Implementation and extended use of computed tomography coronary angiography

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Thesis summary

PART I. IMPLEMENTATION OF CTCA

Part I of this thesis focussed on the implementation of CTCA. In **Chapter 1** we investigated the impact and challenges of implementing CTCA in the Netherlands according to the 2019 ESC guidelines on chronic coronary syndromes. Therefore, we used a survey to investigate the current utilization of CTCA services, status of CTCA protocols and modelled the expected impact of these guidelines in the Netherlands. The survey was disseminated to every Dutch hospital organization providing outpatient cardiology and survey response rate was 100% (68/68 hospital organizations). In 2019, 63 hospital organizations provided CTCA services (92.6%). In these hospital organizations, CTCA was performed on 99 CTCA-capable CT-scanners and concerned a total of 37,283 CTCA examinations. To fully implement the new ESC guideline in the Netherlands, our model suggested that 70,000 additional CTCA examinations would have to be performed. Also, we found that there is substantial variation considering CTCA indications, CTCA equipment, CTCA acquisition and reporting standards between the hospital organizations.

Chapter 2 evaluated the implementation of initial CTCA in the diagnostic work-up for non-coronary cardiac surgery, cardiomyopathy, heart failure and ventricular arrhythmias in our hospital. We found that a diagnostic strategy of initial CTCA is feasible and was performed in 327 of 415 patients (78.8%). The other 88 patients (21.2%) were directly referred to CAG (non-conform protocol). From the 327 patients that underwent initial CTCA, only 55 patients required an additional CAG (16.8%). In the 88 patients directly referred to CAG, only 17.2% had coronary lesions >50% DS, implying that implementation of CTCA in these latter patients would have reduced the need for (additional) CAG.

PART II. THE EFFECT OF CONTRAST ADMINISTRATION ON IMAGE QUALITY OF CTCA

In **Part II** of this thesis we described a patient tailored contrast delivery protocol for CTCA that adjusted the IDR according to patient weight and kV setting of the CT-scanner. **Chapter 3** confirmed improvements in attenuation values for a patient tailored contrast delivery protocol compared to a "one bolus fit all" strategy. The predefined "optimal" target luminal attenuation increased from 39% of patients in the "one bolus fit all" cohort to 72% of patients in the patient tailored contrast delivery protocol. Simultaneously the mean total iodine load reduced significantly from 20.1 to 17.7 grams of Iodine per CTCA examination. Therefore, clinical implementation of such a patient tailored contrast delivery protocol for CTCA, both improves luminal attenuation and reduces total iodine load.

PART III. THE EXTENDED USE OF CTCA IN PATIENTS UNDERGOING TAVI

In **Part III** of this thesis, we evaluated the extended use of CTCA, both for the detection of CAD in the work-up for TAVI and to predict the occurrence of chronic silent brain infarctions following TAVI, which are associated with long-term cognitive deterioration. **Chapter 4** was a systematic review and meta-analysis, including 1275 patients, which summarised the literature on the diagnostic accuracy for CTCA to detect CAD in patients referred for TAVI on scanners with ≥64 detector rows. The patient-based pooled sensitivity, specificity, PPV and NPV were 95.3% (95% CI 93.3% to 96.9%), 65.3% (95% CI 61.6 to 68.9%), 70.8% (95% CI 68.6 to 72.9%) and 94.0% (95% CI 91.6 to 95.8%), respectively. Therefore, CTCA offers high accuracy to exclude coronary lesions in patients undergoing TAVI and using CTCA for the evaluation of CAD could decrease the number of additional CAG by 37% in this high-risk and fragile population.

Because the current guidelines only recommend to consider PCI in case of a >70% lesion in a proximal segment of a coronary artery (Class IIa recommendation, level of evidence C, according to ESC Committee for Practice Guidelines policy), only proximal coronary arteries would need evaluation (20). In **chapter** 5, we assessed the impact of pre-TAVR PCI in all patients with coronary lesions of >50% diameter stenosis (DS) on all-cause and cardiovascular mortality, and differentiated between pre-TAVR PCI in any coronary lesion, in the significant proximal coronary lesions and the non-proximal lesions, and performed an additional propensity score matched analysis. In that analysis, pre-TAVR PCI was not associated with reduced mortality in any of these subgroups. In **chapter 6**, we assessed the diagnostic yield and accuracy of pre-TAVI CTCA to detect left main and proximal coronary stenosis in 1060 patients in the work-up for TAVI. Pre-TAVI CTCA ruled-out ≥50% DS in 51.6% of patients with a sensitivity of 96.4%, specificity of 71.2%, PPV of 57.7% and NPV of 98.0%. For ≥70% DS, pre-TAVI CTA ruled-out stenosis in 70.0% of patients with a sensitivity of 96.7%, specificity of 87.5%, PPV of 66.9% and NPV of 99.0%. With that capability, it is able to substantially reduce the need for CAG if it is implemented as a gatekeeper.

Since CTA is already performed in the TAVI work-up, these images may be used for additional purposes other than the evaluation of CAD as well. Therefore, in **Chapter 7**, we studied whether the degree of calcifications, as measured on pre-TAVI CTCA, causes ischemic stroke after TAVI. In summary, we found that 7 out of 10 patients after TAVI had new white matter hyperintensities at MRI, indicating chronic ischemic stroke. A higher calcification volume in the aortic valve was associated with a larger increase in the white matter hyperintensity volume. These findings show the potential for (automated) calcium screening as an imaging biomarker to predict chronic silent brain infarctions.

In **chapter 8**, we describe an example of the extended use of CTCA in a patient with aortic valve endocarditis of the prosthetic heart valve, 9 months after aortic valve replacement. In this case report, CTCA offered high diagnostic accuracy for detecting infective endocarditis and renders complementary information about valvular anatomy, CAD and the extension of infections.