Anastomosis of the Subclavian Artery to the Distal Aorta for Management of Coarctation of the Aorta

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The classic experimental and clinical work of Gross and Hufnagel1 on coarctation of the aorta demonstrated the feasibility of direct end-to-end anastomosis of the proximal to the distal aorta for management of the usual type of coarctation in the adult. They pointed out that the anatomic configuration of the coarctation could be such that considerable mobilization of the aorta would be necessary to re-establish aortic continuity if a long segment of coarctation had to be resected. The problem of bridging very long defects was solved in 19492 by the introduction of homologous aortic grafts. An improved technique for the sterilization and preservation of such homologous arterial grafts was introduced by Meeker and Gross3 in 1951.

Our own experience with these techniques of management of long aortic coarctations has indicated the satisfactory nature of anastomosis of the proximal end of the divided subclavian artery to the distal aorta in selected cases. This technique permits one to avoid the use of homologous arterial grafts or plastic prostheses, the late long-term results of which are not known.

Certain objections have been raised in the literature to the use of the subclavian artery for this purpose: (a) abnormal kinking of the subclavian artery resulting in a suboptimal type of anastomosis; (b) the interruption of collateral channels normally carried by the subclavian artery. It has been our experience, however, that in selected cases these objections do not obtain.

To analyze the end results of our experience with subclavian artery to aorta anastomosis, we have compared effects between one and nine years after operation in eight patients treated by subclavian-aortic anastomosis to a comparable series of 14 patients treated by conventional end-to-end anastomosis.

Selection of Patients for Subclavian Artery Anastomosis

A number of theoretic considerations in the anatomic configuration of the coarctation indicates that a given coarctation is unsuitable for subclavian anastomosis. These factors include: (a) stiffness of the aorta and subclavian artery, (b) disparity of lumen diameter between the subclavian artery and the distal aorta, and (c) the presence of an appreciable segment of dilated aorta distal to the subclavian artery but superior to the coarctation. Combinations of these factors result in an inadequate anastomosis and kinking of the displaced subclavian artery. It may be found at operation, however, that the diameter of the subclavian artery is approximately equal to that of the distal aorta in many instances and that the coarctation arises immediately distal to this dilated subclavian artery. Under these circumstances the subclavian artery may be used for purposes of re-establishing aortic continuity. The necessary anatomic features are described in Fig. 1.

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TECHNIQUE OF OPERATION

The operative procedure currently used is generally similar to the technique that our group has described previously. The entire segment of the coarctation is exposed, including an appreciable length of the left subclavian artery (Fig. 2). If the anatomic configuration proves suitable for subclavian artery anastomosis, the subclavian artery is obstructed as high in the chest as possible. (Care is taken to preserve as much overlying soft tissue as possible since we have seen Horner's syndrome result from indiscriminate division of soft tissue to the left of the subclavian artery in the cupola.) Arm arterial blood pressures are determined carefully as clamps are applied to the subclavian artery and to the proximal aorta. An Adams' aorta clamp has proved useful for application to the aorta and a Blalock pulmonary artery clamp has proved valuable in occlusion of the subclavian artery distally (Fig. 3). Following closure of the proximal aortic lumen (Fig. 4A), the left subclavian artery is divided a suitable distance above its origin from the arch.

**Figure 1:** Diagrammatic representation of coarctation anatomy suitable for anastomosis of the subclavian artery to the distal aorta.
of the aorta and swung down to meet the distal aorta without tension. We have preferred to close the defect in the distal subclavian artery by interrupted sutures in view of the hazards of slippage of encircling ligatures on vessels of this size (Fig. 4B). Anastomosis between the displaced proximal subclavian artery segment and the distal aorta has been carried out by conventional methods (Fig. 4B).

**End Results of Therapy**

No deaths have occurred in our series of coarctation operations. There have been no major complications, and no minor complications unique to the subclavian artery anastomosis. Patients have had follow-up studies between one and nine years after operation and serial changes of arm arterial blood pressure studied in the immediate and the late postoperative periods. These data have been plotted in Figs. 5 and 6. The change in arterial pressures in the arm following the operative procedure have been plotted against the preoperative systolic and diastolic arterial pressures. It can be seen that in both the early preoperative and the postoperative periods there is no significant difference between the patients managed by subclavian aortic anastomosis.

**Figure 3:** Application of clamps to the coarctation region.

**Figure 4:** A, Closure of proximal aortic defect by horizontal interrupted silk mattress sutures over-run with a continuous silk suture. Division and transposition of the subclavian artery downward. B, Completion of anastomosis and closure of distal end of the subclavian artery.
and those managed in the conventional manner by direct re-establishment of continuity of the aorta.

The anesthetic records have been analyzed to determine whether any alarming elevation of arm (and carotid) systolic pressure occurred during the time that the collateral flow through the subclavian artery was interrupted. The pressure in patients in whom only the aorta was clamped was similar to the pressure in patients in whom the subclavian artery was clamped in addition.

**Summary**

Contrary to current concepts reported in the literature, it has been our experience that anastomosis of the divided left subclavian artery to the distal aorta is a suitable form of correction for adult-type aortic coarctation. For such therapy the lumen size of the subclavian artery should be ade-
quate and the proximal end of the coarctation must be in close proximity to the base of the subclavian artery. Comparison of arm arterial pressure changes between one and nine years after operation indicates no significant difference between subclavian artery anastomoses and direct aorto-aortic anastomoses when the selection of patients is proper. By use of this maneuver, it is possible on occasion to avoid the use of homologous tissue grafts or plastic prostheses, the late effects of which are not known at present.

References

AMYL NITRITE, PHENYLEPHRINE AND CARDIAC MURMURS

The effects of amyl nitrite and phenylephrine on the intracardiac pressures and cardiac output have been studied by Beck and associates in a group of patients having either no hemodynamic abnormality or trivial pulmonary stenosis. Amyl nitrite has been clearly demonstrated to decrease systemic pressures while pressures in the right side of the heart show no significant change, except in the presence of mild pulmonary stenosis. Cardiac output is increased and there is indirect evidence of an increased venous return to the heart. Phenylephrine causes a marked rise in systemic pressure and a lesser rise in pressures of the right side of the heart, while cardiac output is always decreased. The softening of left-sided regurgitant murmurs after amyl nitrite and their intensification following phenylephrine are explained on the basis of the changes in intracardiac pressures. Similarly, the intensification of ejection murmurs after amyl nitrite and the variable changes after administration of phenylephrine are discussed in relation to changes in cardiac output.


INFRA MICROSCOPICAL STUDIES ON ALVEOLITIC PROCESSES

The inframicroscopic study of the common lung lesion, alveolitis, points out in a striking fashion some problems of biology and general pathology. The so common process of the disappearance due to enzymatic liquefaction of the free cells within the alveoli, raises essential questions that may not be answered at this time. Electronic microscopy cannot solve the problems raised by such processes, but it allows a clear idea of its existence and significance. In the irresistible evolution toward a molecular concept of biology and pathology, the findings obtained scattered and incomplete though they may be, constitute landmarks in the immense sphere of pathogenetic studies.