Trajectory of coronary motion and its significance in robotic motion cancellation

ID 69711
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Year 2004
Title Trajectory of coronary motion and its significance in robotic motion cancellation
Journal European journal of cardio-thoracic surgery
Volume 25
Number 5
Pages / **Article-Number** 786-790
Keywords off-pump, coronary artery bypass, robotics
Objectives: To characterize remaining coronary artery motion of beating pig hearts after stabilization with an ?Octopus? using an optical remote analysis technique. Methods: Three pigs (40, 60 and 65 kg) underwent full sternotomy after receiving general anesthesia. An 8-bit high speed black and white video camera (50 frames/s) coupled with a laser sensor (60 m resolution) were used to capture heart wall motion in all three dimensions. Dopamine infusion was used to deliberately modulate cardiac contractility. Synchronized ECG, blood pressure, airway pressure and video data of the region around the first branching point of the left anterior descending (LAD) coronary artery after Octopus stabilization were captured for stretches of 8 s each. Several sequences of the same region were captured over a period of several minutes. Computerized off-line analysis allowed us to perform minute characterization of the heart wall motion. Results: The movement of the points of interest on the LAD ranged from 0.22 to 0.81 mm in the lateral plane (x/y-axis) and 0.5?2.6 mm out of the plane (z-axis). Fast excursions (>50 m/s in the lateral plane) occurred corresponding to the QRS complex and the T wave; while slow excursion phases (<50 m/s in the lateral plane) were observed during the P wave and the ST segment. The trajectories of the points of interest during consecutive cardiac cycles as well as during cardiac cycles minutes apart remained comparable (the differences were negligible), provided the hemodynamics remained stable. Inotrope-induced changes in cardiac contractility influenced not only the maximum excursion, but also the shape of the trajectory. Normal positive pressure ventilation displacing the heart in the thoracic cage was evident by the displacement of the reference point of the trajectory. Conclusions: The movement of the coronary artery after stabilization appears to be still significant. Minute characterization of the trajectory of motion could provide the substrate for achieving motion cancellation for existing robotic systems. Velocity plots could also help improve gated cardiac imaging.
Publisher Springer
ISSN/ISBN 1010-7940
edoc-URL http://edoc.unibas.ch/dok/A5250268
Full Text on edoc No;
Digital Object Identifier DOI 10.1016/j.ejcts.2004.01.019, 10.1016/j.ejcts.2004.01.019
ISI-Number WOS:000221432800032
Document type (ISI) ArticleProceedings Paper