Konczalla and colleagues report on 20 patients undergoing clipping of complex, unruptured intracranial aneurysms (UIAs). The study utilized the technique of rapid ventricular pacing (RVP) to reduce the mean arterial pressure (MAP) to facilitate aneurysm preparation and clip application. Of the 20 patients studied, 16 underwent RVP at a mean rate of 173 bpm for an average of 60 seconds to achieve a reduction in MAP to 35–55 mm Hg. In 15 of these patients, RVP allowed for successful aneurysm clipping, and in 1 patient, RVP failed due to pacemaker electrode dislocation.

In the field of cardiac electrophysiology (study of cardiac arrhythmias) and percutaneous aortic valve replacement, ventricular pacing is common. Temporary pacing electrodes are inserted routinely in patients with bradyarrhythmias who require temporary pacing support. They are also inserted in almost every patient undergoing cardiac electrophysiology studies to diagnose and treat the cause of arrhythmias. Catheter-based electrodes are typically inserted through central venous access (femoral, subclavian, internal jugular) into the right ventricular apex with a very low risk of cardiac perforation or tamponade (much less than 1%). The ventricle can then be paced using an external pulse generator such as a temporary pacing box or an external stimulator. RVP up to 300 bpm is often used to induce ventricular arrhythmias in patients with structural heart disease or to test the functioning of implantable cardioverter defibrillators. When such arrhythmias are induced, they can either be terminated by overdrive pacing in the ventricle (pacing faster than the arrhythmia) or by external cardioversion/defibrillation. Mortality and morbidity associated with such procedures are very rare. Thus, the idea of using RVP for short durations during an invasive procedure is considered neither a foreign nor dangerous concept in cardiology.

RVP reduces the MAP by reducing diastolic ventricular filling time and also changing the activation sequence of ventricular contraction (from apex to base instead of the opposite), both of which contribute to a reduction in stroke volume. In fact, in cardiac electrophysiology, RVP is employed to optimize acquisition of 3D contrast images of cardiac chambers. Highly detailed 3D reconstructions of the left atrium, for example, can be obtained by injecting radiopaque contrast into the chamber during RVP to optimize chamber filling and minimize motion artifact. RVP with rates of 140–200 bpm are also used routinely during transcatheter aortic valve replacements to decrease stroke volume and mean aortic pressure during balloon valvuloplasty of the aortic valve and deployment of the valve. This is even used in patients with depressed ventricular function or nonrevascularized coronary disease, although the duration of RVP is minimized in these cases.

In the report by Konczalla and colleagues, the most common complication reported was dislocation of the pacing electrode (3/16 patients, 19%). Given that repositioning of the electrode is a simple thing to do, requiring only a few seconds, it is unfortunate that 2 patients had their procedures changed due to “failure” of the RVP technique when a simple electrode repositioning would have corrected the issue. The authors fortunately changed their protocol to allow intraprocedural electrode repositioning, and as they reported themselves, this took less than 20 seconds.

This is not to say that RVP does not carry any significant risk, and induction of arrhythmias is always a concern. Two (12.5%) of 16 patients suffered induction of arrhythmias (1 ventricular fibrillation and 1 atrial fibrillation) in this study. Whereas atrial fibrillation is relatively benign, ventricular fibrillation is a significant complication, especially because all patients had no significant structural heart disease according to preoperative cardiac screening. In this case, RVP was continued for 2 minutes, which was
Editorial

We sincerely appreciate the thoughtful editorial by Verma and colleagues regarding our paper on the application of RVP during surgery on complex UIAs.

The first half of their editorial correctly summarizes the basic principles of RVP during cardiac electrophysiology and invasive cardiology procedures, e.g., transaortic valve implantation or balloon aortic valvuloplasty as a routine method in modern cardiology. They also stress the safety of RVP during these procedures. However, data in “cardiac healthy” patients such as in our study are scarce. Within this context it may be of interest to the readers of the Journal of Neurosurgery that RVP was first used by British neurosurgeons during surgery for complex ruptured aneurysms. The first report on RVP, at that time named “elective circulatory arrest by artificial pacemaker,” was published in 1966 by Small et al. in The Lancet. This was followed by 4 subsequent publications between 1967 and 1971 in which 75 patients were reported on for the treatment of cerebrovascular disorders (aneurysms and arteriovenous malformations), with an excellent effect of RVP on induced hypotension. During this period RVP was very often accompanied by hypothermia. However, due to long pacing periods of up to 8 minutes of RVP, the complication rate with ventricular fibrillation and the frequent necessity of open or closed chest reanimation was high. Maybe because of this complication or due to the accompanying hypothermia, this fascinating technique was, at least according to the literature, no longer used during vascular neurosurgical procedures and was forgotten.

Amazingly, the technique of RVP was then resurrected about 25 years later by our cardiological colleagues for the facilitation of stent graft repair, and from that time onward it made its way into the daily practice of invasive cardiology, as noted above. In neurosurgery it took 40 years after its first use in cardiology before it made its way into the daily practice of neurosurgery. 1

The authors report no conflict of interest.

Response

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Amazingly, the technique of RVP was then resurrected about 25 years later by our cardiological colleagues for the facilitation of stent graft repair, and from that time onward it made its way into the daily practice of invasive cardiology, as noted above. In neurosurgery it took 40 years (from 1971 to 2012) until the use of RVP was reported again, in a series of 12 patients reported by Saldien et al. from Antwerp, Belgium. Based on this report, we decided to embark on our study (described in the accompanying