac ischemia which could lead to myocardial infarction. The incidence was the highest for the origin of RCA from the left coronary sinus 45 (24.06%), with angiographic incidence of 0.67%. Of these anomalies, 90% are abnormalities in the origin or distribution of a coronary artery and 10% are fistulas.

As this study shows the incidence of coronary anomalies is more in male population then female population, but the number of male patients under study were more than female patients yet the number of anomalies found in females are significantly more in the population under study as compared to male population. Majority of congenital anomalies of the coronary arteries are benign while 20% are clinically significant. Most coronary artery anomalies are not hemodynamically significant. [29] The term coronary artery anomaly refers to a wide range of congenital abnormalities involving the origin, course and structure of coronary arteries [30].

Although these anomalies, which are remarkably different from the normal structure, exist as early as birth, they are incidentally encountered during a selective angiography routine health checkup [28,31]. Maron et al. in her report concluded Coronary artery anomalies of wrong sinus origin in young athletes is the second major causes of sudden death[13][32]. Some coronary artery anomalies have been correlated with sudden death, myocardial infarction, and anginal syndromes, and they need to be treated. They may be susceptible due to incongruous origin of coronary sinus of Valsalva for developing an acute myocardial or chronic injuries in the area supplied by the anomalous arteries [34-36]. It should be also noted with great care that negative CCTA does not rule out the diagnosis of acute coronary syndrome and spontaneous coronary artery dissection[14]. CTCA even has better diagnostic efficiency for appraising coronary artery anomalies in Kawasaki disease.[15] Coronary postmortem computed tomography angiography (coronary PMCTA) has been playing pivotal role for autopsies to analyze the cause of death by estimating the heart shape, coronary arteries/obstruction/anomalous origin. Histopathological changes like myocardial infarction, anomalous aortic origin of a coronary artery (AAOCA), hypertrophic obstructive cardiomyopathy (HOCM) and acute myocarditis is ascertained using coronary PMCTA[16].

CONCLUSIONS:

Our findings are a good reflection of the true angiographic prevalence of these anomalies in general population in Xinjiang. We concluded that 149 cases (79.67%) had anomalies of origin and distribution, and 5 (2.67%) had coronary artery fistulae. while the in 33(17.65%) patient's coronary arteries are absent, (24 cases (12.83%) in LMA and 9 cases (4.81%) in LCX). The incidence was highest for the origin of RCA from the left coronary sinus 45 cases (24.06%) .The incidence of coronary artery anomalies in male and female is $X^2=8.047$, P=0.005 .The occurrence of coronary artery anomalies in male and female has significant difference ($X^2=15.243$ P=0.000).Coronary computed tomography angiography remains the gold standard and was considered as a primary imaging technique for estimation and diagnosis of various coronary artery anomalies[17, 18]. The CTA also elucidate the normal anatomy of all coronary arteries with its variants, and vascular systems [19].

LIMITATIONS:

Our study is only a one institutional, which is likely to result in partial bias. It is recommended that further multi-institutional and inter-collaborative analysis of data and prevalence is recommended to achieve statistically and epidemiological a broader overview of coronary artery anomalies in xinjiang.

CONFLICT OF INTEREST:

The process and results of this study are not affected by the relevant equipment, materials, and pharmaceutical companies.

REFERENCES:

1. Kolossvary, M., et al., *Plaque imaging with CT-a comprehensive review on coronary CT angiography based risk assessment.* Cardiovasc Diagn Ther, 2017. **7**(5): p. 489-506.

2. Namgung, J. and J.A. Kim, *The prevalence of coronary anomalies in a single center of Korea: origination, course, and termination anomalies of aberrant coronary arteries detected by ECG-gated cardiac MDCT.* BMC Cardiovasc Disord, 2014. **14**: p. 48.

3. Ozturk, E., et al., *Non-coronary abnormalities of the left heart: CT angiography findings.* Anatol J Cardiol, 2016. **16**(9): p. 720-7.

4. Viuff, M.H., et al., *Coronary artery anomalies in Turner Syndrome.* J Cardiovasc Comput Tomogr, 2016. **10**(6): p. 480-484.

5. Diaz, R. and J. Vega, *[Role of coronary computed tomography angiography for the diagnosis of coronary anomalies].* Rev Med Chil, 2016. **144**(10): p. 1277-1286.

6. Girish, M.P., et al., *Ostial atresia of left circumflex coronary artery arising from non-coronary sinus: a combination of rare anomalies.* Cardiovasc Interv Ther, 2016. **31**(4): p. 284-7.

7. Ramesh, D., et al., *Use of CT Angiogram in Interventions Involving Coronary Artery Anomalies: A Case Series.* Am J Case Rep, 2015. **16**: p. 858-62.

8. Shuaib, W., et al., *Coronary anomalies encountered in the acute setting: an imaging review.* Emerg Radiol, 2014. **21**(6): p. 631-41.

9. Challoumas, D., et al., *Coronary arteriovenous fistulae: a review.* Int J Angiol, 2014. **23**(1): p. 1-10.

10. Sunkara, A., et al., *Coronary Artery Fistula.* Methodist Debakey Cardiovasc J, 2017. **13**(2): p. 78-80.

11. Lim, J.J., et al., *Prevalence and types of coronary artery fistulas detected with coronary CT angiography.* AJR Am J Roentgenol, 2014. **203**(3): p. W237-43.

