however, it might be related to vascular injuries that were more frequent in patients with failed PCI, such as coronary perforation (7.4% vs. 1.7%, $p < 0.01$) and residual dissection (9.4% vs. 4.3%, $p < 0.01$), thereby exaggerating the relative benefits of a successful opening of the occluded artery. Consistent with that, our group previously reported analysis of a cohort of patients with failed but uncomplicated CTO PCI procedures, showing similar rates of death and myocardial infarction at a mean follow-up of 2 years (2). It would be appropriate to repeat the analysis of the authors and compare the successful PCI group with the noncomplicated failed group and examine whether their conclusion still holds.

Finally, with regard to the use of drug-eluting stents (DES) versus bare-metal stents (BMS), the authors reported that treatment with DES in comparison with BMS resulted in similar definite/probable stent thrombosis rates (1.7% vs. 2.3%, $p = 0.58$); however, only 4.2% of patients in the DES group versus 42% of the patients in the BMS group reached 5-year follow-up. This major difference in follow-up time could lead to a bias as well.

We agree that performing a randomized clinical trial comparing PCI for CTO and conservative therapy with medications only, such as in the upcoming DECISION-CTO (Drug-Eluting Stent Implantation vs. Optimal Medical Treatment in Patients with Chronic Total Occlusion) trial, might reveal whether treating these complex lesions has an effect on clinical result.

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Reply

We thank Dr. Movahed and Dr. Badr and colleagues for their expressed interest in our study. Dr. Movahed refers to the potential implications of the relatively high perforation rate observed in our study (1). In our study, the definition we employed for coronary perforation included any one of the 3 types proposed by Ellis et al. (2). However, the specific type of perforation was not recorded. A recent Bayesian meta-analysis by Shimony et al. (3) showed that morbidity and mortality after coronary perforation vary directly with the Ellis classification. Mortality was 0.3%, 0.4%, and 21.2% after type I, II, and III perforations, respectively, clearly indicating that not every type of perforation is associated with catastrophic outcomes.

In our study, 30-day mortality in patients with a coronary perforation was 0%, and 1-year mortality was 5.2%. Therefore, it is highly unlikely that a significant number of type III perforations occurred. Finally, the performance of coronary artery bypass surgery was not within an urgent time frame, but within months of the failed percutaneous coronary intervention (PCI) procedure, therefore reflecting the decision to proceed with complete revascularization at a later point. Because of the low mortality rate after coronary perforation, we do not agree with the suggestion that chronic total occlusion (CTO) PCI overall is associated with a poor outcome.

Nonetheless, we do acknowledge the fact that despite favorable outcomes, the rate of this complication was high. Operators performing CTO intervention should make every effort to minimize this potentially hazardous complication and should inform the patient of the risk of a coronary perforation during the informed consent process. Moreover, future randomized clinical trials investigating the potential benefit of CTO PCI should carefully record the incidence, types, and outcomes of coronary artery perforation.

Regarding the comments by Dr. Badr and colleagues, we agree that our study is limited by its observational nature and by the fact that the control group does not include patients assigned to medical therapy. Nonetheless, as our control group consisted of patients with CTO lesions that were deemed suitable for PCI, the applicability of the study results extends beyond the mere intuitive fact that when a procedure fails, it is bad for the patient. In the absence of randomized controlled trials investigating the effect of PCI of CTOs compared with medical therapy, we cannot exclude that part of the observed worse outcome in the failed PCI group in our study may be attributed to harmful effects of a failed procedure. The other part may be attributed to a beneficial effect of a successful procedure.

Finally, we agree wholeheartedly that the results of well-designed randomized controlled trials investigating a potential benefit of CTO PCI, such as EXPLORE (Evaluating Xience V and Left Ventricular Function in Percutaneous Coronary Intervention on Occlusions after ST-Elevation Myocardial Infarction) (4), DECISION-CTO (Drug-Eluting Stent Implantation vs. Optimal Medical Treatment in Patients with Chronic Total Occlusion), and the EURO-CTO (European Study on the Utilization of Revascularization vs. Optimal Medical Therapy for the Treatment of Chronic Total Coronary Occlusions) are eagerly awaited. Long-term follow-up of these studies will also provide further insight into the safety and efficacy of (newer-generation) drug-eluting stents in CTO lesions.

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