3. Bulluck H, Foin N, Cabrera-Fuentes HA, et al. Index of microvascular resistance and microvascular obstruction in patients with acute myocardial infarction. J Am Coll Cardiol Intv 2016;9:2172–4.

4. McGeoch R, Watkins S, Berry C, et al. The index of microcirculatory resistance measured acutely predicts the extent and severity of myocardial infarction in patients with ST-segment elevation myocardial infarction. J Am Coll Cardiol Intv 2010;3:715–22.

5. Payne AR, Berry C, Doolin O, et al. Microvascular resistance predicts myocardial salvage and infarct characteristics in ST-elevation myocardial infarction. J Am Heart Assoc 2012;1:e002246.

REPLY: Meta-Analysis of the Index of Microvascular Resistance in Acute STEMI Using Incomplete Data

We thank Berry and colleagues for their letter regarding our recent study (1), suggesting we used incomplete data, because we did not include studies reporting median index microvascular resistance (IMR). Although different methods are available to accommodate median values in a meta-analysis, they are on the basis of various assumptions, and each method would derive different mean values and SDs. We aimed to provide representative IMR values in a multicenter setting and therefore only included studies reporting mean values. The latest study (2) was not identified on PubMed or Embase at the time. Even if we were able to access the raw data from their group, their IMR values were non-normally distributed, and recalculating mean values and SDs for their cohorts would have been statistically flawed. Besides, the excluded studies also showed a significant difference in IMR values between those with and without microvascular obstruction (MVO) and/or intramyocardial hemorrhage (IMH), and the overall conclusion of our study would have been similar. To illustrate this, we have now used the formula interquartile range/1.35 (3) to derive the SDs of the 3 studies mentioned in their letter, and we have updated our analysis with the median values and derived SDs. The IMR in the MVO/IMH group ($n = 290$) was significantly higher than in the no MVO/IMH group ($n = 297$) (41 U [99% confidence interval (CI): 37 to 46 U] vs. 22 U [99% CI: 19 to 25 U]; $p < 0.001$). Heterogeneity among the studies increased from 0% to 28%. We have not provided the SDs for each group, because they are highly likely to be inaccurate.

We commend Berry and colleagues for their tremendous work in this field, and we would welcome any future collaborative work to advance the field. Large variability in IMR measurement still exists, and there is a need for standardizing IMR acquisition across centers. Even from a single-center experience, the sensitivity and specificity of IMR >27 U to detect MVO with IMH was only 66% and 67%, respectively, and an IMR <27 U (rather than >27 U as stated in their paper [2]) had a negative predictive value of 74%. As it stands, it appears that if a cardioprotective strategy is administered before or immediately after reperfusion, then 50% ST-segment resolution by electrocardiography at 60 min would perform as well as IMR to track a putative treatment effect (2), and cardiovascular magnetic resonance remains the gold standard. However, we agree with them that if the aim is to identify high-risk patients immediately post-primary percutaneous coronary intervention and target them with further adjuvant therapies aiming to restore microvascular perfusion, then IMR would be valuable.

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REFERENCES

1. Bulluck H, Foin N, Carbrera-Fuentes HA, et al. Index of microvascular resistance and microvascular obstruction in patients with acute myocardial infarction. J Am Coll Cardiol Intv 2016;9:2172–4.

2. Carrick D, Haig C, Carberry J, et al. Microvascular resistance of the culprit coronary artery in acute ST-elevation myocardial infarction. JCI Insight 2016;1:e85768.

3. Higgins JP, Altman DG, Gotzsche PC, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. BMJ 2011;343:d5928.