

group of asymptomatic patients who had profound EEG changes—one realizes that the high risk patients are very difficult to identify by angiographic or clinical criteria. Since there is neither cost savings nor medical justification for selective monitoring, its use cannot be supported.

Our series does not clearly establish the advantages of EEG monitoring. It is expensive, oversensitive, and may not detect ischemia in all areas of the brain. On the other hand, the use of shunts (which in our experience may be hazardous and are not always clearly indicated by angiographic or clinical criteria) can be decreased if the EEG data is used wisely. We therefore feel that, despite its shortcomings and costs, EEG monitoring is an accurate method for identifying patients under general anesthesia with cerebral cortical ischemia after carotid clamping. The decision, however, of whether to shunt the patient with electrical dysfunction after carotid clamping should be based not only on the EEG but also on the clinical presentation and the CT scan of the brain. Our data do not show any net benefit in selective shunting unless the patient has suffered a preoperative stroke. In other patients, the act of shunting introduces a risk of stroke due to technical error that at least equals the risk of stroke due to hemodynamic ischemia.

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DISCUSSION

DR. JESSE E. THOMPSON (Dallas, Texas): I enjoyed Dr. DeWeese's paper, with his usual very careful analysis of the problem. Certainly, EEG monitoring is one of the accepted methods of monitoring patients during carotid endarterectomy under general anesthesia, and his excellent results bear this out.

I have no quarrel with this approach, but we have taken the position of using a shunt routinely, and hence do not find it necessary to employ EEG monitoring. This has served us well over the years, and our incidence of neurologic deficits related to the operation has been less than two per cent.

Complications related to the shunt itself are, at least in our hands, virtually nil when one uses it all the time, and I really do not consider it hazardous.

(Slide) The advantages of the shunt are listed here. Actually, it is really quite cheap; our little shunt costs about 20¢. It is simple, quick, safe, and always available. It is effective. It allows for no-haste surgery and acts as a stent for closure. We have found it especially useful for complicated lesions and for patch angioplasty. We have not had the

problem with the white thrombi with the use of the shunt as Dr. DeWeese has described.

The disadvantages of the shunt are listed on the next slide. (Slide) (Laughter) As a result of this, we have continued to use the shunt routinely, and really find it quite advantageous.

DR. DAVID ROSENTHAL (Atlanta, Georgia): Dr. DeWeese and his associates are to be congratulated for this cost/benefit analysis, and for identifying a group of patients who should be considered at high risk during endarterectomy, the poststroke, or the postRIND (reversible ischemic neurologic deficit) patient.

(Slide) As Dr. DeWeese mentioned—and I agree—the safest method for performing endarterectomy is under EEG surveillance in the so-called neurologically "stable" patient. These are patients who have experienced a TIA, amaurosis fugax event, or vertebro-basilar insufficiency symptoms. These neurologically stable patients will generally tolerate cross-clamp well, and in a previous report by our group on some 900 patients we could find no statistical difference in the incidence of postoperative neurologic deficits when endarterectomy

was performed with a shunt, without a shunt, or under EEG surveillance. With EEG monitoring, however, shunt-related problems can be avoided, cerebral function is continually monitored, and the operation seems to be technically easier.

(Slide) The group of patients in whom the method of operation did make a difference were the neurologically "unstable" patients. Those were the poststroke, postRIND, or patients who experienced a stroke in evolution. In this group of patients, stump pressure and EEG monitoring proved to be unreliable indicators of cerebral perfusion, as five per cent of patients with stump pressures of greater than 35 and four per cent of patients without evidence of EEG ischemia developed recurrent neurologic deficits. When prophylactic shunting was employed, and uninterrupted perfusion thereby maintained to the region of cerebral injury, no deficits occurred.

I would like to ask Dr. DeWeese how they currently manage their patients who have experienced a stroke, RIND, or stroke in evolution, and require endarterectomy.

DR. MAURICE H. CHARLTON (Rochester, New York): I would like to report on my experience from the narrow angle of the neurologist present at these operations.

One area to which the EEG is extremely sensitive is hypotension during the surgery and after it, which is one of the causes of neurologic deficit. We have been of assistance in pointing this out to the anesthesiologist.

Second, I think if EEG is performed during these operations, it is important for the neurologist to be in the O.R. Certain fast decisions may need to be made, which is too great a burden for a technician. This is not universal at the two other institutions that I have most experience with. At MGH the EEG is transmitted to the EEG lab by spectral array. At Mayo Clinic, the technician is trained to be observant, and calls in the neurologist when he or she thinks it is desirable. I do not agree with either of those positions.

Another nonspecific advantage of the EEG may be that it gives, if unchanged, the surgeon confidence that he can take his time during surgery.

Third, I have learned that neurologic input is of value in these cases, to point out the clinical behavior, capsular infarctions, use of the CAT scan, the preoperative presence of cognitive deficits, and other more subtle neurologic risks of operation.

Fourth, I have learned over the years to be skeptical of hospital accountants, and it is possible to conceive of the costs of this procedure are both less and more than Dr. DeWeese indicated in different institutions. Every institution should do its own costing for a procedure like this.

Fifth, there are new technologies on the horizon, particularly one called brain electrical activity mapping. It is a CAT-like procedure producing a colored and dynamic topographic display of cerebral blood flow which may give us more insight into cerebral perfusion during these operations.

DR. RICHARD M. GREEN (Closing discussion): We would once again like to thank the Society for giving us the opportunity to present this data this morning, and also to thank Dr. Thompson. It is a great honor to have him discuss our paper. He probably is the most quoted person in the world with regard to carotid surgery, because it appears that everyone quotes his results as their own. I wish that were the case, Dr. Thompson.

We cannot reproduce your results with shunts. We have trouble with shunts and feel they add to the risk of operation except in the neurologically impaired patient.

We agree that the patients who do have a net benefit through the selective approach are those patients with a reversible neurologic deficit. Our approach to those patients is, if the stenosis is critical, to operate early if the deficit is resolving. If the deficit is not resolving, we do not operate earlier than 6 weeks.