increased to 28 cm H_2O, and the surgeon complained that the left lung could not be completely deflated. The position of the DLT was checked again *via* the tracheal lumen. When the fiberoptic bronchoscope was subsequently introduced through the bronchial lumen, it showed the tip occluded by the medial wall of the left main stem bronchus. No attempt was made to reposition the tube. The left lung could be ventilated once the operation had been completed, but unfortunately bronchoscopy was not done after ventilation of the left lung was recommenced.

These two cases illustrate what we feel is a design fault of the left Broncho-cath® DLT in that the endobronchial portion has been cut such that the lumen faces the medial wall of the left main stem bronchus (fig. 1*A*). We have recently had three other cases similar to case 1 above, and the feature common to all four cases has been the left lateral position of each patient. We postulate that in this position the weight of the right lung and mediastinum exacerbates the problem by pressing the medial wall of the left main stem bronchus against the endobronchial lumen. However, case 2 above demonstrated a similar occlusion when the patient was in the right lateral position.

We would like to suggest to the manufacturer that in the future, tubes should be altered so that the endobronchial lumen faces laterally, as in the Robertshaw tube (fig. 1*B*). This design will have additional advantages, in that fiberoptic visualization of the left upper lobe bronchus will be easier and the margin of safety for obstruction of the same bronchus will be increased slightly. The only disadvantage that we can think of is that insertion of a redesigned tube could be slightly more difficult, with the possibility of bronchial wall trauma from the leading edge of the endobronchial tube.

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(Accepted for publication June 4, 1990.)

Anesthesiology
73:576, 1990

In Reply:—In a 1983 clinical trial, Burton *et al.* reported a six-fold reduction in frequency of complications when the Mallinckrodt Broncho-Cath® tube was compared with the Robertshaw tube.[1] The tip design of the Robertshaw tube includes a 45° taper, which may account for a number of complications reported by Read *et al.* in 1983,[2] and by Heiser *et al.* in 1979.[3] Indeed, Robertshaw himself notes that "if the tube is pushed too far down, the left upper lobe may become obstructed." And further, that "such obstruction is possible owing to anatomical variations."[4]

The tip of the Mallinckrodt Broncho-Cath® tube has a flatter 63° taper to minimize the risks identified by earlier designs, and faces medially to facilitate bronchial intubation. Over 500,000 successful procedures have been completed with the Mallinckrodt Broncho-Cath® tube over the past 10 yr, and we have received no product complaint reports or related FDA Medical Device Reports during this period regarding occlusion of the tip by the wall of the left main stem bronchus.

Clinical evaluations of new Mallinckrodt designs have been in progress over the past 6 months to test a yet flatter 90° taper, which may be more appropriate for use with fiberoptic guided bronchial intubations. These evaluations contain some of the recommendations identified by Benumof in 1988[5] to increase the positioning margin of safety and to facilitate entry into the left main stem bronchus. Similar recommendations were raised also by Klippe *et al.* in 1989.[6]

Even these new designs have raised issues such as the potential of bronchial wall trauma caused by the leading edge of the tube. Much work is still required to prove the safety and efficacy of these modifications.

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(Accepted for publication June 4, 1990.)

Anesthesiology
73:576–577, 1990

Markers Other Than Epinephrine To Avoid Intravascular Injection of Local Anesthetic in the Obstetric Patient Require More Study

To the Editor:—The studies of Leighton *et al.* on the epinephrine test dose deserve careful appraisal.[1–3] Stating that "epinephrine injection lacked specificity"[1] and citing Cartwright *et al.*[4] for support is questionable.[5] Furthermore, when the 15-μg epinephrine test dose described for a surgical patient[6] is used in a parturient, the following alterations must be made. When a contraction and the maternal heart rate peak

and start to decrease, as monitored by the cardiotocograph and electrocardiograph respectively, the test dose is injected. At the same time, the parturient, the nurses, and the family (when present) are instructed not to converse. Under these conditions, if as is usual 30 s elapse prior to the next contraction, 15 μg epinephrine intravascularly results in the following: 1) the pulse rate shows a marked sustained increase; 2) without exception and particularly if asked, the parturient states that her heart is pounding or that her "heart feels like it is about to jump out of her chest," which she does not notice during a contraction; and 3) her blood pressure is elevated.

Also, theoretically, based on bench investigation, uterine blood flow in humans should be reduced by an iv injection of epinephrine.[7] While these data cause concern, its magnitude is similar to that observed with a normal human uterine contraction.[7] Nonetheless, although its clinical significance is unknown, the use of epinephrine in a test dose has become controversial.[7] As yet, I am not aware of a single case report of *human* fetal morbidity or mortality resulting from the intravascular injection of 15 μg epinephrine. Have I missed something? If so, citation by Leighton *et al.* of such data would be helpful.

Lastly, although the injection of isoproterenol, other drugs, or even air into the epidural or subarachnoid space in animals is a step forward in determining their safety,[1] it is only a rough guideline to the situation in humans.[8–11] Epinephrine is safe when injected into these spaces in humans.[1] Whether other markers are safe is the real issue.

In conclusion, until the *theoretical* problems of epinephrine as a test[1–3] dose are confirmed in the pregnant human and until injection of other substances into the epidural, subdural, or subarachnoid spaces are proven safe, it is hoped that anesthesiologists have not begun to use them rather than epinephrine as a test dose in their clinical practice.

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(Accepted for publication June 8, 1990.)

Anesthesiology
73:577–578, 1990

In Reply:—In his letter, Dr. Moore raises several important questions. First, he questions our finding that epinephrine injection lacks specificity because of the inherent maternal heart rate variability of laboring women. Three independent research groups have found that in actively laboring women, maternal heart rate variability exceeds 20 beats per min in 24–90% of patients and exceeds 30 beats per min in 12–45% of patients.[1–3]

Unfortunately, Dr. Moore never specifies either in his current letter or in his original article[4] how much a patient's heart rate must increase to indicate an intravenous injection of epinephrine 15 μg. In the past, Dr. Moore has stated that epinephrine 15 μg should increase the heart rate by at least 25 beats per min, and that this increase should last at least 15 s.* Yet when this criterion was applied in a prospective, randomized, double-blind manner, it correctly identified only 50% of the patients who received epinephrine 15 μg iv.[5] Furthermore, 20% of patients receiving intravenous saline had false-positive results. In this study we followed Dr. Moore's recommendations for performance of the injections.[5] All injections were performed when patients were calm and alert, 30 s after a uterine contraction. Nonetheless, neither heart rate changes nor subjective symptoms occurred reliably. In fact, one patient's heart rate decreased after intravenous epinephrine, and six patients receiving intravenous epinephrine reported no or minimal symptoms upon direct questioning.[5]

We agree that intravenous epinephrine may decrease uterine blood flow.[5] Although this effect may be similar in magnitude to that observed during a uterine contraction, the combined effect of a uterine contractions and intravenous epinephrine is unknown. In fact, new, ominous fetal heart rate changes occurred in two of ten patients receiving epinephrine 15 μg iv in our study. (One patient exhibited persistent late decelerations for 10 min, and the other exhibited 4 min of mild fetal bradycardia followed by 7 min of decreased fetal heart rate variability.)[5] In both cases, cesarean section was considered until the fetal heart rate changes resolved.

We agree with Dr. Moore that only those substances proven to be safe should be injected into the epidural space. Therefore, we cautioned the readers of our isoproterenol article that isoproterenol should not be injected into the epidural space until appropriate neurotoxicity

* Moore DC: Personal communication. October, 1986