Intima – Media Thickness of Left Anterior Descending Coronary Artery in a Black Kenyan Population: Correlation with Morphological Features

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Abstract

Background: Intima-Media thickness is an acknowledged surrogate marker for predicting and profiling of atherosclerotic cardiovascular disease. It displays geographical and ethnic variation but is seldom reported among black populations of Africa. The left anterior descending coronary artery is one of the most frequently afflicted arteries by atherosclerosis. This study, therefore, aimed at correlating its intima – media thickness with morphological features of left coronary artery in a black Kenyan population.

Materials and methods: Materials for this study were 126 hearts obtained during autopsy at the Department of Human Anatomy, University of Nairobi Kenya from black adult Kenyans [72 males, 54 females] who died of non-cardiovascular causes. The left coronary artery was identified, its termination pattern recorded and its length and bifurcation angle measured. Specimens for light microscopy were taken from the proximal segment of the left anterior descending artery and processed for paraffin embedding and sectioning. Five micron sections were stained with Masson’s trichrome and examined at magnification x35. The results were analyzed using SPSS version 17.0. Student t-test was performed at 95% confidence interval where p ≤ 0.05 was taken to be statistically significant. They are presented in micrographs and tables.

Results: The mean intima – media thickness was 0.332 mm. It was higher in males (0.357 ± 0.06 mm) than in females (0.25 ± 0.03 mm), increased with number of branches of left coronary artery, from 0.336 ± 0.014 mm in bifurcation to 0.506 ± 0.01 mm in pentafurcation; and was also higher in left coronary arteries that were shorter than 5 mm and those with bifurcation angles >800.

Conclusion: The intima – media thickness of left anterior descending artery is influenced by length, bifurcation angle and terminal branching pattern of left coronary artery, and is higher in males than in females. This suggests that these morphological features of left coronary artery constitute anatomical risk factors for atherosclerosis. Individuals with these features should be screened for atherosclerosis, to inform early intervention.

Keywords: Intima-Media Thickness; Length; Bifurcation angle; Branching pattern; Coronary artery

Introduction

Intima–Media Thickness (IMT) is a reliable sensitive marker of subclinical atherosclerosis [1-3] and an independent predictor of cardiovascular events and target organ damage [4,5]. It is also valuable in evaluation and stratification of cardiovascular disease risk, prediction of long term outcome and monitoring ongoing disease progression and regression [1,2,5]. Atherosclerotic diseases are increasing in Sub Saharan Africa including in Kenya [6,7]. Data on IMT from black African populations, however, though important in the coronary arteries. Recent studies reveal that features of atherosclerosis are present in this artery from an early age [8,9]. This study therefore aimed at correlating IMT in this artery with morphological features of left coronary artery (LCA) among black Kenyans.

Materials and Methods

This study was done on autopsy material from samples of 126 victims (72 males; 54 females) of trauma in whom there was no record of cardiovascular disease. Those who were aged below 18 or over 55 years, who died of non-cardiovascular causes. The left coronary artery was identified, its termination pattern recorded and its length and bifurcation angle measured. Specimens for light microscopy were taken from the proximal segment of the left anterior descending artery and processed for paraffin embedding and sectioning. Five micron sections were stained with Masson’s trichrome and examined at magnification x35. The results were analyzed using SPSS version 17.0. Student t-test was performed at 95% confidence interval where p ≤ 0.05 was taken to be statistically significant. They are presented in micrographs and tables.

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for light microscopy. Specimens were taken within 72 hours of death, to avoid those with overt postmortem damage to the tissues. They were fixed by immersion in 10% formaldehyde solution for three days, then trimmed and processed routinely for paraffin embedding by passing them through increasing concentrations of isopropyl alcohol, (50%; 60%; 70%; 80%; 90%; 95% and 100%) each for one hour and cleared with cedar wood oil for 12 hours. The sections were then infiltrated with fresh molten paraplast wax for 12 hours, and embedded in wax. Five micrometer sections were stained with Masson’s trichrome.

