CAAS QCA 3D

Taking coronary quantification to the next level
Two dimensional Quantitative Coronary Analysis (QCA) is, since its introduction over 25 years ago, a frequently chosen method to determine lesion length and stent size during percutaneous coronary interventions (PCI). The analysis can be performed quickly during the PCI procedure as standard coronary angiograms serve as input. Furthermore QCA is the most frequently used analysis tool in large multicenter studies for evaluation of novel interventional methods, pharmaceuticals and devices.

Two dimensional QCA has certain limitations. When angiographic views do not show the coronary artery of interest clearly, this can lead to underestimation of the vessel length, so-called foreshortening. Another limitation, so called out-of-plane magnification, occurs when the distance between the vessel part of interest and the detector of the X-ray system is not constant along this vessel part. This can lead to over- or underestimation of vessel length and diameter.

To overcome these limitations Pie Medical Imaging has developed CAAS QCA 3D, which offers improved analysis of lesions with difficult morphology.

This document gives insight in how 3D QCA is performed, the benefits of using this novel technology and its accuracy and reproducibility.

The input

Two standard coronary angiograms

Two angiograms which differ at least 30 degrees in rotation and angulation are the basis for 3D QCA. On both angiograms the vessel section of interest is indicated and real-time the 3D reconstruction of the vessel is calculated.

Although common in two 2D QCA, no user input is needed for the calibration in 3D QCA. The true 3D dimensions are calculated from information already present in the DICOM angiograms.

After the 3D reconstruction is calculated the stenosis present can easily be quantified.

The output: the answers needed during daily PCI procedures

Stenotic length & stent length

With QCA 3D the true three dimensional geometric shape and thus true vessel length is calculated. The vessel length is not subject to foreshortening and that is an important factor when determining stent length.

To determine the accuracy and reproducibility of the length calculation a validation study was carried out at the Jagiellonian University Medical College in Cracow, Poland [1].

Thirty marker wires were imaged in patients undergoing angioplasty. With the marker wire in the coronary artery, two angiograms were obtained for QCA 3D. The marker lengths calculated with QCA 3D were compared to the true lengths measured directly on the wire. The comparison demonstrated that QCA 3D showed minimal difference from the true length between markers.
With the highly accurate length calculation QCA 3D can assist the physician in deciding on the number and length of the stents to be used.

<table>
<thead>
<tr>
<th>True length (number of measurements)</th>
<th>Median difference between length calculated with CAAS QCA 3D and true length</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 mm (n=122)</td>
<td>-0.06 (-0.15, 0.03)</td>
<td>P &lt; 0.0001</td>
</tr>
<tr>
<td>10 mm (n=126)</td>
<td>0.325 (0.04, 0.61)</td>
<td>P &lt; 0.0001</td>
</tr>
<tr>
<td>20 mm (n=124)</td>
<td>0.285 (0.003, 0.57)</td>
<td>P &lt; 0.0001</td>
</tr>
<tr>
<td>25 mm (n=62)</td>
<td>0.22 (-0.15, 0.58)</td>
<td>P &lt; 0.0001</td>
</tr>
<tr>
<td>40 mm (n=64)</td>
<td>0.69 (0.07, 1.31)</td>
<td>P &lt; 0.0001</td>
</tr>
</tbody>
</table>

Length calculated by CAAS QCA3D compared with true length

**Cross-sectional area & stent size**

Coronary arteries, especially where a stenosis is situated, are often non-circular in cross-section. Combining information of two angiograms allows for a non-circular reconstruction of the vessel leading to a highly accurate calculation of minimum luminal area.

From the 3D reconstruction for each position in the vessel a minimum, maximum and equivalent diameter is derived. The latter being the diameter of the vessel derived from the cross-sectional area under the assumption the vessel had been circular [2]; defined to represent the diameter in a uniform manner.

To determine the accuracy and reproducibility of the cross-sectional area measurements a validation study was carried out at Erasmus Medical Center, Rotterdam, The Netherlands [3]. The CAAS QCA 3D system was validated against 3D reconstructions based on fusion of angiography and intravascular ultrasound (ANGUS).

The study demonstrated that the luminal areas of QCA3D highly correlate with the luminal areas of ANGUS.

The intra- and interobserver variability was equal to 0.09 ± 0.48 mm² and -0.06 ± 0.50 mm².

Given the high correlation between QCA3D and IVUS, QCA3D can be a time-saving and cost-efficient alternative when determining whether a stent needs to be placed based on minimum luminal area.

**Optimal projection**

The CAAS QCA 3D program provides a so-called optimal projection. This optimal projection can be used for adjusting the position of the C-arm so that the vessel is shown without foreshortening and a clear view of the carina area can be seen. The amount of contrast during intervention can thus be lowered.

**Bifurcation angle**

Recent studies from Erasmus Medical Center [4] and the University of Toronto [5] reinforce the suggested prognostic role (by Louvard et al) [6] of bifurcation
angulation parameters. Using a standard angiogram the bifurcation angles can be under or overestimated. QCA 3D allows true bifurcation angle calculation.

**True carina visualization**

In 2D projections possible vessel overlap can occur, especially at the bifurcated region. Combining two projections will result in an optimal 3D reconstruction of the bifurcation area without vessel overlap [2].

Edge A is visible in image 1, but cannot be seen in image 2. In the 3D reconstruction edge A is always visible.

**Co-registration with other imaging modalities**

Intravascular techniques such as IVUS and OCT provide a highly detailed view from the inside of the coronary artery. Although these techniques provide useful information on e.g. plaque composition and stent strut mal-apposition, it can be difficult in daily practice to relate the IVUS or OCT recording to its exact location in the coronary tree. Co-registration of IVUS and OCT with the 3D model of the coronary artery solves this limitation and assists the physician during the PCI procedure.

The position of the IVUS frame (indicated red) on the angiographic images and 3D reconstruction.

**Conclusion**

3D QCA can be easily applied during routine PCI to support daily decision making such as whether to stent and if so which stent should be used. Thus 3D QCA can play a role in optimal patient treatment.

The optimal projection calculation can lead to less contrast use during the intervention.

Extensive validation studies have demonstrated the accuracy and reproducibility of CAAS QCA 3D and currently it is the most accurate 3D QCA software based on two angiographic projections [7].

**References**


