Modified Morise score in predicting obstructive coronary artery disease prevalence at 64-row coronary CT angiography

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Purpose

Several risk models such as Diamond-Forrester [1], Duke [2], and Morise [3] risk models are used to predict obstructive coronary artery disease (CAD). Since most patients receiving coronary CT angiography have an intermediate risk, these models might not well differentiate patients with obstructive CAD from those without.

The above risk models consist mainly of the disease status of patients and do not include functional parameters. We hypothesized that contrast medium arrival time (AT) would reflect the function of the heart at the time of the scan and have an additive value over these conventional risk models.

Our purpose was to evaluate modified Morise score (MMS) including AT in conventional Morise score to predict CAD prevalence in coronary CT angiography.

Methods and materials

Patients

The records of 732 consecutive patients who underwent coronary CT angiography were retrospectively examined. The patients with several risk factors of CAD with chest pain and/or dyspnea, abnormal results of electrocardiogram, cardiac echo or treadmill test were included in our study. The exclusion criteria were as follows: patients with known CAD (n=54); protocol not obeyed (n=7); known allergy to iopamidol (n=4); longer injection time due to simultaneous pulmonary artery evaluation (n=2). The final study group included 665 patients (Fig. 1).

The pretest cardiovascular risk was assessed by the Morise pre-test score [3].

CT data acquisition

All patients underwent CT angiography with the 64-row CT (Brilliance 64; Philips, Tokyo, Japan). Retrospectively electrocardiogram-gated helical scans were performed in all patients. The scanning parameters were as follows: detector configuration, 64×0.625 mm; tube potential, 120 kVp; tube current-time product, 800#1050 mAs, depending on the body weight; gantry rotation time, 420 ms; and helical pitch, 0.2.
The patients received 21.0 mgI/kg/s of iopamidol 370 mgI/mL (Iopamiron 370; Bayer, Osaka, Japan). Contrast medium was injected for acquisition duration plus 7 s, followed by a 30-mL saline flush. Bolus tracking method was performed to determine the scan timing. The scan started 6 s after the descending aorta reached 100 Hounsfield Unit (HU). The time from the start of the injection to the threshold of 100 HU was recorded (AT).

**CT data analysis**

The Society of Cardiovascular Computed Tomography 18-segment classification was applied for analysis of coronary angiography data [4]. All segments with a diameter of at least 1.5 mm at their origin were included. The reconstructed images were evaluated and classified by two cardiovascular radiologists. Anatomically obstructive CAD was defined as #50% stenosis.

**Statistical Analysis**

The Student's $t$-test was used to compare continuous variables and the Fisher's exact test or the chi-squared ($\chi^2$) test was used to compare categorical variables.

AT-heart-rate product (AHP) and modified Morise score (MMS) was defined as AT*heart rate/100 and AHP*Morise score/10, respectively.

Receiver-operating characteristics (ROC) curve analysis was used to assess the performance of the Morise score and MMS to detect obstructive CAD on a per-patient basis. The area under the ROC curve (AUC) was calculated and the AUCs were compared by the DeLong method.

The study group was divided into quartiles based on MMS (1st quartile, 0#11.9; 2nd quartile, 12.0#14.2; 3rd quartile, 14.3#17.3; 4th quartile, #17.4) for regression analysis.

All statistical analyses were performed using JMP software (version 9.0.0; SAS, Cary, NC) except the DeLong method which was performed using EZR (Saitama Medical Center, Jichi Medical University), which is a graphical user interface for R (The R Foundation for Statistical Computing) [5]. A $p$-value <0.05 was deemed to indicate significance.

**Images for this section:**
Fig. 1: Patient inclusion and exclusion criteria.
**Results**

**Patient demographics**

A total of 441 patients (66%) were absent of obstructive CAD. Patients with obstructive CAD were more often male, old, and heavy. The Morise risk score, AT, AHP and MMS were larger in patients with obstructive CAD compared with patients without ($p<0.0001^*$, 0.06, 0.0014, and <0.0001, respectively).

<table>
<thead>
<tr>
<th></th>
<th>Patients without obstructive CAD</th>
<th>Patients with obstructive CAD</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>441 (66%)</td>
<td>224 (34%)</td>
<td></td>
</tr>
<tr>
<td>Male/Female</td>
<td>186/255</td>
<td>129/95</td>
<td>0.0002$^*$</td>
</tr>
<tr>
<td>Age (y)</td>
<td>63.4 ± 13.1</td>
<td>70.9 ± 9.6</td>
<td>&lt;0.0001$^*$</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>59.8 ± 13.4</td>
<td>62.1 ± 11.4</td>
<td>0.03$^*$</td>
</tr>
<tr>
<td>Morise risk score</td>
<td>12.1 ± 3.6</td>
<td>13.4 ± 2.7</td>
<td>&lt;0.0001$^*$</td>
</tr>
<tr>
<td>AT (s)</td>
<td>18.7 ± 2.8</td>
<td>19.1 ± 3.3</td>
<td>0.06</td>
</tr>
<tr>
<td>AHP</td>
<td>11.3 ± 2.0</td>
<td>11.8 ± 2.5</td>
<td>0.0014$^*$</td>
</tr>
<tr>
<td>MMS</td>
<td>13.7 ± 4.8</td>
<td>15.7 ± 3.6</td>
<td>&lt;0.0001$^*$</td>
</tr>
</tbody>
</table>

**Table Patient demographics**

**ROC Analysis**

ROC analysis showed that MMS significantly improved the AUC compared with Morise score alone in predicting obstructive CAD ($p=0.01$, Fig. 2).

**Regression analysis by MMS quartiles**

The prevalence of obstructive CAD was significantly higher in the second to fourth quartiles compared with the first quartile of MMS (odds ratio (OR): 2.21, 95% confidence interval (CI): 1.34-3.71; OR: 2.66, 95%CI: 1.63-4.41 and OR: 3.72, 95%CI: 2.28-6.18, respectively, Fig. 3).

**Images for this section:**
Fig. 2: ROC curves for the prediction of obstructive CAD using the Morise risk score alone (dotted line) and MMS (bold line). MMS significantly improved the AUC compared with Morise risk score (0.63 vs 0.59, p = 0.01).
**Fig. 3:** The prevalence of obstructive CAD was significantly higher in the second to fourth quartiles compared with the first quartile of MMS.
Conclusion

Larger MMS was associated with higher prevalence of obstructive CAD. Contrast medium arrival time had an additive value over the Morise model alone to predict obstructive CAD in coronary CT angiography.

Personal information

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