Morphometry was done on light microscopy slides. Ten serial sections from each specimen were used. Analogue photographs were taken using a photomicroscope at a constant magnification of X35. The photographs were then scanned using a HPTM scanner and analyzed using Scion Image TM Multiscan software. Intimal and medial thickness was measured. The extent of the intima was defined as between the lumen and the internal elastic lamina. Four random points (ISa, ISb, ISC, ISd) were selected and the average was computed based on the protocol by [10]. The media was defined as the area between the internal elastic lamina and the external elastic lamina. Four random points (Msa, Msb, Msc, Msd) (Figure 1) were selected and the average size computed.

Data gathered were coded, tabulated and analyzed using the Statistical Program for Social Sciences (SPSS) for Windows TM version 17.0. Descriptive statistics were applied to determine means, frequencies and ranges for intimal and medial thickness. The Intima – Media Thickness was taken to be the sum of the thickness of the intima and that of the media. The Intima – Media Thickness was corrected for heart weight and size. Student t – test was used, at 95% confidence interval where the differences were considered significant at p ≤ 0.05. The results are presented by means of micrographs and tables.

Results

Mean IMT was 0.332 ± 0.06 mm. It was predominantly due to tunica media in mild hyperplasia (Figure 2A), which was present in nearly 50%. In over 30% of the cases, IMT was due to intimal thickness which contributed over 50% (Figure 2B), in some cases forming over 80% (Figure 2C). In 50% of the cases, high IMT was associated with thick highly vascularized tunica adventitia (Figure 2D).

IMT was higher in males (0.357 ± 0.06 mm) than in females (0.25 ± 0.03 mm). This difference was statistically significant [p=0.01] and persisted even after correcting for heart size and weight. Differences between age groups were not statistically significant and disappeared after correcting for heart weight. The intima - media thickness was correlated with branching pattern, length and bifurcation angle of left coronary artery.

The branching pattern of LCA comprised bifurcation (54.8%), trifurcation (32.3%), quadrifurcation (9.7%) and pentafurcation (3.2%). The IMT increased from 0.336 ± 0.01 in bifurcation to 0.506 ± 0.01 mm in pentafurcation. This difference was statistically significant (p=0.001). The sex difference for bifurcation and trifurcation was statistically significant. There were no female cases with either quadrifurcation or pentafurcation (Table 1).
Table 1: Mean IMT of LAD correlated with branching pattern of LCA

<table>
<thead>
<tr>
<th>Branching Pattern of LCA</th>
<th>IMT of LAD (mm)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ± SE</td>
<td></td>
</tr>
<tr>
<td>Bifurcation Overall</td>
<td>0.336 ± 0.014</td>
<td>0.015</td>
</tr>
<tr>
<td>Male</td>
<td>0.337 ± 0.02</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>0.302 ± 0.016</td>
<td></td>
</tr>
<tr>
<td>Trifurcation Overall</td>
<td>0.416 ± 0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Male</td>
<td>0.418 ± 0.016</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>0.88 ± 0.024</td>
<td></td>
</tr>
<tr>
<td>Quadrifurcation</td>
<td>0.454 ± 0.014</td>
<td>N/A</td>
</tr>
<tr>
<td>Pentrafurcation</td>
<td>0.506 ± 0.01</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table 2: Correlation of length of LCA with IMT of LAD in a black Kenyan population

<table>
<thead>
<tr>
<th>Length (mm)</th>
<th>Frequency</th>
<th>(%)</th>
<th>IMT (Mean ±SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 2.5</td>
<td>21</td>
<td>16.7</td>
<td>0.40 ± 0.03</td>
</tr>
<tr>
<td>2.6 – 5.0</td>
<td>27</td>
<td>21.4</td>
<td>0.38 ± 0.01</td>
</tr>
<tr>
<td>5.1 – 7.5</td>
<td>30</td>
<td>23.8</td>
<td>0.37 ± 0.02</td>
</tr>
<tr>
<td>7.6 – 10.0</td>
<td>18</td>
<td>14.3</td>
<td>0.36 ± 0.001</td>
</tr>
<tr>
<td>10.1 – 12.5</td>
<td>12</td>
<td>9.5</td>
<td>0.34 ± 0.002</td>
</tr>
<tr>
<td>12.6 – 15.0</td>
<td>9</td>
<td>7.1</td>
<td>0.33 ± 0.001</td>
</tr>
<tr>
<td>15.1 – 17.5</td>
<td>3</td>
<td>2.4</td>
<td>0.33 ± 0.001</td>
</tr>
<tr>
<td>17.6 – 20.0</td>
<td>6</td>
<td>4.8</td>
<td>0.30 ± 0.012</td>
</tr>
<tr>
<td>Total</td>
<td>126</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Correlation of bifurcation angle of left coronary artery with IMT of LAD in black Kenyans

