Multi-depth myocardial blood flow for major adverse cardiac events survival prediction

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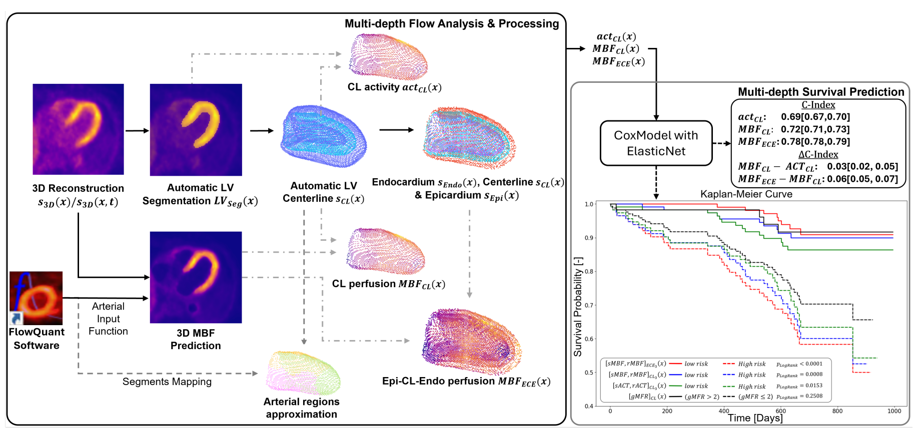

Fig. 1. Multi-depth processing pipeline (left) and survival prediction performances (right). All point clouds are defined in scanner space to sample activity or blood flow.

Introduction

Major adverse cardiac events (MACE) are among the leading causes of death worldwide. Quantitative myocardium perfusion imaging based on rubidium (Rb) PET allows measuring myocardial blood flow (MBF) in the left ventricle (LV), which proved to be predictive for MACE. Clinical

routine relies on an approximate 3D LV centerline (CL) flattened to a 2D polar map (PM).
Previous studies [4, 1] showed the importance of transmural perfusion. In this work, we hypothesise the importance of transmural MBF in MACE prediction. We propose a fully automated LV segmentation and centreline extraction up to scanner resolution. We further extract perfusion close the epi-/endocardium to investigate the importance of multi-depth MBF for MACE prediction.

Methods

We established a cohort of 234 patients with suspected myocardial ischemia unrolled to undergo [^{82}Rb] cardiac Silicon PhotoMultiplier (SiPM) under approved ethics protocol. Follow-up revealed 47 events on average 572 days (2 to 862 days) after the exam. All patients were processed using FlowQuant [3] to obtain the arterial input functions and three arterial regions. 3D MBF was produced using the model proposed in [6].
To compare the survival prognosis Cox models with elastic net penalty [2] were fitted using the different perfusions, i.e. normed Rb activity ($ACT_{CL}(x)$) vs CL MBF ($MBF_{CL}(x)$) vs Epi-CL-Endo (ECE) MBF ($MBF_{ECE}(x)$), and dichotomised using the median predicted hazard for kaplan-meier analysis [5] (KM). The Cox models were trained using a stratified five-fold approach with a 100-fold bootstrap C-Index estimate pooled to estimate the confidence intervals (CIs).

Results

Cox model using the concatenated normalised activity from rest and stress average on the three main regions reached a C-Index of 68.92[67.46,70.35]. Same setup using the MBF values sampled at the CL reached a C-Index of 72.34[71.25,73.40] while the ECE MBF model reached a C-Index of 78.83[78.15,79.51]. When plotting the KM separated by median hazard, a qualitative difference is visible even though the log rank test returned a significant difference for all curves ($p<0.05$).

Conclusion

When comparing the C-Indexes and their CIs, the MBF-based model outperforms the normed activity one. By further including the epicardial and endocardial parts of the LV, the C-Index largely improves, reinforcing the importance of transmural perfusion. Even though the results are very encouraging, further studies with a larger cohort are still required.

References

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