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Coronary Artery Anatomy, Variations-Anomalies and Incidental Extracoronary Findings In a Multiracial Population: A Large Scale Retrospective Study with Electron Beam Tomography in Istanbul

Çok Irklı Bir Kentte Koroner Arter Anatomisi, Varyasyonlar - Anomaliler ve Ekstrakoroner Insidental Bulgular: İstanbulda EBT ile yapılmış Geniş Ölçekli Bir Retrospektif Çalışma

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ABSTRACT

Background: In this large scale retrospetive study with Electron Beam Tomography (EBT) in a multiracial population in the city of Istanbul; we aimed to determine the coronary artery anomalies and major anatomy by using the EBT coronary angiography scans.

Material and Method: In this study, 454 subjects (M=431, F=23, mean age:57 years) coming from 10 different races were included. Non-ionic intravenous contrast agent had been used in all of the examinations. Origins and courses of the coronary arteries were evaluated with the main branches and cases with variations and anomalies were also determined.

Results: In this study; 89% of the cases had right dominance, 10% of them had left dominance, and 1% of them had codominance. In total, 6% of the cases have ramus intermedius that originated from left main coronary artery as a separate branch. In 2.6% of the patients included in the study had coronary artery origin anomalies. In this group as an interesting fact that myo-cardial bridging rate reached up to 33.3% and especially it was related to the proximal segment. In fact, in the patients with no coronary artery anomalies (n=442), myocardial bridging was dedected only in 8.2% of patients. On the other hand, we detected a fistula between the coronary arteries and the pulmonary system in 3 of the subjects (%0.66). Also in 20 subjects (%4.4) in the study group, it was seen that there were accompanying extracoronary pathologies.

Conclusion: In conclusion, it was discovered that the variations and anomalies with the anatomical features detected due to the population diversity in the cosmopolitan city of Istanbul; are showing differences from the literature information. For this reason, radiology experts working in big metropolitan cities

like Istanbul, should know that they may face with variations and anomalies rather than usual in the coronary artery scans.

Keywords: *Electron Beam Tomography, Coronary Vessel Anomalies, Anatomy*

ÖZET

Amaç: Retrospektif yapılan bu çalışma ile bir çok farklı ülkeden ve ırklardan insanın yaşadığı İstanbul'da; koroner arter anatomisini ve anomalilerini EBT ile yapılmış koroner anjiografiler kullanarak tespit etmeyi amaçladık.

Gereç ve Yöntem: Bu araştırmada, 10 değişik ırktan hastaların bulunduğu 454 olgu (E=431, K=23, ortalama yaş: 57 yıl) çalışmaya dahil edildi. Tüm olgularda, noniyonik intravenöz kontrast madde kullanıldı. Koroner arter orijinleri ve seyirleri değerlendirildi. Ana koroner dalların varyasyonları ve anomalileri tespit edildi.

Bulgular: Çalışmada, olguların % 89'inde sağ dominansi, % 10'inde sol dominansi, % 1'inde kodominansi sözkonusuydu. Totalde, %6 olguda sol ana koroner arterden ramus intermedius ayrılmaktaydı. Çalışmaya dahil edilmiş tüm olguların %2.6'sında koroner arter orijin anomalisi izlenmişti. Bu olgularda myokardial köprüleşme oranının %33.3'e vardığı ve diğer olgulardan farklı olarak da köprüleşmenin özellikle proksimal segmenti ilgilendirmesi ilginç bulundu. Oysa, koroner arter orijin anomalisi bulunmayan olgularda (n=442), %8.2 oranında miyokardial köprüleşme tespit edilmişti. Diğer taraftan, olguların 3'ünde ise (% 0.66) koroner arterler ile pulmoner sistem arasında fistül tespit edilmişti. Çalışma grubunda 20 olguda (%4.4) extrakoroner patolojilerin eşlik ettiği tespit edilmişti.

Sonuç: Sonuçta, bu çalışma ile kozmopolit bir kent olan Istanbuldaki populasyon çeşitliliği nedeni ile tespit edilen varyasyon ve anomaliler ile anatomik özelliklerin, diğer literatür bilgilerinden farklılık göstermekte olduğu ispatlanmıştır. Bu nedenle, radyoloji uzmanları; Istanbul gibi dev bir metroplisde veya benzer santrallerde, koroner arter taramalarında alışılmış oranların dışında varyasyon veya anomaliler ile karşılaşabileceklerini bilmelidirler.