<table>
<thead>
<tr>
<th>Angle (0)</th>
<th>Frequency</th>
<th>(%)</th>
<th>IMT (Mean ± SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>26 – 40</td>
<td>7</td>
<td>-7.1</td>
<td>0.35 ± 0.02</td>
</tr>
<tr>
<td>41 – 60</td>
<td>15</td>
<td>-11.9</td>
<td>0.36 ± 0.01</td>
</tr>
<tr>
<td>61 – 80</td>
<td>48</td>
<td>-38.1</td>
<td>0.39 ± 0.03</td>
</tr>
</tbody>
</table>

Discussion

Normal intimal thickness of LAD ranges from 100-350 μm and medial thickness from 150-250 μm [11,12]. Intima – media thickness of 0.332 mm observed in the current study, is within the range reported in literature [13,14]. The age dependent increase is also concordant with literature reports [15]. This implies that predisposition to atherosclerosis associated with intima –media thickness is similar across populations, suggesting that the Kenyan population is as vulnerable to atherosclerosis as others.

The intima –media thickness was significantly higher in short coronary arteries than in normal and longer ones. This observation is consistent with literature reports that shorter common trunks of LCA are more prone to atherosclerosis [16-18].

It implies that in the Kenyan population, 37.1% of individuals may bear this intrinsic factor for atherosclerosis. Intima – media thickness was also higher in the arteries with variant branching pattern; that is trifurcation, quadrifurcation and pentafurcation. This is consistent with reports that unusual branching patterns cause disturbed flow, reducing wall shear stress, thus making the affected vessels more prone to atherosclerosis [19-21]. In this regard, 45.2% of the Kenyan population would be intrinsically, due to this structural determinant, prone to atherosclerosis. Another consistent anatomical feature associated with high IMT is the wide branching angle (>800). This is also consistent with literature reports that high bifurcation angles are associated with higher risk of atherosclerosis [22]. In the current study, 42.9% of the individuals had bifurcation angles >800, suggesting higher propensity to atherosclerosis. Accordingly, individuals who present for cardiovascular evaluation should be screened for termination pattern, bifurcation angle and length of LCA so that control measures for CVD may be commenced early.

High intima – media thickness causes coronary artery stenosis. Such stenosis and potential acute coronary syndromes correlate with carotid intima – media thickness, carotid plaque histology and cerebrovascular events [23,24]. Indeed, coronary atherosclerosis is associated with carotid atherosclerosis [25]. Accordingly, concurrent ultrasound screening of the vulnerable Kenyan population for carotid IMT may improve early detection of adverse cardiovascular risk.

Limitations

The main limitations of this study were the small sample size and the use of light microscopy to study postmortem specimens. Postmortem damage and tissue shrinkage during processing may undermine the results. Since all specimens were subjected to the same methodology, these would be errors of analysis carried through all the measurements hence the comparisons are still valid.
Conclusion

The intima – media thickness of left anterior descending artery is influenced by length, bifurcation angle and terminal branching pattern of left coronary artery, and is higher in males than in females. This suggests that these morphological features of left coronary artery constitute anatomical risk factors for atherosclerosis. Individuals with these features should be screened for atherosclerosis, to inform early intervention.

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References

12. Ullah QW, Qamar K, Butt SA. Wall thickness of major coronary arteries in Pakistani population. Pak Armed Forces J.