University of Glasgow | College of Medical, Veterinary & Life Sciences

Head of College Scholars List Scheme
Summer Studentship
Report Form

This report should be completed by the student with his/her project supervisor. It should summarise the work undertaken during the project and, once completed, should be sent by email to: jill.morrison@glasgow.ac.uk within four weeks of the end of the studentship.

1. Student

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3. Research Project Report

3.1 Project Title

Visual Assessment and Classification of Coronary Thermodilution Waveforms in Patients with ST-elevation Myocardial infarction.

3.2 Project Lay Summary

Primary Percutaneous Coronary Intervention (pPCI) is one of the strategies to improve the myocardial perfusion and it is widely used in patients with ST-elevation Myocardial Infarction. However, chest pain persists in some patients even after successful percutaneous coronary intervention and it is thought to be associated with microvascular function of the patient. The shape of the coronary thermodilution waveforms of 324 heart attack survivors that underwent pPCI will be assessed and classified. The information of the coronary physiology including Index of Microvascular Resistance (IMR) and Hyperemic Transit Time will be recorded as well. New insights will be provided into the relationship between the shape of the waveforms and clinical outcomes of the patients.

3.3 Start Date: 08/06/2015 Finish Date: 01/08/2015

3.4 Original Project Aims and Objectives

1.) To assess the shape of the coronary thermodilution waveforms in patients with ST-elevation Myocardial Infarction
2.) To relate the shape of the coronary thermodilution waveforms to the coronary physiology information including IMR and Hyperemic Transit Time.
3.) To relate the findings to the infarct size, left ventricle volume and function shows on Cardiac Magnetic Resonance (CMR) Imaging
4.) To evaluate whether the shape thermodilution waveforms obtained after pPCI can predict the clinical outcomes of the patients with ST-segment elevation myocardial infarction.

3.5 Methodology

Analysis of existing data that have been already acquired in the BHF-funded MR-MRI "natural history" study of STEMI survivors in the West of Scotland. 324 patients were enrolled (May 2011 – Nov 2012) and all of the clinical data have been entered into a database held by the Glasgow Trials Unit. Clinical data includes coronary thermodilution waveforms, Cardiac Magnetic Resonance Imaging scans and echocardiographs of the volunteers. Information regarding left ventricle ejection fraction at baseline and during follow-up (%), left ventricle end-diastolic volume at baseline and during follow-up (ml), acute infarct size (% LV mass), presence of microvascular obstruction, myocardial salvage index (%) were obtained from the analysis of CMR scans.

Visual analysis of existing coronary thermodilution waveforms obtained was carried out using Radiview 2.2 software and thermodilution waveforms are classified into 3 groups:

Profile	Characteristic
Sharp Unimodal	- Sharp decrease of temperature - Rapid return to baseline temperature - Narrow profile - Hyperemic transit time less than 0.30s
Wide Unimodal	- Slow return to baseline temperature after peak - Wide profile - Hyperemic transit time more than 0.30s
Bimodal	- irregular shape with 2 or more populations - Hyperemic transit time varies

