between the normal and injured animals may increase at deeper levels of anesthesia. In other words, MAC and EC_{50} probably represent very different end-points. We are not surprised with the results of Shapira *et al.* because cryogenic injury produced in a fashion similar to the present report did not alter MAC for halothane in rats.† We have repeated our experiments with pentobarbital and confirmed the 30% decrease in EC_{50}. The pharmacodynamics of fentanyl also appear to be altered in this model.‡

We agree wholeheartedly that clear definition of model and type of injury are of great importance in the evaluation of these experimental results.

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† Todd MM: Unpublished data.
‡ Unpublished data.

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77:211–212, 1992

I. Factors Affecting Distribution of Catheter-injected Local Anesthetic

To the Editor:—In a recent article, Rigler and Drasner[1] reported that when intrathecal microbore catheters are injected at "clinically relevant rates," the 28-G catheter produces the greatest maldistribution of drug. They believe this is a function of the flow rate. However, we do not see how the data in the article support this conclusion.

Rigler and Drasner[1] determined the clinically relevant injection rates for 20-G (macrobore) and 28-G (microbore) catheters. They found that "normal injection rates" (NIR) with macrobore catheters (NIR = 12 s/ml) are faster than with microbore catheters (NIR = 53 s/ml). This difference in injection rate relates to the difference in the radius of the two catheters (flow rate is proportional to radius[4]).

After determining NIRs, Rigler and Drasner[1] performed experiments with injection rates other than the NIR. Using Rigler and Drasner's data (their table 1), we interpolated the peak lidocaine concentration that can be expected with NIR (fig. 1). This figure shows the predicted maximum lidocaine concentrations with NIR for catheters in the lateral and central position. Figure 1 also shows: 1) the 28-G catheter produces a *lower peak* concentration than the 20-G multiport catheter, and 2) the 28 gauge catheter causes a peak concentration *similar* to the 20-G endport catheter.

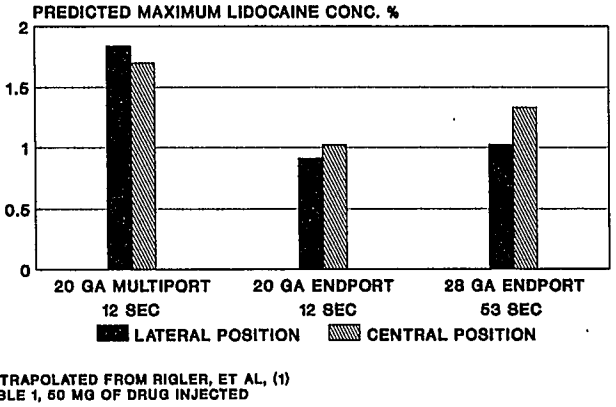

FIG. 1. Predicted maximum sacral lidocaine concentration (%) at "normal" injection rates for 20-G multiport, 20-G endport, and 28-G endport catheters. Data was extrapolated from Rigler *et al.*,[1], table 1, 50 mg 5% lidocaine with 7.5% glucose injected.

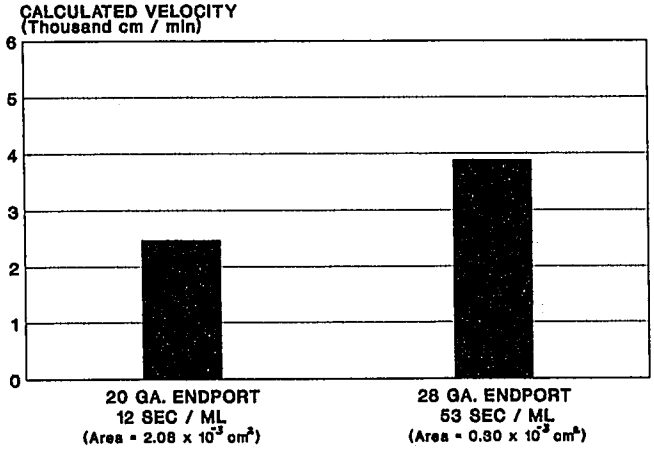

FIG. 2. Calculated velocity at "normal" injection rates for 20-G endport and 28-G endport catheters.