12. Varghese, A., J. Keegan, and D.J. Pennell, *Cardiovascular magnetic resonance of anomalous coronary arteries.* Coron Artery Dis, 2005. **16**(6): p. 355-64.

13. Attili, A., et al., *Echocardiography and coronary CT angiography imaging of variations in coronary anatomy and coronary abnormalities in athletic children: detection of coronary abnormalities that create a risk for sudden death.* Echocardiography, 2013. **30**(2): p. 225-33.

14. Eleid, M.F., et al., *Spontaneous coronary artery dissection: challenges of coronary computed tomography angiography.* Eur Heart J Acute Cardiovasc Care, 2018. **7**(7): p. 609-613.

15. Kim, J.W. and H.W. Goo, *Coronary artery abnormalities in Kawasaki disease: comparison between CT and MR coronary angiography.* Acta Radiol, 2013. **54**(2): p. 156-63.

16. Takei, H., et al., *Usefulness of coronary postmortem computed tomography angiography to detect lesions in the coronary artery and myocardium in cases of sudden death.* Leg Med (Tokyo), 2018. **30**: p. 46-51.

17. Yesilyurt, H., et al., *The prevalence of coronary artery anomalies with coronary computed tomography.* Turk J Med Sci, 2017. **47**(1): p. 188-193.

18. Erol, C., M. Koplay, and Y. Paksoy, *Evaluation of anatomy, variation and anomalies of the coronary arteries with coronary computed tomography angiography.* Anadolu Kardiyol Derg, 2013. **13**(2): p. 154-64.

19. Kosar, P., et al., *Anatomic variations and anomalies of the coronary arteries: 64-slice CT angiographic appearance.* Diagn Interv Radiol, 2009. **15**(4): p. 275-83.

20. Montaudon M, Latrabe V, Iriart X, Caix P, Laurent F. Congenital coronary arteries anomalies: review of the literature and multi-detector computed tomography (MDCT)-appearance. Surg Radiol Anat. 2007;29(5):343-55.

21. Schmitt R, Froehner S, Brunn J, Wagner M, Brunner H, Cherevatyy O, et al. Congenital anomalies of the coronary arteries: imaging with contrast enhanced, multidetector computed tomography. Eur Radiol. 2005;15(6):1110-21.

22. Goo HW, Seo DM, Yun TJ, Park JJ, Park IS, Ko JK, et al. Coronary artery anomalies and clinically important anatomy in patients with congenital heart disease: multislice CT findings.Pediatr Radiol. 2009;39(3):265-73

23. Rahalkar AM, Rahalkar MD. Pictorial essay: Coronary artery vari-ants and anomalies. Indian J Radiol Imaging. 2009;19(1):49-53

24. 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. The Journal of Invasive Cardiology2005, 17(1):56-58.

25. Angelini P, Flamm SD. Newer concepts for imaging anomalous aortic origin of the coronary arteries in adults. Catheter Cardio-vasc Interv. 2007;69(7):942-54

26. Eckart RE, Scoville SL, Campbell CL, Shry EA, Stajduhar KC, Potter RN, et al. Sudden death in young adults: a 25-year review of au-topsies in military recruits. Ann Intern Med. 2004;141(11):829-34.

27. Dodge-Khatami A, Mavroudis C, Backer CL. Congenital Heart Surgery Nomenclature and Database Project: anomalies of the coronary arteries. Ann Thorac Surg 2000; 69: 270-97.

28. Mirchandani S, Phoon CK: Management of anomalous coronaryarteries from the contralateral sinus. International Journal of Car-diology2005, 102(3):383389

29. S B Pillai, M M Khan, A Diamond, P P McKeown The prevalence and types of coronary artery anomalies in Northern Ireland The Ulster Medical Journal, Volume 69, No. 1, pp. 19-22, May 2000.

30. Angelini P: Coronary artery anomalies:an entity in search of an identity. Circulation2007, 115(10):1296-1305.

31. Dogan SM, Gursurer M, Aydin M,Gocer H, Cabuk M, Dursun A: Myocardial ischemia caused by a coronary anomaly left ante-rior descending coronary artery arising from right sinus of Valsalva. International Journal of Cardiology2006, 112(3):e57-59.

32. Maron BJ: Sudden Death in young Athletes. New England Journal of Medicine2003, 349:1064-1075

33. Naveen G, Satendra T, Aditya K, Deepak Kumar G, Nakul S. Primary congenital anomalies of the coronary arteries: a coronary arteriographic study. Int J Cardiol 2000; 74: 39-46.

34. Pelliccia A: Congenital coronary artery anomalies in young patients: new perspectives for timely identification. Journal of the American College of Cardiology2001, 37(2):598-600

35. Angelini P, Walmsley RP, Libreros A, Ott DA: Symptomatic anomalous origination of the left coronary artery from the opposite sinus of valsalva. Clinical presentations, diagnosis,and surgical repair. Texas Heart Institute Journal/from the Texas Heart Institute of St2006, 33(2):171-179.10.

36. Mavi A, Sercelik A, Ayalp R, Pestemalci T, Batyraliev T, Gumusburun E: Variants in origin of the left circumflex coronary artery with angiography. Saudi Medical Journal2002, 23(11):1390-1393.