Calcium Quantitation
Agatston Score

Local Image Features Extraction
— LIFEx —

C. Nioche[1], Ming-Ting Wu[2], I. Buvat[1]

[1] Laboratory of Translational Imaging in Oncology, U1288 Inserm, Institut Curie, University Paris Saclay, 91401 Orsay, France
[2] Kaohsiung Veterans General Hospital, Taiwan

LIFEx version 7.8.n,
Last update of document: 2025/04/17

Part I Calcium Quantitation protocol

Part I

Calcium Quantitation protocol

Chapter 1
Introduction

1.1 What is this protocol?

The purpose of the *Calcium Quantitation* protocol from LIFEx (see fig:1.1, p.8) is to calculate the Agatston score.

The Agatston score characterizes the extent of coronary artery calcification detected by an unenhanced low-dose CT scan as routinely performed in patients undergoing cardiac CT.

This score is used for an early risk stratification as patients with a high Agatston score (>160) have an increased risk of a major adverse cardiac event (MACE).

Although this score does not allow for the assessment of soft non-calcified plaques, it has shown a good correlation with contrast-enhanced CT coronary angiography.

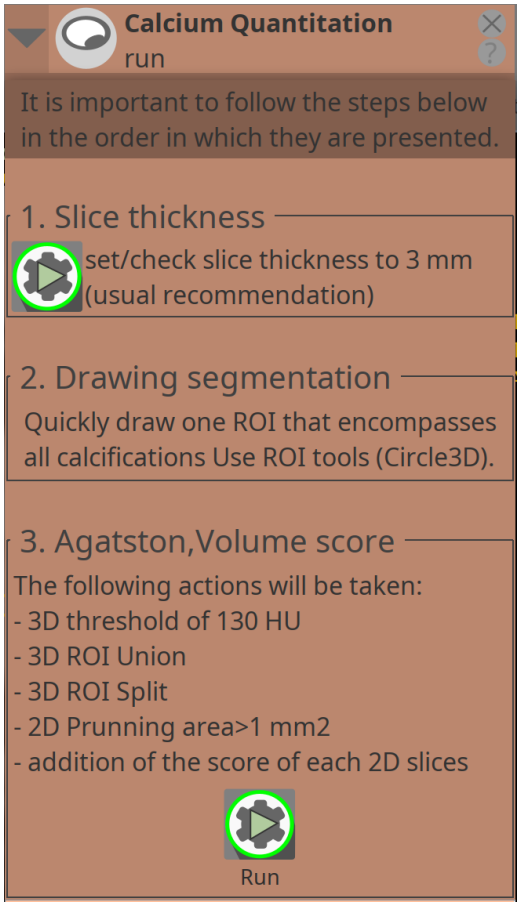

Figure 1.1: Composition of the Calcium Quantitation user interface

Chapter 2
Method of calculation

2.1 How to use the Calcium Quantification protocol?

The construction of the Calcium Quantitation protocol consists in:

1. loading the unenhanced low-dose CT scan;
2. creating all the ROIs to be included in the calculation;
3. clicking on run button of user interface protocol.

2.2 Prerequisite and input parameters

For creating a calcium score, you need (see fig.2.1, page 10):

- the unenhanced low-dose CT scan;

- ROIs that encompass the calcified regions. Many tools can be used to obtain this ROI: Circle3D then absolute threshold (130 HU).

Method of calculation

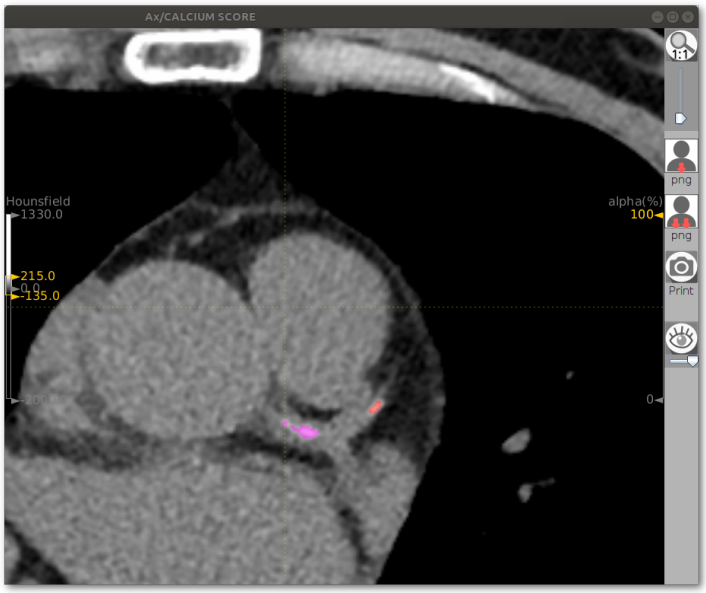

Figure 2.1: axial slice of unenhanced low-dose CT scan with two calcification specks (red and magenta specks)

2.3 Density factor

The calculation is based on the weighted density score given to the highest attenuation value (HU) multiplied by the area (expressed in square millimeters) of the calcification speck.