Anahtar Kelimeler: *Elektron Beam Tomografi, Koroner Damar Anomalileri, Anatomi*

INTRODUCTION

By this retrospective study with using the Electron Beam Tomography (EBT) scans of a multiracial population from the city of Istanbul, coming from many different countries; we aimed to detect the coronary artery anatomy (branch anatomy, dominance, variations) and anomalies (origin and/or course anomalies, fistulas, myocardial bridging) and we also aimed to make the coronary artery map of this huge population in this metropolitan city by comparing our results with the reported data in the literature.

MATERIALS AND METHODS

In this study, coronary artery tomographic angiographies obtained with EBT of the 454 cases (M=431, F=23, mean age:57 years) who have applied to a special medical center between the years of 2004-2007 were included. We included only patients who had recorded scans, processed images and prepared radiology reports. While 166 of the subjects were Turkish (42 of them Azerbeijani, Albanian, Kazakh), the rest 288 subjects were of Armenian, Greek, German, American, French, Arabic, or of Russian origins that including approximately 25 to 40 persons. All of the examinations acquired by using a total of 90-110 ml (average 1.5 ml/kg) non-ionic intravenous contrast substance in the EBT (Imatron C-150 XP ultrafast CT scanner, SF, Calif) system with the power settings of 600 mA ve 130 kV (Figure 1).

Scanning was performed in the electrocardiographically triggered mode.

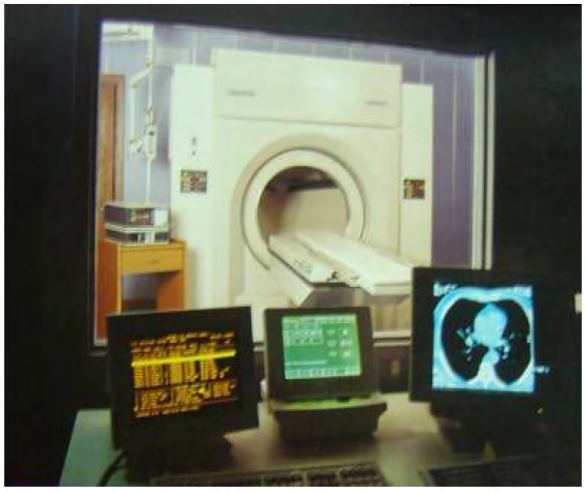

Figure 1: *Imatron C-150 XP ultrafast CT scanner EBT system: imaging room and technician console table.*

The patients were imaged in the supine position by using a section orientation approximated to the short axis of the heart. Following acquisition of localizer scans, flow measurement over the ascending aorta was performed after administration of nonionic contrast material at a dose of 0.2-0.3 mL per kilogram of body weight. The contrast medium was injected at a rate of 5 mL/sec into antecubital vein, and electrocardiographically triggered scans (two adjacent sections with 15 scans per section) were acquired of the ascending aorta at the level of the tracheal bifurcation. The scanning was triggered as follows: The first scan was acquired simultaneous with the start of contrast medium administration, followed by 14 repetitive scans. The scanner's standard software was used to calculate an attenuation-time curve (Hounsfield units-HU- per unit of time) for the ascending aorta from the source data to determine the time of maximum contrast medium concentration. For the subsequent functional study, 90-100 mL of contrast medium was injected at a flow rate of 4 mL/sec, and images were acquired at the time of maximum contrast medium concentration during a single inspiratory breath hold. Images obtained were evaluated by thick axial projections, obliquely reformatted images and three-dimensional images. During the evaluation; coronary origins and courses were evaluated to determine the variations and anomalies and to detect the existence of any fistula or myocardial bridging (Figure 2).

