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DISCUSSION

DR. FRANK G. MOODY (Salt Lake City, Utah): Dr. White and his colleagues in Seattle have done us a service by continuing to pursue their interest in radiomanometry. This is a technique that has been used for about 30 years in Europe, and apparently with good success. In America there has been sporadic application, and, actually, great reluctance to use it; and I guess that relates, possibly, to its lack of specificity and reproducibility.

For example, if both tests are consistent and positive, then you'll always find pathology in the duct. Therefore, that would mean to me that the cholangiography would be equally good, and I guess Dr. White would agree with that, because he stated that the manometry could be used in the place of cholangiography in this situation.

Now, if the manometry is positive and the cholangiography is negative for identifying pathology, then you have a 35% false-positive rate, which is extremely high for any type of diagnostic procedure that one can apply clinically.

We have taken this problem to the laboratory, and we have studied rhesus monkeys in a restraining chair, developing flow/pressure relationships, without any type of medication in these animals, and we've found that on any given day, indeed, we could get reproducible curves, but on other days we couldn't reproduce the same curves.

We became curious about this and decided to test it on the opossum so we could place electrodes into the sphincter and measure the spike potentials. The reason why we used the opossum is that their sphincter of Oddi is outside the duodenum. We chose to study the GI hormones, rather than the neural control of the sphincter, and we found very early that glucagon, cholecystokinin and, to our surprise, pentagastrin caused a marked increase in the spike potentials and a decrease in the rate at which materials could be perfused through the common bile duct in these critters.

I suspect that these hormones, possibly, are playing a role in Dr. White's patients. Now, I realize that they can't be quantitated or measured; but one might be able to overcome this by using some type of a dilatatory substance on the papilla, and I wonder if, indeed, you did use amyl nitrite in some of your studies.

In addition, did you also make measurements after you removed the stones, or cut the sphincter?

I hope that Dr. White and his colleagues will continue to try to apply this particular technology. In some way, it's helping them, because a 1% incidence of overlooked stones is really a tremendous accomplishment. I imagine it relates more, however, to their very

careful attention to detail in their cholangiography, and in their way that they actually carry out the explorations of the ducts, rather than to the value of this particular test.

DR. GEORGE D. ZUIDEMA (Baltimore, Maryland): I would like to comment on several points which Dr. White's manuscript has raised.

First of all, going back to the presentation which Dr. Eg Dahl made earlier, we would all agree that it's important to avoid unnecessary common duct explorations. It's been shown to double the mortality and to increase the hospital stay by five days, not to mention the additional discomfort which the patient experiences. Therefore, any test which would improve the accuracy of diagnosis should conceivably be of considerable help.

The basic idea, then, is to improve the accuracy of common duct exploration.

Now, let us take a quick look at the various groups which Dr. White showed us; I'd comment on two of them. First of all, in Group 4, with 25 patients in whom the x-ray examination was successful, there was only one unnecessary common duct exploration. In Group 1, however, with 121 patients, in which both the radiology and the manometry were satisfactory, there were 15 negative common duct explorations.

It seems to me that some of these may have occurred when they were gaining experience with the technique; but at any rate, the unnecessary operations were there.

The technique, it seems to me, has some advantages and some disadvantages. I think that in taking it up we would all probably experience the same kind of learning curve which Dr. White and his colleagues showed, with a relatively high incidence of technical failures early in the experience.

There is a major problem, however, which is hard to get around. If we were to rely on the manometry alone, we would have the problem of detecting intrahepatic stones. For this reason, I feel that it's unlikely that the cholangiography used alone as a screening test would be very helpful, because I think if we were to take one examination, we would probably get more information from a cholangiogram. There might conceivably be an advantage in the obese patient, where we're all familiar with the technical problems associated with cholangiography.

Now, this study is based on a simple hydraulic system, and therefore should lend itself to the construction of a model where one can vary the size of the stones within the model, the rigidity of

the duct wall, and so on. I'd like to ask Dr. White if he knows whether it has been studied in this way, so that the laws of hydraulics can be applied.

Finally, if the resting pressure alone would be of any value in a screening fashion, combined with cholangiography, I wonder whether he's had the experience using a readily available central venous pressure catheter, one which would be available in every operating room and could be used without investing in a lot of special equipment.

DR. JOHN WILLIAM BRAASCH (Boston, Massachusetts): Dr. White has the disadvantage in this study of starting with a low recurrent stone rate so any meaningful change in this level by his added technique is difficult to establish.

We have had no experience with manometric cholangiography and have preferred to use the choledochoscope as an adjuvant procedure for examination in large ducts. We feel that this has been helpful in finding the overlooked stone in the proximal system, where most of our recurrent stones have hidden.

We should all realize, of course, that with the advent of post-operative stone manipulation through the T-tube tract, the overlooked stone is no longer the great tragedy that it used to be. Our radiologists are getting quite good as this technique, even extracting stones from the tertiary radicles within the liver. Then, too there is the technique of fiberoptic papillotomy, which I am certain allows many overlooked stones to pass.

DR. THOMAS T. WHITE (Closing discussion): I certainly appreciate the discussion. As far as Dr. Moody's question about dilating substances, we have used amyl nitrite or glucagon to get rid of the abnormalities. Relative to measuring pressure after a common duct exploration, the pressure goes up every time you pass an instrument

through the sphincter so that, in most instances, pressure measurements at this point are meaningless unless we do a choledochoduodenostomy or a sphincteroplasty, when it should be normal.

As far as Dr. Zuidema's question about Group I versus Group IV, there is no question that many of the ten surgeons involved in the project did not believe the test in Group I patients at the beginning of the study. Thus, if they thought the bile duct needed to be explored, they went right ahead and did it. It is for this reason that there were 15 negative explorations out of 121. It is certainly true that intrahepatic stones would not be shown by this technique. Owen Daniel has done a series of flow and pressure studies using different sizes of openings at the end of the tubing in an experimental hydraulic system. This shows that an opening of 0.1 mm will allow a flow of 10 ml per minute at 30 cm of water. Professor Von Brücke from Linz, Austria, has done the same thing and drawn the same conclusion. As far as the Intracath or other tubing of this nature, the problem with flow studies using a 5-F children's feeding tube is that you will only get a flow of about 3 ml per minute through the system because of the internal friction. Tubing which is of the same diameter for the whole length has so much friction that it slows the flow even of saline. Flow is slowed even further if radiopaque medium is put into the tubing rather than saline. For this reason we use a small cannula at the end and a large IV tubing above which allows about 40 ml of saline to pass through the system per minute.

Relative to Dr. Braasch's question, I'd like to say that choledochoscopy should be followed by T-tube cholangiograms even if the visual examination appears to be normal, because of the possibility of residual stones out of the field of view. Second, we have had more overlooked stones in patients who had a bile duct 7 mm or less in diameter than with patients with big ducts. In these patients we cannot use a Berhene directable cannula to remove the stones and have to have a second operative procedure or an endoscopic papillotomy.