

4. Culligan, J. A.: Buckling and Kinking of the Carotid Vessels in the Neck. *Minnesota Med.*, **43**:678, 1960.
5. Derrick, J. R.: Carotid Kinking and Cerebral Insufficiency. *Geriatrics*, **18**:272, 1963.
6. Derrick, J. R., Estess, M. and Williams, D.: Circulatory Dynamics in Kinking of the Carotid Artery. *Surgery*, **58**:381, 1965.
7. Derrick, J. R. and Smith, T.: Carotid Kinking as a Cause of Cerebral Insufficiency. *Circulation*, **25**:849, 1962.
8. Edington, G. H.: Tortuosity of Both Internal Carotid Arteries. *Br. Med. J.*, **2**:1526, 1901.
9. Fisher, A. G. T.: Sigmoid Tortuosity of the Internal Carotid Artery and Its Relation to the Tonsil and Pharynx. *Lancet*, **2**:128, 1915.
10. Freeman, T. R. and Lippitt, W. H.: Carotid Artery Syndrome Due to Kinking: Surgical Treatment in Forty-four Cases. *Am. Surg.*, **28**:745, 1962.
11. Gass, H. H.: Kinks and Coils of the Cervical Carotid Artery. *Surg. Forum*, **9**:721, 1959.
12. Henley, W. S., Cooley, D. A., Gordon, W. B. Jr. and DeBakey, M. E.: Tortuosity of the Internal Carotid Artery. Report of Seven Cases Treated Surgically. *Postgrad. Med.*, **31**:133, 1962.
13. Hohf, R. P.: The Clinical Evaluation and Surgery of Internal Carotid Insufficiency. *Surg. Clin. North Am.*, **47**:71, 1967.
14. Hsu, I. and Kisten, A. D.: Buckling of the Great Vessels. *AMA Arch. Int. Med.*, **98**:712, 1956.
15. Jackson, Joseph L.: Tortuosity of the Internal Carotid Artery and Its Relation to Tonsillectomy. *Can. Med. Assoc. J.*, **29**:475, 1933.
16. Kelly, A. B.: Tortuosity of the Internal Carotid Artery in Relation to the Pharynx. *J. Laryngol. Otol.*, **40**:15, 1925.
17. Lorimer, W. S. Jr.: Internal Carotid Artery Angioplasty. *Surg. Gynecol. Obstet.*, **113**:783, 1961.
18. McKenzie and Woolf, C. F.: Carotid Abnormalities and Aneurysm Surgery. *J. Laryngol. Otol.*, **73**:596, 1959.
19. Metz, H., Murray-Leslie, R. M., Bannister, R. G., Bull, J. W. and Marshall, J.: Kinking of the Internal Carotid Artery in Relation to Cerebrovascular Disease. *Lancet*, **1**:424, 1961.
20. Najafi, H., Javid, H., Dye, W. S., Hunter, J. A. and Julian, O. C.: Kinked Internal Carotid Artery. *Arch. Surg.*, **89**:134, 1964.
21. Parrott, J. C.: Internal Carotid Artery Insufficiency. *Am. J. Surg.*, **108**:777, 1964.
22. Quattlebaum, J. K. Jr., Upson, E. T. and Neville, R. L.: Stroke Associated with Elongation and Kinking of the Internal Carotid Artery. *Ann. Surg.*, **150**:824, 1959.
23. Riser, M., Gerard, J. and Ribaut, L.: Dolichocarotide interne avec syndrome vertigineux. *Rev. Neurol.*, **85**:145, 1951.
24. Roberts, B., Hardesty, W. H., Holling, H. E., Reivich, M. and Toole, J. F.: Studies on Extracranial Cerebral Blood Flow. *Surgery*, **56**:826, 1964.
25. Rundles, W. R. and Kimbell, F. D.: The Kinked Carotid Syndrome. *Angiologica*, **20**:177, 1969.
26. Skillern, P. G.: Anomalous Internal Carotid Artery and Its Significance in Operations on Tonsils. *JAMA*, **60**:172, 1913.
27. Smith, G. M.: Tortuosity of the Internal Carotid Artery. *Br. Med. J.*, **1**:1601, 1902.
28. Spencer, W. J.: Pseudostroke: Acute Cerebrovascular Insufficiency with Congenital Carotid Kinking. *JAMA*, **186**:76, 1963.
29. Weibel, J. and Fields, W. S.: Tortuosity, Coiling, and Kinking of the Internal Carotid Artery II. *Neurology*, **15**:462, 1965.

#### DISCUSSION

DR. ALTON OCHSNER, JR. (Metairie): I think this is such a significant paper that many surgeons in this audience will be looking now for these carotid elongations and kinks. I would like to point out, however, that our neurologist confreres, with rare exceptions, think they have no significance at all. Of course, I do not agree with them; I agree with Dr. Quattlebaum that they are significant.

In the last 4 years we have had 40 cases not associated with any significant stenosis in the carotid artery. A third of these are my own cases; the others are cases of two young men that I assisted, one of whom, Dr. Ricardo Del Real, is now practicing here in Boca Raton.

From this experience, I think, particularly because there may be those who will be interested in looking into this subject further in terms of diagnosis and treatment, I would like to make a few cogent remarks.

