up to the tricuspid annulus would always include the main right coronary artery. The authors conclude that both ablations are unfeasible with bipolar radiofrequency in clinical practice. The only viable options are to cut and sew up to the annulus, which is impractical, or to use an additional unipolar device to complete the last 2 cm on each annulus, which is more expensive and probably less effective.

Our experience led us to a totally different point of view. In regard to left ablation, we share the authors' concern on the risks of ablating a major coronary branch close to the posterior mitral annulus,² but rather than impeding left ablation, coronary anatomy should guide the ablation strategy. In patients with right dominance or a codominant system, the coronary-free spot of the AV groove must be actively identified and marked before ablation.³ In the minority of patients with a left dominant coronary artery, the terminal portion does frequently leave the AV groove obliquely, before the crux cordis,² thus potentially leaving once again a safe spot for clamping. In the rare occasions that this safe spot is absent, we would complete the last couple of centimeters with a unipolar probe, reaching the annulus at or around the posteromedial mitral commissure,^{2,4} aware there is no safe energy source to ablate across a major coronary vessel.

In regard to mitral clamping, the authors' findings contrast with prior experimental evidence⁵ and our clinical experience.^{3,4} Complete left ablation with bipolar radiofrequency entailing clamping across the mitral annulus (ie, biting at least 2 mm of the posterior mitral leaflet) has been our technique of choice ever since 2006³ in now more than 200 patients. One possible explanation of such discrepancy is that, in the clinical setting, clamping across the mitral annulus is invariably performed under cardioplegia, on the flaccid heart, in diastolic arrest. The model used by Castella and colleagues¹ is different: The 9 "fresh" hearts were used for the study up to 36 hours after explantation or demise.¹ It is noteworthy

that rigor mortis, which affects myocytes earlier than skeletal muscle, leads to an irreversible contraction of the myocardial fibers that is almost complete only 2 hours after death (or explantation).⁶ Such contraction is functionally similar to that occurring during systole. Understandably, clamping close to the base of the contracted left ventricle may well turn out to be impractical. But, although Castella and colleagues' model may reveal the possible shortcomings of the technique on the contracting heart, we think it is poorly representative of the clinical context of everyday open ablation.

On the right side, because, almost invariably, blind clamping across the AV groove would also include the right coronary artery, ablation up to the tricuspid annulus should take a different route, but again, this is definitely feasible. As in Wolf-Parkinson-White surgery, after entering the epicardium adjacent to the right atrial wall, the deepest portion of the AV groove is developed by blunt dissection, thus preparing the way for the external jaw of the clamp down to the plane of the tricuspid annulus.⁴ In our preliminary experience this ablation proved routinely feasible, irrespective of the specific coronary anatomy.⁴

Despite Castella and colleagues' report,¹ we are convinced that clamping across the AV valves is still a viable way to perform a complete biatrial set of lines using bipolar radiofrequency alone, thus combining efficacy, swiftness, and cost-effectiveness.

Stefano Benussi, MD, PhD
Division of Cardiac Surgery
S Raffaele University Hospital
Milan, Italy

Domenico Corradi, MD
Pathology Section
Department of Pathology and
Laboratory Medicine
University of Parma
Parma, Italy

Ottavio Alfieri, MD
Division of Cardiac Surgery
S Raffaele University Hospital
Milan, Italy

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Reply to the Editor:

We appreciate Benussi and colleagues' comments on our study and recognize their expertise in the field of atrial fibrillation surgery. In their letter, our findings are stated precisely one by one.¹

On the right side, both atrial and ventricular walls are thin enough to be included within the jaws of a bipolar clamp, so the main issue is to avoid the right coronary artery. We agree with Benussi and colleagues' comments, in which they refer to the technique of dissecting the right coronary artery to introduce the epicardial jaw of the clamp underneath the coronary to reach the tricuspid annulus. This is the only way to perform an ablation not using a monopolar device or the cut-and-sew technique.

