Measuring reperfusion of the hand of patients undergoing coronary bypass surgery using laser speckle contrast analysis: An objective Allen’s test.

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Introduction: The radial artery (RA) has become a routinely used graft for coronary artery bypass graft surgery (CABG) [1,2]. The Allen’s test is performed prior to surgery to test the collateral circulation to the hand of the ulnar artery. If reperfusion returns within 5 seconds the test is considered negative and the RA may be used as bypass graft [3]. The predictive value of a positive test is 53% [4]. Several other methods can be used to measure the reperfusion. One is laser speckle contrast analysis (LASCA) which uses a laser to measure movement of red blood cells during reperfusion [5].

Aim: To investigate if LASCA provides a more objective determination of the reperfusion time compared to the conventional Allen’s test.

Materials and methods: When the hand is illuminated with coherent laser light (here 660nm, 75mW), the backscattered light will result in constructive and destructive interference consisting of bright and dark areas, speckles (Figure 1) [5]. This speckle pattern will change due to movement of red blood cells during the Allen’s test. LASCA uses these changes to visualize the perfusion [5] on the palmar side of the hand (Figure 1C, red box). The reperfusion time of patients undergoing CABG is calculated using LASCA and compared to the Allen’s test performed by the nurse practitioner.

Figure 2: Perfusion images of a left hand of a 56 year old male patient at 0 to 8 seconds during an Allen’s test. As can be seen the perfusion increases over time and then normalizes again. The colorbar indicates no perfusion (blue) and maximum perfusion (red).

Results: Perfusion images at six different time points during an Allen’s test of a 56 year old male patient are shown in Figure 2. The perfusion is measured at 30 frames/sec. and each frame is averaged and set against time (Figure 3). The reperfusion time is calculated using the first derivative of the 6th order polynomial curve fit.

LASCA measurements showed a negative Allen’s test of both hands of eleven patients. Six had a borderline reperfusion time of 5 – 5.5 seconds and/or a positive Allen’s test of one or both hands. These results were consistent with the conventional Allen’s test performed by the nurse practitioner. Furthermore, differences in reperfusion of different parts of the hand could be seen.

Conclusion: LASCA is able to visualize reperfusion of the hand and measure a quick, moderate, slow reperfusion response or no reperfusion. It is technically feasible to determine the reperfusion time of the hand. In the future, LASCA could be a useful and objective tool to assess ulnar collateral supply to the hand prior to harvesting of the radial artery as a bypass graft.

References: