

Abstract

Atherosclerosis is a disease that affects a large portion of postmenopausal women, i.e., women whose ovaries have ceased to produce female sex-steroids (estrogen), and causes subsequent cardiovascular disease and coronary heart disease. The golden goal of this project is the development of a mass-screening tool, well suited for quantifying the extent of calcific deposits in the lumbar aorta of postmenopausal women. A mass-screening tool has to deliver reliable and easily reproducible data which should give information regarding the degree of calcification, as well as the density progression of the individual plaques. In order to make such a diagnostic tool available to the broad public, an easy, cost-efficient solution has to be found, which suggests lateral 2-D x-rays. The problem associated with common x-rays though is, that soft tissue, and thus a healthy aorta, is not visible. This means, that the inference of the calcification index and progression has to rely solely on the visible calcific deposits in the aorta.

The region of interest for our purposes is the lumbar region, denoted by L1 - L4, since the laterally taken x-ray images from the thoracic region are too contaminated with noise due to the rib cage. Furthermore, the bifurcation of the aorta with the first parts of the common iliac arteries most commonly occurs at L4, which restricts the region of interest to the first four lumbar vertebrae.

The here presented approach towards a largely automated quantification tool for atherosclerotic plaque is based on three sequential processes:

- First, the region of interest is defined, i.e., the location of the aorta is approximated. For this, a shape regression model is used, that estimates the optimal aorta shape from the shape of the four lumbar vertebrae.
- Second, the calcifications are detected using a semi-automatic approach. Non-linear stretching, an image enhancing method, enhances the local contrast in an image. Seed points are then manually placed on the enhanced images, which in turn are used as input for a region growing algorithm.
- The here presented attempt to improve upon the shortcomings of the currently used categorical score for atherosclerosis, is based on simulating how a calcified aorta would have looked like in a healthy state by inpainting the calcified areas. The difference between the calcified and the non-calcified image then yields the new calcification index.

Regarding the plaque quantification, we introduce and compare different methods of inpainting for the background estimation, and we evaluate several approaches to refining the calcified areas detected in the second step on the basis of optimizing the signal-to-noise ratio of the continuous measure. A pilot study into the associations of the new atherosclerosis measure with known risk factors, revealed that more significant associations could be found with our continuous score than with the original categorical score.