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DISCUSSION

DR. HARRIS B. SHUMACKER (Indianapolis, Indiana): On rare occasions, there are presented experiences so startling in their break with traditional management and so excellent in outcome, one can only gasp with amazement. Such is the report of Crawford and his associates. Their present extensive series of cases confirms the conclusions reached in the earlier report.

When one relives the days when fear of paraplegia accompanied all but the briefest operations necessitating aortic cross-clamping in the absence of collaterals such as prevail in coarctation, and the efforts to protect the cord by cooling, various perfusion techniques, and arterial shunting, one realizes how truly remarkable this new approach is. Obviously, the direct attack upon the aneurysm, without need for such ancillary protective aids, or anticoagulants, saves time and blood. The use of buttons of aortic or aneurysmal wall giving rise to one or more major branches has proved useful to others, as it has to the Crawford group.

Their suggestion regarding restoration of blood flow to intercostals and lumbar is patently an important innovation. The results obtained confirm the opinion generally held that the proximal branches are much more important in preserving cord function than the more distal ones. It will be interesting to learn whether these and future observations confirm the supposedly enormous importance of the artery of Adamkiewicz, as well as that of the anterior spinal artery.

Most of us have feared cases involving the entire descending thoracic and abdominal aorta because paraplegia seemed almost inevitable. They have shown this not to be true. To be sure, their only instances of paraplegia were in this group of 22 cases, but then only in five. Furthermore, their reconstitution of blood flow to intercostal and lumbar arteries seems to have lessened the risk by at least half.

They have shown that cases previously thought inoperable or only partially resectable are, indeed, curable. They have demonstrated that they can treat these life-threatening aneurysms with a very low mortality, in contrast to the high risk which has generally prevailed.

Obviously, their work should be expanded. Others who operate well and without wasting time might see if they can duplicate these fantastic results. Almost certainly, no one who operates slowly and tediously should undertake to do so.

The Crawford group deserves our most hearty congratulations for a truly inspiring contribution.

DR. JOHN CONNOLLY (Irvine, California): First I'd like to congratulate Dr. Crawford on his superb operative results with one of the most technically challenging lesions that we're asked to operate on. I think that, perhaps, because most of us are not as quick and as technically facile as Dr. Crawford, we might approach the lesions that he listed today a little more conservatively, and I for one always have a heparinless shunt available.

Now to give you some idea of the incidence of suprarenal involvement and thoracic involvement, I'd like to note our findings in a series of aortograms. In 132 consecutive aortograms in patients with palpable abdominal aneurysms, we noted that there were 31% who had multiple aneurysms. If we look to see what these multiple aneurysms are, it's of importance that four of the 132 or 3.8%, appear to extend above the renal arteries, and six, or 4.5%, also involve the thoracic area.

If we look at what did we do to these four, some years ago we would have tried to resect these completely, as described by Dr. Crawford. In one of the four we did so. We resected the entire aorta, reconstructing mesenteric and renal arteries, as mentioned today, using a similar technique, but with a shunt. In one case we found that the aneurysm that was above the renals could be managed by a plication, without resection of any of the mesenteric or renal vessels. In one case we decided that the suprarenal widening was not too dangerous and we left it alone and did an infrarenal resection with graft replacement. In one case we decided that the involvement above the renals did not warrant a suprarenal operation because of the general poor condition of the patient.

In the group with thoracic involvement, in one case we decided that the patient's general condition did not warrant a thoracoabdominal operation, but in the other five cases we decided to do an infrarenal resection as the first procedure and then as a separate operation later we resected the thoracic aneurysm.

I would like to call to your attention the work of Wakabayashi of our Department. His contribution has been twofold: 1) to leave the back wall of the distal aorta—and I noted that Dr. Crawford does the same thing, and 2), the use of a nonthrombogenic shunt during the operation because we do not operate as rapidly as Dr. Crawford.

I think a shunt should always be available. There may be instances where you don't need it, but in our hands, we've found it to be very helpful. It can be either placed in the atrium proximally, or directly into the aorta through a purse-string suture with distal return to a femoral artery. The important thing is that it should be a big shunt so that you can equalize pressures above and below.

We think it's mandatory to have pressure monitoring above and below.

By leaving the back wall of the distal thoracic aorta and using a shunt we have been able to operate on 49 lesions of the descending thoracic aorta, 12 of which involved the entire aorta from the subclavian to the diaphragm, without a case of postoperative paraplegia.

Finally, if you look at our 132 routine aortograms, 2% had unusually enlarged lumbar arteries, and it may be that an unusually enlarged lumbar artery also needs to be inserted even in an infrarenal aortic resection.

