

3D Fusion Echocardiography Improves Transoesophageal LV Assessment

Kashif Rajpoot¹, Daniel Augustine², Christos Basagiannis²,
J. Alison Noble¹, Harald Becher³, and Paul Leeson²

¹ Institute of Biomedical Engineering, University of Oxford, Oxford, UK

² John Radcliffe Hospital, Oxford, UK

³ University of Alberta Hospital, Edmonton, Canada

Introduction

Accurate left ventricular (LV) assessment by transoesophageal echocardiography (TOE) can be clinically important particularly in intensive care or intraoperative settings. Assessment from TOE views is limited by foreshortened imaging planes and mitral valve pathology. Transgastric short-axis (SAX) views allow better alignment but may be limited by patient tolerability or patient-related factors (e.g. post gastric surgery). Fusion of multiple 3D volume datasets is now technically possible and improves LV visualisation from transthoracic windows. We hypothesized that fusion of full 3D TOE volumes would improve LV image quality and allow SAX image reconstruction from the oesophagus with improved image quality vs. transgastric SAX views.

Methods

3D 2 chamber or 4 chamber volumes were obtained in 30 sequential patients undergoing TOE study. The optimal 2 or 4 chamber view on 2D imaging was visually assessed and a 3D dataset acquired in that position. 2-5 further 3D volumes were acquired following small probe manoeuvres (1cm withdrawal or advancement; minor lateral/medial rotation; and angle adjustment (<5)). Transgastric SAX views were attempted in the same patients when clinically appropriate and feasible (n = 14, 12 successful). 3D images were fused together using an in-house developed programme. The optimal and fused 2 or 4 chamber views with their corresponding mid SAX image were analysed (using Philips QLAB 7.1 iSlice) to compare quality (using the standard segmental approach) and field of view (FOV). Each segment was assigned a rating 0-3 depending on the amount of visualised endocardial border defined as: 0 (<50%), 1 (50-75%), 2 (75-99%), and 3 (100%).

Contrast-to-noise ratio (CNR) was used as a quantitative measurement of the image quality defined as the ratio of the signal intensity differences between image regions (myocardium and blood pool) to the image noise (variance of image regions). Two readers analysed all images.

Results

Each reader analysed 720 segments. Image quality of both 4 or 2 chamber and SAX views improved with fusion (mean 1.8 vs. 2.2 (p<0.05)). There were fewer 0 ratings

post fusion (68 vs. 28) and greater 2/3 ratings (135 vs.187). The FOV improved in all images post fusion. The image quality of the optimal (unfused) mid SAX TOE view was similar to the transgastric view (mean 2.0 vs. 2.0 ($p = 0.8$) and improved with 3D fusion (mean 2.5, $p < 0.05$). CNR improved post fusion by 64% ($p < 0.05$). Interobserver agreement showed a mean difference in image quality assessment of 0.2 image points (CI 0-0.3) and good correlation ($r = 0.78$, $p < 0.05$).

Conclusions

3D fusion TOE significantly improves LV segmental image quality and allows acquisition of SAX views from the oesophagus in all patients. Fused datasets were noted to have increased FOV in the near field. This approach may reduce requirement for transgastric images; improve patient procedure tolerability/safety as well as shorten procedure time.