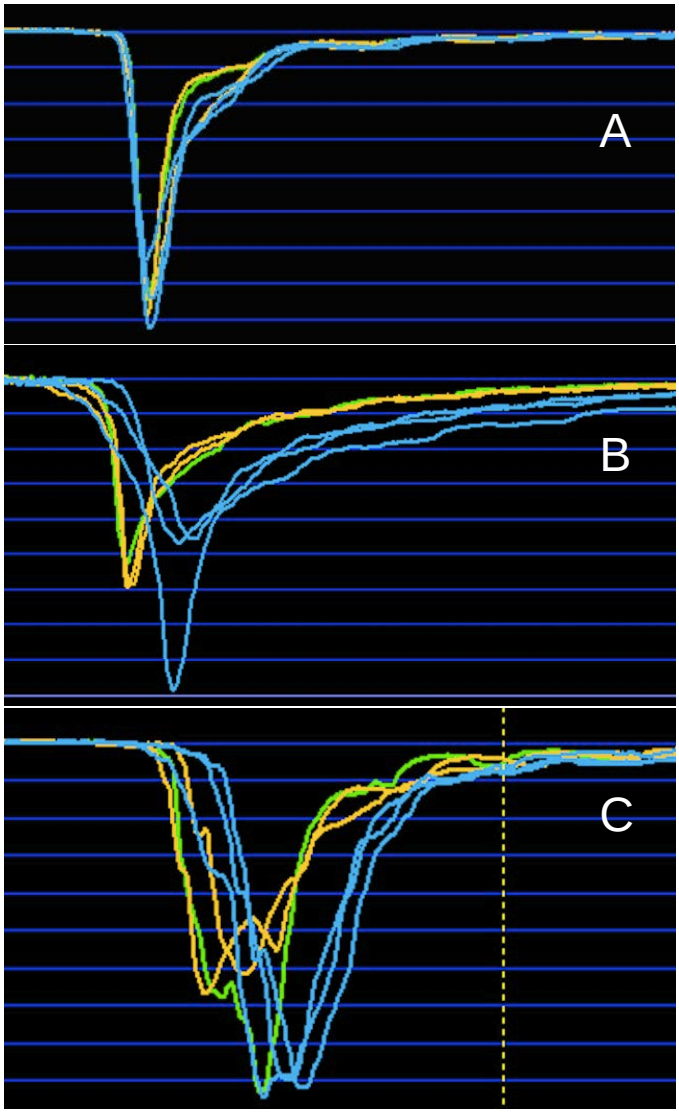


Figure A shows an example of a sharp unimodal profile (green line), figure B and C shows an example of wide unimodal profile and bimodal profile respectively (green line).

Subjects were classified into 3 groups according to the shape of the thermodilution waveforms. To find out the relationship between shape of thermodilution waveforms and clinical outcomes of the patients, the results are compared with other data obtained from imaging analysis of CMR including left ventricle ejection fraction at baseline and during follow-up (%), left ventricle end-diastolic volume at baseline and during follow-up (ml), infarct size at baseline and during follow up (% of LV mass), myocardial salvage index (%) and presence of microvascular obstruction. The statistical analyses were conducted using SPSS version 22.

3.6 Results

A total of 280 waveforms were analyzed, 111 patients have a bimodal profile, 91 patients have a sharp unimodal profile and 78 patients have a wide unimodal profile. The mean IMR value was 35.8±30.6 with a median of 25 (5-174). Wide unimodal group and bimodal group have a significantly higher IMR value compared to sharp unimodal group (Bimodal: 50.2±38.9, Wide Unimodal: 40.4±18.5, Sharp Unimodal: 14.3±4.9). Likewise, wide unimodal group and bimodal group have a longer hyperemic transit time when compared to sharp

unimodal group (Bimodal: 0.64±0.45s, Wide Unimodal: 0.58±0.24s, Sharp Unimodal: 0.20±0.06s).

From CMR analysis, no significant difference existed in left ventricle ejection fraction and end-diastolic volume at baseline among the three groups. Nevertheless, ejection fraction during follow-up was significantly lower in the bimodal group and wide unimodal group than that in the sharp unimodal group (B: 59±10.1%, W: 61.5±8.9%, S: 66.8±7.7%, P<0.01). Besides, end-diastolic volume is significantly lower in sharp unimodal group during follow-up (S: 146.6±33.2 LV mass %, W: 162.2±40.6 LV mass%, B: 160.7±50.0 LV mass%).

Prevalence of microvascular obstruction on CMR scans of respective groups was 67.6% (Bimodal), 31.9% (Sharp Unimodal) and 52.6%(Wide Unimodal). Both acute infarct size (%) and follow-up infarct size were significantly lower in sharp unimodal group (S: 12.9±11.3% and 8.5±7.6% respectively, B: 21.8±14.4% and 15.2±10.8%, W: 18.6±17.5% and 14.2±9.9%). Sharp unimodal group also had the highest myocardial salvage index (%) when compared to the other two groups (S: 70.7±23.2%, W: 58.8±24.9%, Bi: 58.32±23.1%). Mean myocardial salvage index for all 3 groups is 62.5±24.3). However, myocardial salvage (% LV mass) of all three groups was almost similar (S: 19.1±8.7, W: 18.7±9.1, Bi: 18.8±8.1).

