# HIGHLIGHTS

## Rapid Estimation of Left Ventricular Contractility from End-Systolic Relations by Echocardiographic Automated Border Detection and Femoral Arterial Pressure

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SOME two decades ago, Suga and Sagawa proposed the end-systolic elastance as a new, relatively load-independent measure of myocardial contractility derived from a series of ventricular pressure-volume loops obtained under varying myocardial preload. Their work has provided an important conceptual framework for understanding global ventricular function and an experimental paradigm for studying alterations in contractility due to physiologic and pharmacologic manipulations. Unfortunately, application of their method has been largely confined to the animal and human cardiac catheterization laboratories because of its requirement for having instantaneous measures of intraventricular volume and pressure available.

Recently, Gorscan *et al.* (page 553) have undertaken an ambitious series of studies in an effort to make the method of Suga and Sagawa more readily available for intraoperative investigations. First, they (and others) demonstrated the capability of a new echocardiographic border detection system to estimate changes in left ventricular volume in real-time. Next, they developed specialized computer software to acquire the instantaneous ventricular area signal (from an appropriately equipped echocardiograph machine) and combine it with the signal from an intraventricular pressure catheter to form pressure-area loops (as surrogates for pressure-volume loops). They then demonstrated the utility of pressure-area loops derived from transesophageal echocardiograms to assess intraoperative changes in left-ventricular performance following cardiopulmonary bypass.

In the current article, Gorscan *et al.* describe the next logical step in their work, constructing their loops using femoral arterial pressure as a surrogate for the more invasive and technically difficult left-ventricular pressure measurement. Because the femoral artery pressure wave is delayed and distorted as compared with the ventricular pressure, they devised procedures (at first manual, and then semi-automatic) to correct for the time delay, and they tested how the resulting elastance estimates compared with those made using ventricular pressure. In the small number of patients reported, it appears that this technological tour de force has successfully produced a means to estimate changes in global function of the left ventricle without having to pass catheters into it.

Investigators wishing to confirm and utilize this work will first have to make a considerable investment in computer hardware and then replicate Gorscan *et al.*'s software (which is not commercially available). A remaining constraint is the requirement for occluding inferior vena caval flow transiently, which limits the method to cardiac surgery (where a tape can be placed easily around the vena cava) or other situations when passage of a balloon catheter into the vena cava is justified. Nevertheless, the method of Suga and Sagawa finally may find practical application in the operating room, thanks to the efforts of Gorscan and his colleagues.

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## Hemodynamic and Analgesic Profile after Intrathecal Clonidine in Humans

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DESPITE multiple publications and continued interest in clinical use of intraspinal clonidine, this study by Filos *et al.* (page 591) is the first randomized, blinded, dose-response study of intrathecal clonidine for post-

operative analgesia. In this study, intrathecal clonidine, 150–450 μg as a single bolus after cesarean section, provided rapid onset and complete analgesia that lasted more than 15 h after the largest dose and was accompanied by minimal sedation and decreased blood pressure. These data carry important implications for the clinical use of clonidine for analgesia and can be explained by clonidine's physicochemical properties.

Clonidine has been administered transdermally, orally, intravenously, epidurally, and intrathecally for analgesia. By routes other than intraspinal administration, clonidine has been shown to be minimally effective or ineffective in the treatment of severe postoperative pain. In contrast, epidural clonidine is effective, but the dose required is large (>600 μg), and the duration of action is brief (<6 h) (Eisenach JC, Lysak SZ, Viscomi CM: Epidural clonidine analgesia following surgery: Phase I. ANESTHESIOLOGY 71:640–646, 1989). Although such large doses are associated with minimal hemodynamic effects, sedation is marked, and further studies have attempted to reduce epidural clonidine dose and sedation by combination with local anesthetics and opioids. These other drugs, of course, can produce their own side effects, and the reduced dose of clonidine, though lessening sedation, may exacerbate hypotension.

Filos *et al.* now demonstrate that intrathecal administration of clonidine avoids many of the difficulties after epidural administration—the dose is low, sedation is not severe, and sustained analgesia from a single injection is possible. These findings are reminiscent of recent clinical experience with the opioid sufentanil for labor analgesia (Camann WR, Denney RA, Holby EO, Datta S: A comparison of intrathecal, epidural, and intravenous sufentanil for labor analgesia. ANESTHESIOLOGY 77:884–887, 1992). In that study, a small dose of sufentanil (10 μg) caused mediocre analgesia after intravenous or epidural injection, but rapid onset and prolonged analgesia after intrathecal injection. The results from Filos *et al.* suggest that, like sufentanil, the analgesic benefits of the lipophilic $\alpha_2$-adrenergic agonist clonidine can be realized most effectively after intrathecal injection.

Like many good studies, this report raises as many questions as it answers. Hypotension, which may be more prominent after intrathecal than epidural injection, was not a significant problem in these healthy women after cesarean section, but the hemodynamic effects of intrathecal clonidine in high-risk patients undergoing major surgery have not been examined. Prolonged analgesia from a single injection suggests that preoperative rather than postoperative intrathecal clonidine injection may provide "preemptive" analgesia, lessen anesthetic requirements, and provide postoperative analgesia. Alternatively, addition of intrathecal clonidine to opioids, local anesthetics, or both may provide profound and sustained analgesia with few side effects. We now have the dose-response data to design such studies and address these questions.

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