Noninvasive Assessment of In-Stent Restenosis by High Definition Computed Tomography Coronary Angiography with New Gemstone Detector

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Background

64-MDCT has a good diagnostic accuracy for In-stent restenosis (ISR) detection.

Stent diameter <3mm as well as stent strut thickness ≥140µm were associated with decreased image quality and diagnostic accuracy.

References:
- Am J Cardiol 2008;101:1567-1573
- J Nucl Cardiol 2010;17:470-8
- Invest Radiol 2010;45:000-000
<table>
<thead>
<tr>
<th>Stent Name</th>
<th>Thickness (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSUNAMI</td>
<td>79</td>
</tr>
<tr>
<td>Vision/Xience</td>
<td>81</td>
</tr>
<tr>
<td>Driver/Endeavor</td>
<td>91</td>
</tr>
<tr>
<td>Liberte/Taxus Liberte</td>
<td>96</td>
</tr>
<tr>
<td>S stent</td>
<td>119</td>
</tr>
<tr>
<td>Express2/Taxus express</td>
<td>132</td>
</tr>
<tr>
<td>Bx velocity/Cypher</td>
<td>140</td>
</tr>
</tbody>
</table>
High definition computed tomography (HDCT)

High spatial resolution by real garnet scintillator

47% greater detail in the heart

Reconstruction engine, ASIR

(Advanced Statistical Iterative Reconstruction)
Purpose

The purpose of this study is to assess In-stent restenosis using High Definition Computed Tomography coronary angiography.
Method

We enrolled consecutive 158 patients with previous coronary stent implantation who were received HDCT coronary angiography for clinical indications

121 male and 37 female
age 68 ± 8.3 years old
306 stents (1.7 ± 1.1 stents/patient)
High Definition CT

LAD: Cypher 3.0×23 mm
Diagonal: Cypher 2.5×18 mm

equipment: GE Discovery CT750 HD
HDCT protocol

- single 64 slices
- Gountry Rotation time 350ms
- Tube Current 600mA, voltage 120kvp
- Timing: test injection method
- contrast medium: iopamiron 370
- contrast medium volume: 21mgl/kg/sec
- infusion velocity: 3~5mL/sec
- β blocker: propranolol oral 10-20mg
Image Quality score (IQ score)

1 excellent in stent lumen was distinct, without artifact
2 good in stent lumen was clear, with a few artifacts
3 adequate in stent lumen was partially clear, with moderate artifacts, and lumen was assessable
4 insufficient in stent lumen was indistinct, with obvious artifacts, and lumen was partially assessable
5 non-assessable

Nondiagnostic image quality: IQ score 4 or 5
IQ score

1: excellent
2: good
3: sufficient
4: insufficient
5: non-assessable
In stent restenosis (ISR)

Defined as

- >50% luminal narrowing in the stent lumen
- significant stent edge stenosis
## Result

### Patient characteristics

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Height, cm</td>
<td>163 ± 8</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>63 ± 12</td>
</tr>
<tr>
<td>Body mass index, kg/m²</td>
<td>24 ± 3.2</td>
</tr>
<tr>
<td>Hypertension, n(%)</td>
<td>116 (73%)</td>
</tr>
<tr>
<td>Diabetes Mellitus, n(%)</td>
<td>62 (39%)</td>
</tr>
<tr>
<td>Dyslipidemia, n(%)</td>
<td>75 (47%)</td>
</tr>
<tr>
<td>OMI, n(%)</td>
<td>73 (46%)</td>
</tr>
<tr>
<td>post CABG, n(%)</td>
<td>8 (5%)</td>
</tr>
</tbody>
</table>

n = 158
stent type

- BMS: 86 stents
- DES: 220 stents

stent diameter

- 2.5
- 2.75
- 3
- 3.5
- 4

3.0 ± 0.5mm
Effective Radiation Dose  9.6 ± 7.4 mSV
Heart rate 64 ± 8 bpm
use of beta blocker 42%
HR<65bpm  56%
Nondiagnostic image quality n=38 (12%)

Feasibility 88%
<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>stent diameter</th>
<th>Cypher</th>
</tr>
</thead>
<tbody>
<tr>
<td>stent diameter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;3mm</td>
<td>109</td>
<td>2.5±0.6</td>
<td>81%</td>
</tr>
<tr>
<td>3mm&lt;=</td>
<td>197</td>
<td>3.3±0.3</td>
<td>55%</td>
</tr>
<tr>
<td>Heart Rate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HR&lt;65</td>
<td>178</td>
<td>3.0±0.5</td>
<td>63%</td>
</tr>
<tr>
<td>65&lt;=HR</td>
<td>128</td>
<td>3.0±0.5</td>
<td>65%</td>
</tr>
<tr>
<td>coronary branch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RCA</td>
<td>87</td>
<td>3.2±0.5</td>
<td>48%</td>
</tr>
<tr>
<td>LAD</td>
<td>157</td>
<td>3.0±0.4</td>
<td>71%</td>
</tr>
<tr>
<td>LCX</td>
<td>58</td>
<td>2.8±0.4</td>
<td>66%</td>
</tr>
</tbody>
</table>
IQ score

P <0.0001

n=109

IQ score

<3mm

2.8±1.1

n=197

3mm<=

2.0±0.9

Feasibility

77%

93%

(P<0.0001)
Feasibility 87%

- RCA: 2.2±1.0, n=87
- LAD: 2.4±1.1, n=157
- LCX: 2.0±0.8, n=58

P=0.01

IQ 1
IQ 2
IQ 3
IQ 4
IQ 5

ns
ns
P=0.01

n=87
n=157
n=58

Feasibility 83%
Feasibility 98%
HR<65

Feasibility 90%

n=178

2.2±1.0

n=128

2.5±1.1

P <0.0087

(P=0.15)

IQ 1 IQ 2 IQ 3 IQ 4 IQ 5
2.5mm sirolimus-eluting stent

Feasibility 76%

vs 92% in the other stents

(P<0.0001)
<table>
<thead>
<tr>
<th></th>
<th>ICA</th>
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<tbody>
<tr>
<td>HDCT</td>
<td>+</td>
<td>17</td>
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<tr>
<td></td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>80</td>
</tr>
</tbody>
</table>

- Sensitivity: 100%
- Specificity: 99%
- Positive predictive value: 95%
- Negative predictive value: 100%

$n=98$
Limitations

- retrospective study
- selection bias
- limited number of patients who received invasive coronary angiography
Conclusion

HDCT coronary angiography with new gemstone detector allows accurate noninvasive assessment of significant ISR

Noninvasive assessment of ISR using HDCT could be attractive and feasible alternative