Prevalence and Imaging Findings of Myocardial Bridging on Multi-Slice CT Coronary Angiography

Miyokardiyal Köprülerin Çok Kesitli BT Anjiyografide Sıklığı ve Görüntüleme Bulguları

ABSTRACT Objective: We aimed to evaluate the prevalence, appearance, and accompanying atherosclerotic findings of myocardial bridging (MB) by using 16-detector multi-slice computed tomography (MSCT). Material and Methods: Between January 2005 and February 2008, 1380 consecutive coronary computed tomography angiography (CTA) which were performed due to suspicion of coronary artery disease, were evaluated. Results: Ninety of them were excluded from analysis due to poor image quality. A total of 122 MBs were detected in 94 of 1290 coronary CTA (7.3%). The distribution of MBs in accordance with the coronary arteries are as follows: 6.6% at proximal left anterior descending coronary artery (LAD), 47.5% at middle LAD, 9.8% at distal LAD, 16.4% at diagonal arteries, 8.2% at intermediate artery, and 11.5% at obtuse marginal artery. The lengths of intra-myocardial segment (tunnelled artery) were between 5 and 40 mm, and the depths within myocardium were between 0.5 and 7 mm. In addition, atherosclerotic findings varying from plaque to severe stenosis were present in the 45% of arteries with MB. Conclusion: The prevalence of MB in coronary CTA was comparatively lower than in autopsy studies, but higher than in catheter angiography studies. CTA provides non-invasive determination of both superficial and deep MB. It is useful to show the length and depth of tunnelled artery and accompanying atherosclerotic findings for determining the cause of patient symptoms.

Key Words: Myocardial bridging; coronary vessels; tomography, spiral computed

ÖZET Amacı: On altı dedektörlü çok kesitli bilgisayarlı tomografi (ÇKBT)’de miyokardiyal köprüler (MK)’in sıklığı, görünüm özellikleri ve eşlik eden aterosklerotik bulguları değerlendirilmekti. Gerçek ve Yöntemler: Ocak 2005 ile Şubat 2008 tarihleri arasında koroner arter hastalığı şüphesiyle uygulanan arıdağı 1380 koroner BT anjiyografisi tettikli MK varlığı açısından değerlendirildi. Bulgular: Doksan BT anjiyografisi tettikli görüntü kalitesinin yeterli olması nedeni ile değerlendirilemediği 59 vakada girdi. Geride kalan 1290 BT anjiyografide 94 (%7.3) hasta 122 MK saptandi. MK’lerin koroner arterlerine dağılımı şovledi. Proksimal sol ön inen koroner arter (LAD); %6.6, orta kesim LAD; %47.5, distal LAD; %9.8, diagonal arterler; %16.4, intermedıat arter: %8.2 ve obıtuz marginal arter: %11.5. MK’de intramyokardiyal segmentlerin uzunluğu 5-40 mm ve miyokard içindeki derinlikleri ise 5.3-7 mm arasında değişmekteydi. Ayrıca MK olan koroner arterlerde %45 oranında plakta ciddi daralmaya kadar değişen ek aterosklerotik bulgul mevcuttu. Sonuç: Koroner BT anjiyografide MK sıklığı otopsi çalışmalarda belirtilenin daha az, kateter anjiyografı çalışmalarda belirtilenin ise daha yüksek bulundu. Koroner BT anjiyografı hem yüzeyel hem de derin seyirli MK’yi non-inzaviv olarak tespit edebilir. Hastanın şikayetlerinin nedenini belirlemeye intramyokardiyal koroner arter segmentin uzunluğu ve miyokarddaki derinliği ile eşlik eden aterosklerotik bulguları göstermek oldukça yararlıdır.

Anahtar Kelimeler: Miyokard köprüleşmesi; koroner arter; bilgisayarlı tomografi

Miyokard bridging (MB) is defined as an intramural segment of a coronary artery that normally courses epicardially. The intramyocardial coronary segment is called tunnelled artery. MB is
mostly located in the mid-portion of the LAD coronary artery.\textsuperscript{1-6} Although MB is an asymptomatic condition in generally, it can cause ischemic symptoms especially during certain efforts.\textsuperscript{7-9} Moreover, this anomaly has been associated with various clinical manifestations such as unstable angina, myocardial infarction, arrhythmia, and sudden death.\textsuperscript{7,10-14} In general, narrowing at systole and widening at diastole in the coronary artery segment during the catheter coronary angiography (it is called milking effect) has been accepted as diagnostic for MB.\textsuperscript{1,4,7,13} MB frequency has been reported to be 0.8–4.9% in catheter angiography studies.\textsuperscript{7,8,15} However, autopsy studies showed wide variance, ranging from 5% to 86%.\textsuperscript{7,8,16}