In regard to the ablation toward the mitral annulus, there are 2 issues: the danger of ablating coronary tissue and the impossibility of reaching the last millimeters of the annulus. We agree with and follow the concept introduced by Benussi and colleagues² of guiding

the jaws of the bipolar clamp toward the coronary-free spot of the mitral annulus. This can be found toward P2 in right coronary dominance, toward P3 in codominance, and near the crux cordis in left coronary dominance. These facts are clearly shown in mitral annulus dissections, where the right coronary or circumflex artery circulates on the atrial side within the fat of the atrioventricular groove. Our study emphasizes Benussi and colleagues' concept of tailoring the ablation pattern to the coronary anatomy, but we profoundly disagree that the actual technology used in bipolar radiofrequency can reach the posterior mitral annulus. We have tested this with the 2 most referred bipolar clamps in the literature, Cardioblade (Medtronic, Minneapolis, MN) and AtriCure (AtriCure, Inc, Cincinnati, OH), in 8 explanted human hearts. Neither system reached the mitral annulus in any heart. Rigor mortis or contracture was not present in any heart at the time of testing because these hearts were studied soon after explantation and preservation had been at 4°C. I personally performed the studies in all of the 8 explanted hearts, and there was no rigor or rigidity that limited our clamp positioning. The hearts felt like they were cardioplegically arrested. Our findings are corroborated with the postoperative necropsy of a heart in which a bipolar radiofrequency ablation was performed under cardioplegic arrest. Macroscopic and microscopic studies confirmed that the ablation line did not reach the mitral annulus.

The difficulty of reaching the mitral annulus at the level of the posterior leaflet with a clamp can be described by 3 anatomic facts. First, there is an important discrepancy in muscle thickness between the atrial and the ventricular walls. Second, the muscle of the atrial wall is followed by the posterior mitral leaflet in the endocardial side of the thick ventricular wall. Third, at the epicardial level, fat covers the difference in thickness between both walls at the atrioventricular groove, mainly covering the atrial wall and hosting the coronary ar-

tery and sinus. Clamping the atrial tissue including the annulus would entail clamping the first millimeters of the ventricular wall, the last one being 9 to 11 mm thick and impossible to clamp with actual bipolar technology. This is why even in small left atria, and regardless of the length of the radiofrequency clamp, it is impossible to reach the mitral annulus at the posterior leaflet.

The results obtained by Benussi and colleagues³ using only bipolar radiofrequency technology are encouraging, but we doubt all patients in their report have the mitral line complete. Therefore, it is possible that this line is not as important as previously thought or that leaving a 4- to 8-mm gap in the line does not influence the results.

Manuel Castellá, MD, PhD
Cardiovascular Surgery
Hospital Clinic
University of Barcelona
Barcelona, Spain

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CHANGES IN NONINFARCTED MYOCARDIUM EXPLAIN BENEFITS OF ON-PUMP BEATING-HEART CORONARY ARTERY BYPASS GRAFTING FOR ACUTE MYOCARDIAL INFARCTION

To the Editor:

We read with great interest the article by Miyahara and associates¹ comparing outcomes in patients undergoing emergency coronary artery bypass grafting (CABG) for acute myocardial infarction (MI), using on-pump beating-heart

(OPBH) surgery, with outcomes of conventional CABG using aortic cross-clamping and cardioplegia. This study is one of four published over the past 3 years reporting improved outcomes with this new technique.

These studies claim the avoidance of reperfusion injury after crossclamping of the aorta as the reason for the benefits seen. However, we believe an important concept has been overlooked here, namely, the effects of global ischemia on the noninfarcted myocardium. There is extensive evidence, especially from the work of Gudbjarnason and associates,² that the "normal," noninfarcted myocardium, remote from the infarct, undergoes profound physiologic and biochemical changes as a result of the infarct. The noninfarcted myocardium is far from normal owing to depletion of adenosine triphosphate and creatine phosphate, increased oxygen consumption, and a reduction in glycogen levels^{2,3} (Figure 1). These changes indicate a state of stimulated metabolism in response to the increased workload performed by the noninfarcted myocardium to compensate for the nonfunctioning, akinetic infarct. As a result, hypertrophy occurs in the noninfarcted portion in an attempt to maintain normal cardiac function.⁴ These metabolic and structural changes render the noninfarcted myocardium highly susceptible to the effects of ischemia, such as those induced by crossclamping the aorta.³

Many years ago, in our laboratory, we studied the effects of cardioplegic arrest on the recently infarcted heart in greyhound dogs.³ After cardioplegic arrest, we demonstrated a dramatic decrease in recovery of function in the recently infarcted hearts compared with recovery in noninfarcted hearts (18% recovery of prearrest function in infarcted hearts compared with 56% in noninfarcted hearts; $P < .001$). The implication from this work is that the avoidance of global ischemia is the major reason for the success of OPBH surgery after MI.

We have developed a novel technique of myocardial preconditioning