First, the only way this can be diagnosed is by angiography, and one does not look for murmurs, because there should not be any murmurs. Angiograms must be performed on people with symptoms of cerebrovascular insufficiency without murmurs.

[Slide] This is a continuous condition, I think, with beginning elongation and folding back upon itself, and eventually complete looping or kinking. It is in these early stages that the symptoms are most likely to be seen. This complete looping is seen as an incidental finding sometimes, and may lead the neurologists to believe that none of this is important. This is, of course, one of the few diseases that I know of in which in the late stages the symptoms are less.

[Slide] In taking angiograms, one must recognize that this condition is sometimes seen only in one plane, and it is usually the AP projection. This is a lateral projection of the carotid artery,

and if that is all you had, you would miss this condition. However, there is a kink, or an uncoiling which can lead to kinking, when the X-ray is taken in the AP position.

[Slide] This is just another example of the same thing. In the lateral position there is no evidence of kinking. In the AP position there is a kink.

[Slide] This is just one patient with X-rays in AP, with the head turned to one side and the head turned to the other side. The kinking is seen in the AP position when the head is turned to one side, but not when the head is turned to the other side. So taking the X-ray in two planes may be necessary to completely rule in or rule out this condition.

The amount of kinking or coiling can be lessened or greatedened by the position of the head, and sometimes if you want to take real effort, [slide] you can actually demonstrate the occlusion. This is an AP view of an uncoiled, potentially kinkable internal carotid artery, with the head extended.

[Slide] This is the same patient with the head flexed, and the blood flow is cut off there.

Regarding comments about treatment, we would have to take issue with the authors about the use of local anesthesia. We think that general anesthesia is important in the management of this condition, because if the kinking is to be completely overcome, the internal carotid artery must be dissected up to the base of the skull. Sometimes the kink will not be found except at the very base of the skull. In order to do this, you have to have retraction on the base of the skull, and I think it is too much of a hardship on both the patient and the surgeon to do it under local anesthesia.

Do not pull on the carotid! I think part of the etiology of this condition is the lack of elastic tissue, and I can assure you that traction on the carotid will put it apart. I have done this in two instances. We recovered from it, but I would not want anybody

else to have to go through what my coronaries went through at that point.

Sometimes the external carotid can be preserved. Sometimes it is elongated too, and the whole system can be foreshortened without sacrificing the external carotid.

We do not advocate resection of the carotid bifurcation, but of a partial segment of the common carotid. The internal carotid does not hold sutures well, and we prefer not to anastomose internal carotid to common carotid, but rather common carotid to common carotid.

When there is an associated stenosis, the common carotid should be cut very close to the bifurcation, and the vessel peeled back over the plaque like you peel a banana, to remove the stenosis. We think that when you sacrifice the external carotid artery, you should leave the stump open to be ligated as the final stage, because you can flush the internal and common carotid through this system.

DR. JULIAN K. QUATTLEBAUM, JR. (Closing): In defense of local anesthesia, we, like you, do dissect the vessel all the way up to the base of the brain, but maybe the Georgia crackers are tougher than those people down in New Orleans, even though Tulane did whip Georgia this year in football.

We do not have a big problem, giving morphine and atropine ahead of time. If they become restless on the table, a little intravenous Demerol or Valium will relax them.

We have done 96 resections under local anesthesia, and the only operative neurologic deficit that we have had under a local agent was in one who ultimately underwent transplantation. This patient developed a contralateral hemiparesis *before* the vessels were to be occluded; before we touched them.

We have had no deficit in the 96 resections that we have done under local agents. It does afford us the opportunity to repeat our compression test at the table by temporary occlusion of the vessel. We have had one person who was negative to compression in the office who became positive on the table, and we transplanted that vessel instead.

We use carotid compression as a prognostic method in all of our carotid surgery—for plaques as well—and we have found that if the test is positive, even in the presence of general anesthesia with hypothermia we have serious operative complications in about 10% of the cases. If the test is negative for 2 minutes, we generally proceed under a local agent to take advantage of the opportunity to test again before committing ourselves to resection.

We feel in most of our cases that it is necessary to resect the carotid bifurcation. Actually, what we do is divide the internal carotid just above the bifurcation and sacrifice the external, because so many of them have such elongation of the internal carotid that the anchoring of the bifurcation by the external prevents us from getting it down low enough to eliminate the kink.

Since the outset we have been convinced that the production of symptoms depends upon the fortuitous positioning of the head in such a way that the vessels are kinked, rather than merely elongated. While we have seen three patients with complete obstruction due to kinking and many with lesser degrees of overt kinking on arteriograms, we also look for elongation which might logically be expected to produce kinking, though such is not present at the time of the arteriogram, just as Dr. Ochsner said.

Roberts has demonstrated that the neutral position of the head is the one most favorable to full cerebral flow. In his group of cadavers in which this was studied, flow was never increased by turning the head away from the neutral position; and it is in this position, of course, that most angiograms are made. The following slides demonstrate the potential effect of differing head position in the presence of carotid elongation.

[Slide] The head is in the neutral position, and the artery tends to fold on itself. It comes up, goes back down, and it comes up this way.

[Slide] The second slide shows the head turned toward the side in question, and the artery obviously kinks at this point.

[Slide] The third slide, with the head turned the opposite way, shows complete obstruction of the internal carotid at that point, the dye going on off to the external.