There are mainly two types of approaches for treatment in patients with symptomatic MB. These are medical (i.e., nitrates, beta-blockers, calcium channel blockers) or interventional (i.e., stent, angioplasty, myotomy, bypass).\textsuperscript{7,17,18}

In recent coronary CTA studies by MSCT, MB prevalence was reported to be between 3.5% to 30.5%.\textsuperscript{3,19,20} CTA provides not only determination of both superficial and deep MB but also evaluation of adjacent anatomic structures and associated atherosclerotic findings.\textsuperscript{4,19-27} Physical activity may lead to myocardial ischemia in patients with deep MB.\textsuperscript{7,8,10,12,14} We aimed to evaluate the prevalence, appearance, and accompanying atherosclerotic findings of MB by using ECG gated 16-detector MSCT coronary angiography.

\section*{MATERIAL AND METHODS}

Between January 2005 and February 2008, 1380 consecutive CTA studies which performed due to suspicion of coronary artery disease (chest pain, positive non-invasive stress test, multiple atherosclerotic risk factors etc.) were evaluated by a radiologist experienced in coronary CTA.

At our department, CTA examinations were routinely performed with 16-detector row computed tomography scanner (Aquilion 16 system, Toshiba Medical Systems Corporation, Japan). For patients with heart rate over 75 per minute, 50–100 mg beta-blocker (metoprolol) orally one hour prior to examination or 5–10 mg metoprolol intravenously just before examination was administered. Technical factors were as follows; kVP: 120-135, mA: 350, detector collimation: 16 x 1 mm, pitch: 0.25, rotation time: 0.5 sec, slice thickness: 1 mm, reconstruction interval: 0.5 mm. Contrast material was used as follows: 80-100 mL non-ionic iodine contrast material (Ultravist 370, Schering or Iomepron 400, Bracco) with a speed of 4-5 mL/sec using an automatic injector.

The axial images were obtained at diastolic phase (between 40% and 80% of R-R interval) using retrospective ECG gating procedure. The images were evaluated at the Vitrea Work Station (Vital images, Minnesota, USA). In case of coronary artery segment under the myocardial fibers was accepted as a MB, especially on multi-planar reformat (MPR) images (Figure 1-4). Localization of MB and associated atherosclerotic findings were reported. Length and depth of tunnelled artery was measured on axial and oblique reformatted images. MBs were separated into two groups as “superficial” or “deep” in according to muscle thickness over the tunnelled artery. If the muscle thickness was less than 1 mm, it was accepted as “superficial” or 1 mm and more it was accepted as “deep”.

\section*{RESULTS}

Among 1380 coronary CTA examinations, 90 of them were excluded from analysis due to poor image quality secondary to motion artifact. A total of 122 MBs were detected in 94 of 1290 coronary CTA examinations (7.3%). The mean age of patients with MB including 74 males and 20 females was 54 (range 30-80) years.

\begin{figure}
\centering
\includegraphics[width=0.5\textwidth]{figure1.png}
\caption{Curved MPR images show normal epicardial (A) and intra-myocardial coronary artery (B) on CTA.}
\end{figure}

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MB was present a single localization in 68 patients, two different localization in 24 patients, and three different localization in 2 patients. The distribution of MBs in accordance with coronary arteries is shown in Table 1. The depths of MB were between 0.5-7 mm (mean = 1.7 mm), and the lengths were between 5-40 mm (mean = 18 mm). 33% of MBs (n = 40) were superficial and 67% of them were deep (n = 82). Accompanying atherosclerotic findings (varying from plaque to severe stenosis) were present in the 45% of coronary arteries with MB. The distribution of these findings according to CTA were as the following: slight (%0-49 narrowing): 21%, moderate (%50-69 narrowing): 10%, severe (%70 and more narrowing): 14%. Atherosclerotic findings were present proximal to MB in 70% and distal to it in 30%.
DISCUSSION

In the past, diagnosis of MB was provided by viewing of the “milking effect” in catheter angiography. In catheter angiography studies, the prevalence of MB has been reported to be 0.8–4.9%. In CTA studies, however, MB prevalence was shown much higher (3.5–30.5%) than catheter angiography. The sensitivity of CTA in detecting MB is much higher due to good delineation of coronary artery and its relation to adjacent myocardium. The most frequent localization of MB is in the LAD both catheter coronary angiography and CTA studies. In our study, MBs were located 80.3% in the LAD.