In summary, I would like to say that we are not nearly as aggressive as we used to be in attacking the area between the diaphragm and the renal arteries. I'd like to ask Dr. Crawford what evidence he has about percentage of rupture of the abdominal aorta in this area, because obviously there is an increased risk when we have to operate in that area, and we prefer to try to preserve that area if we can and do our operations as two separate operations, an infrarenal and a thoracic, because we know that by this technique we can avoid that devastating complication of paraplegia.

DR. LYMAN A. BREWER, III (Los Angeles, California): Gentlemen, this has been a remarkable series of cases, a historic presentation.

We have had an interest in paraplegia following thoracic and thoracoabdominal resection of the aorta for a number of years. In a survey of 10,000 cases of coarctation in the aorta that we conducted a few years ago, we found there was an incidence of 0.5% of paraplegia. This was not related to the cross-clamp time or the number of intercostals divided.

The paralysis in these cases was thought to be due to a variation in the anterior spinal artery, which is segmental; especially important are the ninth thoracic and the great vessel of Adamkiewicz, which is usually around the second or third lumbar artery. If one of these key intercostal vessels is divided permanently, and if it is an end artery and there is no collateral circulation, then paraplegia may be the very unfortunate result. It is unfortunate for the patient, who suffers greatly due to this dreadful complication; it is unfortunate for the empathetic surgeon, who has sleepless nights which are augmented by the fact that he may be sued.

Dr. Crawford has been a pioneer in the resection of the thoracic and upper abdominal aneurysms in a rapid fashion without any protective measures being taken to preserve the blood supply to the spinal cord. We have used jump grafts, bypass left atrial grafts, as Connolly presented, and hypothermia. As Dr. Connolly pointed out, I believe that the surgeons who operate more slowly have to lean on these techniques.

Now Dr. Crawford comes up with a new technique of preserving the intercostal and lumbar arteries and attaching them to his graft. This does not protect the spinal cord during surgery but offers more spinal blood flow following the operation. Therefore, we have a problem, Dr. Crawford:

1. Which cases should have this special technique?
2. Does the cross-clamp time affect the result, as far as paraplegia is concerned?
3. Are you particularly concerned about the ninth thoracic and the first and second lumbar arteries?

This has been a splendid presentation by Dr. Crawford, and we are grateful to him for his brilliant pioneering work in this extremely difficult field of surgery.

DR. DENTON A. COOLEY (Houston, Texas): I rise to ask some questions and to make a point. Our technique of resecting such lesions is almost identical to the technique presented today. Dr. Crawford did not mention how he managed the left kidney. In our technique we choose to leave the kidney lying in its natural fossa. This requires division of the left renal vein, with reanastomosis at the completion of the operation. We believe it is technically more simple to do the arterial anastomosis when the kidney is lying in its natural sulcus, and also that it causes less renal injury, and, therefore, fewer postoperative complications.

I would also like to know if Dr. Crawford finds it necessary to remove the spleen, and if there are any complications attendant upon removal.

It has been our policy to use small doses of heparin to protect the organs distal to the point of aortic occlusion; we believe that many of the complications that we formerly attributed to ischemia were actually caused by microthrombi. Therefore, we use 1 mg/kg body weight and a low porosity Meadox Dacron graft to conserve blood.

Finally, may I pose a question about paraplegia and cord damage? I would like to know if any of the patients in the series who developed paraplegia underwent reimplantation of the segmental vessels. Dr. Crawford, how firmly are you convinced that reimplantation of these vessels prevents cord damage?

DR. E. STANLEY CRAWFORD (Closing discussion): I want to thank those who have discussed our paper both for their kind remarks and for the additional knowledge which they have added to the subject. I would agree that simple luminal dilatation is not indication for operation but true mural deterioration and aneurysmal formation is, evident by the fact that a significant number of cases in this series required operation for rupture of aneurysm proximal to previous infrarenal aortic aneurysm resection. I also agree that two of the major factors in the development of paraplegia are aortic clamping and aortic resection. The key to successful resection in the majority of these chronic cases was manipulation of the collateral circulation: aortic clamping by pharmacologic maneuvers and resection by sparing collateral channels and reattachment of collateral sources in the extensive cases. We do not feel that the ninth thoracic and first two lumbar arteries important in these cases unless extensive segments of both the thoracic and abdominal aorta are replaced. In such cases, we try to reattach one or more of these vessels. Reattachment of intercostal and lumbar arteries in such cases has reduced the incidence of paraplegia from 38 to 14%. For simplicity, to minimize periaortic bleeding, and to avoid renal vein anastomosis, we prefer to reflect the left kidney forward and to the right. The spleen is removed in about half the cases either for injury or to use the splenic artery for arterial reconstruction. We feel that heparin is contraindicated because it adds to the bleeding problem. We have had only one case of embolism which was corrected by conventional methods.