3.7 Discussion (500 words)

The results above suggests that the shape of thermodilution waveforms could have a clinical value in predicting microvascular function and outcomes in patients with ST-segment elevated myocardial infarction. Sharp unimodal modal group performed better with lowest prevalence of microvascular obstruction, highest myocardial salvage index and lowest IMR. Besides, patients in sharp unimodal group performed better during follow-up by having a higher percentage of left ventricle ejection fraction and lower end-diastolic volume. Patients in bimodal group and wide unimodal group on the other hand did not perform as well as the patients in sharp unimodal group. Bimodal group especially, had the highest prevalence of microvascular obstruction, which was reported to be associated with worse clinical outcome after successful pPCI[1].

Diagnostic methods for assessing coronary artery function have improved drastically in recent years and coronary physiological parameters like IMR and CFR (Coronary Flow Reserve) have been shown to possess significant value in clinical practice. The shape of thermodilution waveforms is closely related with IMR and could be helpful in predicting early microvascular disease in patients after successful pPCI. An IMR >30 is said to be high and related with microvascular dysfunction in coronary artery disease[2]. Both wide unimodal group and bimodal group have a higher mean IMR value accompanied with worse clinical outcomes during follow-up when compare to sharp unimodal group. The relationship between IMR value and the prevalence of microvascular obstruction was not explored in this study. However, it was reported that IMR was not an independent predictor of MACEs (Major Adverse Cardiac Events) in STEMI patients after pPCI[3]. Hence, the main finding of the study was to support the role of thermodilution waveforms as a complementary tool in predicting clinical outcomes in patients with STEMI after pPCI to help facilitate decision-making for treatments after pPCI.

References

1.) Yamamuro A, Akasaka T, Tamita K, Yamabe K, Katayama M, Takagi T, Morioka S. Coronary flow velocity pattern immediately after percutaneous coronary intervention as a predictor of complications and in-hospital sur- vival after acute myocardial infarction. *Circulation*. 2002;106:3051–3056.

2.) Professor Colin Berry. Fractional Flow Reserve, Coronary Flow Reserve and the Index of Microvascular Resistance in Clinical Practice. *Institute of Cardiovascular and Medical Sciences, University of Glasgow and Golden Jubilee National Hospital, Scotland, UK. 2014*

3.) Masashi Fukunaga, Kenichi Fujii, Daizo Kawasaki, Hisashi Sawada. Thermodilution-Derived Coronary Blood Flow Pattern Immediately After Coronary Intervention as a Predictor of Microcirculatory Damage and Midterm Clinical Outcomes in Patients With ST-Segment−Elevation Myocardial Infarction *Circulation: Cardiovascular Interventions.2014.*

4. Reflection by the student on the experience and value of the studentship

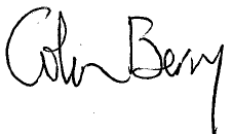
The 8-week experience has been rewarding as it provided me with insights into how a research is done from gathering ideas, data-collecting, statistical analysis, literature reviews to writing a report. Having to learn different computerized software to collect data including Qmass standalone and Radiview 2.2, I learn to appreciate the importance of IT skill in clinical research. Besides, I have also acquired skills in using IBM SPSS software to perform simple statistical analysis. Such skill was not taught in my course curriculum and I was glad I was given the opportunity to learn it this summer.

The project was based in the Golden Jubilee National Hospital and British Heart Foundation, giving me an opportunity to meet many amazing cardiologists and clinical research fellows whom some I have the honour to work with. The working environment was nurturing as all my queries were answered with patience in the best manner.

The experience was enjoyable and I am thankful to be given this opportunity to participate in the program.

5. Dissemination:(note any presentations/publications submitted/planned from the work):

6. Signatures:

Supervisor	Date	Student	Date
	21 September 2015		11th August 2015