Figure 5 of the article by Rigler and Drasner shows the distribution profile of different catheters at various injection rates. *At NIRs,* the histograms illustrate that, while the multiport macrobore catheter distributes drug rostrally, the distribution with the 20-G endport and the 28-G catheter are *similar.* Neither catheter causes any appreciable amount of drug to flow rostrally. Furthermore, increasing the injection rate with the 28-G endport catheter to 30 s decreases lidocaine concentration levels.

Therefore, we do not agree with Rigler and Drasner's[1] conclusions 1) that microbore catheters produce the greatest maldistribution and 2) that distribution is primarily a function of flow rate. Rigler and Drasner[1] underestimate the importance of the microbore catheter's

velocity profile. Velocity is equal to the flow/cross sectional area. For a given flow rate, the velocity of a drug solution injected through a 28-G catheter is seven times greater than that of a 20-G catheter. Figure 2 compares the velocities for the 20-G and the 28-G catheter at NIR. Because the 28-G catheter produces a higher velocity (and more turbulence) with a slower injection rate, the two catheters have similar distribution profiles (see Figure 1).

Based on our analysis of Rigler and Drasner's data,[1] we conclude that 1) hyperbaric local anesthetic solution injected through a sacrally directed microbore catheter with NIR *does not* maldistribute any more or less than through an endport macrobore catheter; 2) the velocity with which the fluid leaves the catheter tip is equally and perhaps more important than flow rate in enhancing distribution; and 3) because of this effect of velocity, we recommend a typical injection rate of 1 ml in 30 s when using microbore catheters for continuous spinal anesthesia.

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II. Factors Affecting Distribution of Catheter-injected Local Anesthetic

To the Editor:—I have several comments to make regarding the article by Rigler and Drasner,[1] which examined the distribution of local anesthetics when injected using a catheter in a subarachnoid space model.

This case study was published in the Laboratory Investigation section and could lead the reader to believe that the conclusions are based on sound scientific methodology. In fact, most of the comparisons were based on single events only, and therefore this article suffers from a major scientific flaw. Conclusions were drawn from single injections at a given rate, through a given catheter type and a given position in the subarachnoid space model. Although the results presented are intellectually acceptable, they do not address the possibility that they could have occurred by chance.

I therefore urge the authors to repeat the study with a large enough n (certainly not an n = 1) so that we, as critical readers, may be satisfied that the conclusions are derived from information that is statistically significant. In the event that ANESTHESIOLOGY's intention was to publish it as a case study, then it should have been identified as such.

At our institution, we have recently also studied the spread of isobaric and hyperbaric solutions in a subarachnoid space model using a 25-G needle, a multiport 20-G catheter, and a 20-G distal port catheter under various conditions. Each specific condition was reproduced five times, and measurements were performed every minute for 5 min. The data were then analyzed for their statistical significance using a paired Student's *t* test. With a centrally located injection, using a 25-G needle or a multiport catheter, both hyperbaric and isobaric solutions distributed symetrically.[2] However, using the distal port catheter the spread was *directional* (*i.e.*, greater along the orientation of the catheter) with both types of solutions. We did not find that the baricity affected the asymmetry in spread, which remained constant ($P < 0.001$). As one would expect, the overall spread was twice as great with the hyperbaric as compared with isobaric solution ($P < 0.001$).

We also found in our study that spread had not stabilized by 3 min after injection. There was a 10–20% increase in spread depending on the mode of injection between 3 and 5 min. This may have introduced some error in the measurements in the paper by Rigler and Drasner, as the eight samples were drawn "beginning 3 min after each injection," and as it is unclear how long after injection the last sample was drawn. This again would warrant repetition of the measurements to determine the variance and the validity of the conclusions. Based on our results, we recommend the use of a multiport catheter with a cephalad orientation using a hyperbaric solution for a high-level (T_4–T_6) block or an isobaric solution for a intermediate level (T_{10}–T_{12}) block. The use of a cephalad-oriented distal port catheter should be avoided, as it may run the risk of a large incidence of high spinals, especially when using hyperbaric solutions.

In conclusion, while our recommendations may agree with those of Rigler and Drasner, we have statistically validated the results used to draw these conclusions, thereby providing confidence that the data reflect an outcome not biased by a chance observation.

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