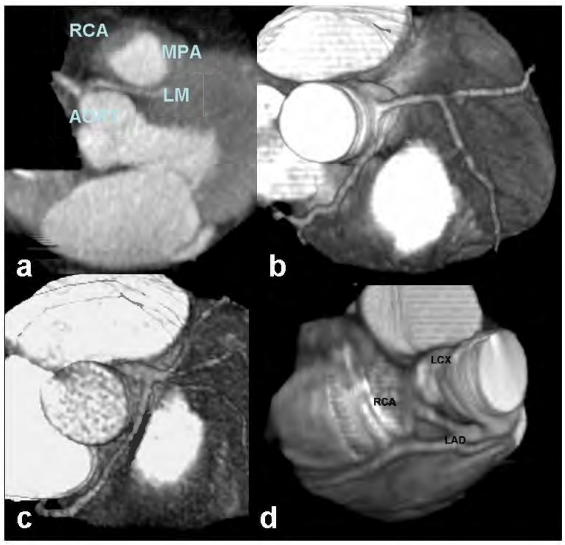

Figure 2: a) *LMCA (LM) exits the right valsalva sinus and courses through the aorticopulmonary space. About 15 mm later it shows intramyocardial course. LAD originates from the intramyocardial segment of LMCA and after a short course it becomes superficial till to the apex.* ***b)*** *RCA originates close to the left coronary valsalva sinus.* ***c)*** *RCA, exits the left valsalva sinus and reaches the normal trace by coursing in the the aortopulmonary window.* ***d)*** *Right sinus valsalva originated single coronary artery. Other coronary arteries originated from this anomalous single right coronary sinus show a course to reach the expected traces.*

Concerning data from each of the searched parameters were stored and summarized in separate tables (Table I, II). The incidence of the results were calculated by using the data in tables formed at the end of the study.

Table I. Coronary artery origin anomalies and the incidence of the myocardial bridging

Related segment	Origin	No.of cases	Myocardial bridge
LAD, LCX	Right coronary sinus	1	Prox LAD
LM	Right valsalva sinus	1	Prox LAD
LCX	Right valsalva sinus	1	Prox LAD
RCA	Right valsalva sinus posterior	1	-
RCA	Right valsalva sinus	1	-
RCA-LM	Right valsalva sinus single truncus	1	Prox LCX
LAD	Right valsalva sinus	2	-
LAD	Non-coronary cusp	1	-
LAD	RCA	1	-
LCX	RCA	1	-
RCA	Left valsalva sinus	1	-

Table II. Cases with incidentally detected extracoronary pathologies

Extracoronary pathologies	No.of cases
Pulmonary Embolism and Pulmonary hypertension	1
Prominent pericardial effusion	2
Lung mass (malignant)	1
Lung nodule (changes excluding fibronodule or fibroatelectasia)	3
Infiltration (tbc)	1
Tortuous common collaterals in the chest wall (Behcet disease)	1
Pulmonary fibrosis (IPF)	1
Sarcoidosis (hilary large lymph nodes-StageI)	1
Hodgkin lymphoma (hilary confluent lymphadenopathy)	1
Ascendant aorta aneurysm (5-7cm)	6
Descendant thoracic aort aneurism	1
Hydatic cyst (primary cardiac involvement)	1

RESULTS

With considering all groups; 89% of the cases had right dominancy, 10% of them had left dominancy, and 1% of them had codominancy. While considering the courses of the main branches; 78.8% had two, 19% had one, 2% had three and 0.2% had four patent diagonal arteries were detected in the course of LAD (left anterior descending). On the other hand, in the LCX (left circumflex) course; 89.8% had one, 10% had two, 0.2% had three units of obtuse marginal arteries were present that originated from the main LCX trunk. Approximately, 6% of the cases had ramus intermedius that was originated separately from the LMCA (left main coronary artery).

In %2.6 of the included cases, existent coronary artery origin anomalies were detected (Table 1). In these cases; myocardial bridging rate reached up to 33.3% as an interesting fact and proximal segment of the related arteries were affected. However, in the patients who have normal coronary artery anatomy (n=442); 8.2% myocardial bridging anomalies were detected (8% of the patients had mid-LAD and of 0.2% had distal-LAD). For all of the cases no critical narrowing of the lumen was established at the affected segment by bridging. Also we detected fistulas between the coronary arteries and the pulmonary system in 3 of the subjects (%0.66). On the other hand, in 20 subjects (%4.4) in the study group, it was seen that there were accompanying extracoronary pathologies which were mentioned in the official reports (Table II).