It is mandatory to show a coronary artery segment penetrates through the myocardium for the diagnosis of MB. Therefore, it is helpful the evaluating of axial, MPR, and 3D images on CTA (Figure 1–4). Additional clues are angulation of the tunnelled artery while leaving the myocardium and the narrower diameter of the intra-myocardial segment than the adjacent epicardial segment (Figure 3, 4). The MPR images are essential to measure the length, depth, and diameter of tunnelled artery.

In our study, all MBs were at the left side. We did not detect a MB at the right coronary artery. The percentages of MB are as follows: 6.6% at proximal LAD, 47.5% at middle LAD, 9.8% at distal LAD, 16.4% at diagonal arteries, 8.2% at intermediate artery, and 11.5% at obtuse marginal artery. The prevalence of MB was reported to be 26% in 300 patients with atypical chest pain in Zeina et al CTA study (using 16- and 64-detector MSCT). In their study, the percentages for localization of MBs were as follows: 61.5% at mid LAD, 23% at distal LAD, 1.3% at first diagonal artery, 1.3% at second diagonal artery, 2.6% at ramus artery, 1.3% at right coronary artery, and 2.6% at obtuse marginal artery. Konen et al reported 30.5% MB prevalence in their study (using 40- and 64-detector MSCT) in 118(82,837),(880,917)

### TABLE 1: Distribution of MBs in coronary arteries.

<table>
<thead>
<tr>
<th>Coronary Artery</th>
<th>Number of MBs</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAD proximal</td>
<td>8</td>
<td>6.6</td>
</tr>
<tr>
<td>LAD middle</td>
<td>58</td>
<td>47.5</td>
</tr>
<tr>
<td>LAD distal</td>
<td>12</td>
<td>9.8</td>
</tr>
<tr>
<td>Diagonals</td>
<td>20</td>
<td>16.4</td>
</tr>
<tr>
<td>Intermediate</td>
<td>10</td>
<td>8.2</td>
</tr>
<tr>
<td>Obtuse marginal</td>
<td>14</td>
<td>11.5</td>
</tr>
<tr>
<td>Right</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>122</td>
<td>100</td>
</tr>
</tbody>
</table>

Konen et al reported 30.5% MB prevalence in their study (using 40- and 64-detector MSCT) in 118 patients with suspected coronary artery disease or known coronary artery disease. MB localizations were reported in Konen et al study as follows: 57.4% at mid LAD, 15% at distal LAD, 12.8% at diagonal branches, 8.5% at intermediate artery, and 6.3% at obtuse marginal artery. Kantarci et al reported 3.5% prevalence for MB in 626 patients using 16-detector MSCT. In addition, all MBs were at the LAD in their study. Our study consisted of larger patient groups (n=1290) and we found 7.3% prevalence for MB. This prevalence is lower than the study of Zeina et al and Konen et al, but higher than Kantarci et al. The higher prevalence rate of MB may be related to high temporal resolution and image quality which is due to the use of 40 and 64 detector MSCT.

Ferreira et al divided intra-myocardial LAD into two types in a necropsy study of 90 consecutive hearts: the superficial type (76%) in which coronary segment runs on the inter-ventricular groove, and the deep type (24%) in which intra-myocardial segment deviates toward right ventricle. Konen et al divided MB for the LAD into three types according to their depth and course: superficial, deep, and right ventricular types. They determined muscle thickness of 1 mm as a borderline in order to discriminate superficial and deep type MB. Considering the thickness of muscle on the coronary artery segment, we separated all MBs into two groups as the “superficial” and “deep” using 1 mm borderline. In conclusion, 33% of MBs were superficial and 67% of them were deep.

Our results also showed that atherosclerotic findings varying from plaque to stenosis (slight, moderate, severe) were present in the 45% of coronary arteries with MB. These findings were proximal to MB in 70% and distal to it in 30%. This result shows that there may be a tendency to atherosclerosis in arteries with MB. Zeina et al reported similar results in this subject.
CONCLUSION

We found that the prevalence of MB in the coronary CTA was comparatively lower than in autopsy studies, but it was higher than in catheter angiography studies.

REFERENCES


Coronary CTA can easily determine superficial or deep intra-myocardial coronary segment. It is useful to show the length and depth of tunnelled artery and accompanying atherosclerotic findings for determining the cause of patient symptoms.