Density factor

- 130-199 HU: 1
- 200-299 HU: 2
- 300-399 HU: 3
- 400+ HU: 4

For example, if a calcified speck has a maximum attenuation value of 400 HU and occupies 8 sq mm area, then its calcium score will be 32.

2.4 Agatston score

The score of every calcified speck is summed up to give the total calcium score.

Grading of coronary artery disease (based on total calcium score)

- no evidence of CAD: 0 calcium score
- minimal: 1-10
- mild: 11-100
- moderate: 101-400
- severe: >400

Method of calculation

Chapter 3
Results

3.1 Output results

The grading of CAD is one of these grades: no / minimal / mild / moderate / severe. The selected grade is written with red color text (see fig. 3.1, page 14).

The total of calcium scores extracting from all ROIs is shown too (example 404.12 showed in fig. 3.1, page 14).

For each ROI, density factor and local calcium score are given. Theses results are shown on result file. A summary of all ROI is shown in user interface of the protocol (see fig.3.1, page 14).

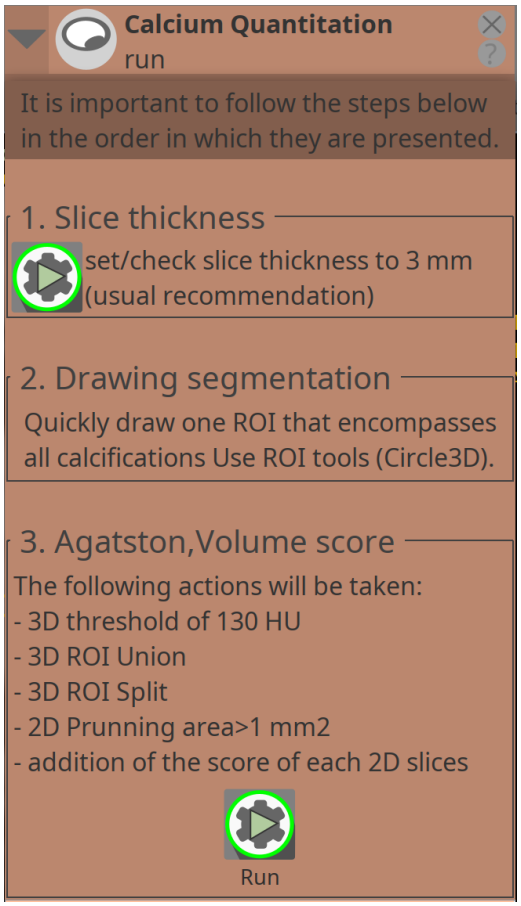

Figure 3.1: Graphic user interface of result of calcium quantitation: grading is shown in red.

3.2 Output file

A result file is written after each calcium score calculation. It includes all the slice to slice details for each ROI. This file is in comma separator value (csv) format and can be read in Excel with "," as separator symbol.

Below is an example of how to write this file:

```
LIFEx5.87
ROI z maxValue NbVoxels(#) VoxelArea roiArea DensityFactor CalciumScore Sum
of CalciumScore
6d 39 237.0 10 0.2384 2.38 2 4.76 4.76
11 37 237.0 8 0.2384 1.90 2 3.81 8.58
8b 36 438.0 48 0.2384 11.44 4 45.77 54.35
8b 35 615.0 32 0.2384 7.62 4 30.51 84.87
8b 34 270.0 13 0.2384 3.09 2 6.19 91.07
8b 33 535.0 28 0.2384 6.67 4 26.70 117.77
7b 39 232.0 13 0.2384 3.09 2 6.19 123.97
7a 39 210.0 14 0.2384 3.33 2 6.67 130.65
```

```
7a 38 157.0 5 0.2384 1.19 1 1.19 131.84
1a 31 463.0 69 0.2384 16.45 4 65.80 197.64
1a 30 266.0 19 0.2384 4.52 2 9.05 206.70
6a 39 165.0 5 0.2384 1.19 1 1.19 207.90
2z 20 208.0 21 0.2384 5.00 2 10.01 217.91
1b 28 360.0 24 0.2384 5.72 3 17.16 235.08
1b 25 472.0 44 0.2384 10.49 4 41.96 277.04
13 36 401.0 30 0.2384 7.15 4 28.61 305.65
13 35 254.0 31 0.2384 7.39 2 14.78 320.43
5z 39 286.0 13 0.2384 3.09 2 6.19 326.63
6c 39 527.0 44 0.2384 10.49 4 41.96 368.59
6b 39 151.0 4 0.2384 0.95 1 0.95 369.54
8a 39 500.0 30 0.2384 7.15 4 28.61 398.15
8a 38 650.0 91 0.2384 21.69 4 86.78 484.94

z spacing of series (mm):  2.5
Calcium score (sum):  484.94

Wanted z spacing for calcium score (mm):  3.0
Corrected calcium score (3mm):  404.119
```


3.3 Output messages

Success messages. Success messages will be displayed after calculation of score.

Error messages. Error messages will be displayed if the prerequisites are not present (see above). Once the prerequisites are met, result should be displayed. If not, please contact contact@lifexsoft.org.