DISCUSSION

Imaging of the coronary arteries with a non-invasive method could first acquired with EBT, which have different techniques from the conventional CT technology. EBT is generated as a cardiac-spesific system. Because of small field of view and not providing isovolumetric resolution this method is restricted anymore to be used widely. Moreover, it is a known fact that EBT is no longer used for scanning purposes in the coronary artery pathologies due to multi-sectional tomographies replacing it in routine examinations which include 64 or more detector elements. All those issues are beyond the scope of this study. In our styudy, existing data collected from the archieve belong to the most popular time of the EBT coronary angiography. With this retrospective study using the EBT scans in a multiracial population, we aimed to detect the coronary artery anatomy and anomalies of this huge population in this metropolitan city by comparing our results with the reported data from literature. Istanbul is the largest city in Turkey, largest city proper and second largest metropolitan area in Europe, and fourth largest city proper in the world with a population of 12.6 million. It is also a megacity as a cultural and financial center of Turkey. Also it is the only metropolis in the world that is situated on two continents. In a such crowded city (app. 2500 people per squaremeter) with diversity we evaluated the coronary arteries in our study; and 89% of the subjects had right dominancy, 10% of them had left dominancy, and %1 of them had codominancy. According to the literature data reported about the general population (right %72, Left %10, codominancy %18); while the right dominance was higher in our study, codominancy was very rare compared to the general literature data (1,2).

In the evaluation of anatomic courses of coronary arteries we were able to show the traces of the main branches but other thin branch anatomies couldn't be recorded due to the pulsation artefacts and low resolution. Although there is no certain consensus about the diagonal and obtuse margin branches in the literature; we think that knowing the variative branch number of the main trunks will be helpful and useful preventing errors, especially in the aspect of an existing

ocluded artery or it will be a guide through interventional approaches.
In %6 of our (n=27) cases, ramus intermedius was originating from the LMCA as an additional branch. The incidence of this branch in the general population was stated as %10-30 (4). This variation was found as less frequent in our study group.

Myocardial bridging was first discovered and described in 1922 (5). Left front mural descending coronary artery was shown as an anatomic variation which may cause sudden deaths during exercising in individuals (6,7). In the cases who have coronary artery origin anomaly (%2.6), myocardial bridging rate reached up to 33.3% that affecting dominantly the proximal segment of related artery (LMCA, LAD). In fact, in the cases with no coronary artery anomalies (n=442), 8.2% myocardial bridging was detected (%8 of the patients had mid-LAD, %0.2 had distal LAD bridging). No more than %10-20 luminal calibration reduction or occlusion was found in any affected segment. Myocardial bridging rate found in our study was chaning in wide intervals (between %5-25) such as the data in the literature, and it was showing similiarities with the general population (1,2).

Asymptomatic coronary artery anomalies (as it can exist incidentally), in the healthy population was reported to be causing %1-2 of the coronary artery anomaly-related sudden deaths (8,9). Indeed, in 12 of our cases (%2.6) coronary artery origin anomalies were present (Table II). In the previous studies, on the other hand, coronary artery origin anomaly incidence was reported about %1 (8). Coronary artery origin anomaly rate was found higher in our study. Also it was interesting that these patients have high myocardial bridging rate at the proximal left coronary system.

Finally, in the anomaly category; fistula formations were detected between the coronary artery system and pulmonary arteries in 3 subjects (0.66%) (between LAD-pulmonary arteries in 2 cases and between LMCA-pulmonary artery in 1 case). In the literature, coronary artery fistulas were reported at the rate of 0.2% in the coronary arteriography series in adult populations (10). In another study made by Iscan et al, this rate was reported to be around %0.04 (11). According to our study, it was understood that the anomaly in the aspect of the fistula is quite higher than what was expected.

In %4.4 of the subjects included in the study, extracoronary thoracic pathologies were reported (Table II). Although it is not possible to define a certain consensus or an incidence for these cases, detecting the pathologies early will save time and money (12-15). Moreover, reporting these findings also may be helpful about the legal issues.

The most important limitation of the present study was that; we couldn't reach the standard conventional angiography correlation information or images. Because it was not possible to follow the DSA correlation and make further follow-ups due to the constant locational changes of the subjects coming from different cities, countries or continents. We have tried to overcome this problem by excluding the subjects who were directly advised DSA correlation and whose imaging was reported as not optimal or sceptical. In the same way; in 2% of the cases in the study RCA (right coronary artery) distal part, 1% of the LCX distal part and 3% of the LAD distal part (till the apex of the heart) couldn't be monitored. However, this result was excluded out of the evaluation process because it was thought that this finding may have resulted to the technical insufficiencies of the EBT examination.

In conclusion, it was discovered that the variations and anomalies with the anatomical features detected due to the population diversity in a cosmopolitan city are showing differences from the

information in the literature. For this reason, in big cosmopolitan central cities like Istanbul in where there is a multiracial living population, it may be faced with surprise pathologies during the cardiac-coronary CT scanning process. Thus, radiologists working in these kind of centers should be aware about the possibility of diversity about the incidences of the coronary or extracoronary abnormalities.

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