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Deliberate Hypotension for Hip Arthroplasty: Still More Questions Than Answers

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For more than four decades, investigators have debated the potential advantages and disadvantages of deliberate hypotension during anesthesia for total hip arthroplasty.(1) Available data from randomized clinical trials suggest that deliberate hypotension may reduce intraoperative blood loss,(2) though past studies conflict regarding the impact of such techniques on the need for postoperative transfusion.(2,3) Moreover, since most available trials pre-date modern transfusion approaches,(4) little definitive evidence exists regarding the potential benefits of deliberate intraoperative hypotension for patients undergoing hip arthroplasty in current practice.

One key gap in knowledge related to the safety of hypotensive anesthesia for hip arthroplasty concerns the potential for such techniques to produce adverse neurological consequences such as stroke. To date, available trials(2,3) have not observed large differences in the rate of such outcomes among patients undergoing hypotensive anesthesia

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versus other regimens for hip arthroplasty. Yet these studies have varied markedly in their approaches to assessing such outcomes and have been under-powered to detect differences in the rate of rare events such as postoperative stroke, which may occur in approximately 2 of every 1,000 hip arthroplasty patients.(5) In this context, Bombardieri and colleagues (6) present new work in this issue of *Anesthesia & Analgesia* related to the potential effects of hypotensive anesthetic techniques on cerebral perfusion; and while the data that they present do not offer definitive evidence regarding the risks or benefits of hypotensive techniques for hip arthroplasty, they offer insights that may help to guide practitioners' decisions regarding the use or avoidance of such techniques, and to inform future investigations in this area.

Bombardieri and colleagues studied 52 patients without known prior cerebrovascular disease undergoing hypotensive epidural anesthesia, a technique initially described by Sharrock and Salvati (7) that employs extensive epidural blockade and continuous epinephrine infusion guided by invasive hemodynamic monitoring. Bombardieri et al. used transcranial Doppler ultrasound to measure changes in cerebral blood flow velocity that accompanied the intraoperative reductions of blood pressure to an average mean arterial blood pressure value of approximately 50 mmHg, compared to an average baseline value (measured after the initiation of sedation but prior to epidural blockade) of 84 mmHg. While the authors found only small changes in the average change in cerebral blood flow velocity of the patients in their sample, the extent of change varied markedly from patient to patient. For example, at the first measurement taken under hypotensive anesthesia, the change in mean cerebral blood flow velocity ranged from a relative decrease of 44% from baseline to a relative increase of 87%, with no clear correlation observed between mean arterial blood pressure and mean cerebral blood flow velocity. Over the course of the hypotensive episode, nearly one-quarter of their sample experienced relative decreases in cerebral blood flow velocity of 20% or more.

On a basic level, the paper highlights the caution that needs to be exercised in drawing inferences for individual patients from population averages. An old joke is relevant here. Three statisticians go duck hunting. The first one shoots and misses a foot too high. The second one misses a foot too low. The third declares: "We got it!" In an analogous sense, Bombardieri et al.'s observation that cerebral blood flow velocity hardly changed at all on average is true in a statistical sense; yet it also obscures the paper's more ambiguous, and more useful, finding that changes in cerebral blood flow varied widely across their sample, with a substantial minority of patients experiencing potentially worrisome decreases.

Placing emphasis on the heterogeneity of the authors' findings can help to move us away from binary questions about whether hypotensive epidural anesthesia is "safe" or "unsafe" in some general sense, and instead encourage us to think quantitatively about the specific risks and benefits that this type of anesthesia might hold for an individual patient. Importantly, the observational, non-randomized design of the present study precludes causal inferences regarding the effect of hypotensive epidural anesthesia on cerebral blood flow. Yet these data highlight the need for further investigations to quantify the risk of meaningful reductions in cerebral blood flow with hypotensive anesthesia compared to other techniques and the relative importance of such reductions to neurological outcomes that may be

influenced by cerebral blood flow and other factors such as baseline comorbidities and cerebral metabolic rate.

While it is encouraging that the authors note that no patients in the present cohort experienced an adverse neurological event, postoperative cognitive or neurological outcomes were not formally assessed; moreover, given the low incidence of postoperative stroke, the relatively small samples of this and prior studies(8) preclude quantification of the risks of this technique for neurological end-outcomes. Moreover, the present work does not speak to how the risks of this approach might vary when applied outside of the single center in which this study occurred. All of the patients in the present cohort experienced short operative times and received care from anesthesia providers who had substantial experience with this technique. Neither the present work nor the past literature that the authors cite(3,7,8) speak to what risks and benefits this technique might carry if applied in a different context with longer surgical times or less experienced providers.

In the end, providers and researchers should think carefully about what potential benefits might be gained, in terms of concrete patient outcomes, in deciding where to go next with techniques such as hypotensive epidural anesthesia. While the present study raises concern for potential adverse effects that need to be taken seriously, adequately powered randomized trials are still needed to better define the extent and magnitude of these risks. Absent these, the present work may serve as a note of caution to practitioners and patients who are considering such techniques, and as a call to advocates of hypotensive anesthesia to work to more clearly quantify the potential risks and benefits of these techniques for patient outcomes.

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