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SUCCESSFUL LIGATION OF THE ANTERIOR DESCENDING BRANCH OF THE LEFT CORONARY ARTERY

W. ALBERT BREWER, M.D.*

FRED W. HOLMES, M.D.**

The purpose of this paper is to report a case of successful ligation of the anterior descending branch of the left coronary artery in a 29-year-old colored male, whose recovery has been followed by serial electrocardiograms. The case may be of interest because of information available from study of the patient in the light of the anatomical location of the surgical occlusion.

On September 16, 1950, the patient was stabbed in the chest with a paring knife. He was admitted to the emergency room of Memorial Hospital, Phoenix, Arizona, within 20 minutes of the injury. He was said to have been unconscious for a brief period before admission. When first examined, his lips were slightly cyanotic. The pulse was rapid and barely perceptible, and the blood pressure could not be obtained. Dark blood was oozing from a small puncture wound near the left edge of the sternum in the fourth intercostal space. Heart sounds were distant. The neck veins were distended. During examination, which was carried out rapidly, the patient became widely disoriented, possibly from cerebral anoxia. Pericardiocentesis was carried out immediately, yielding 150cc. of fluid blood. The blood pressure then rose to 80/50 with a pulse rate of 140 and the patient became quiet and cooperative.

He was then taken to the operating room where intra-tracheal anesthesia, using sodium pentothal, nitrous oxide, oxygen and curare, was administered. The left chest was entered through the bed of the fifth rib. Troublesome bleeding, occurring from the left internal mammary vessels, was controlled by silk ligatures. No blood was present in the left pleural space. The pericardial sac was opened, releasing 250cc. of liquid blood, with rapid improvement in the patient's general condition. No injury to the presenting surface of the heart was noted at first, but with downward traction, a 1cm. stab wound in the anterior wall of the right ventricle, just below the base of the conus arteriosus and immediately adjacent to the descending branch of the left anterior coronary vessels, began to bleed freely. At this point, ventricular fibrillation appeared, but stopped spontaneously in the matter of seconds after the traction suture at the apex was removed. Closer inspection of the cardiac wound revealed a small swelling of one of the coronary vessels, probably the artery. This was thought to be traumatic in origin and rupture here postoperatively was feared. Therefore, the vein and artery were ligated in continuity with fine silk in the lower part of their proximal one-thirds. The wound in the auricle was closed with 3 fine silk sutures. The pericardium and chest wall were closed without drainage, using silk throughout, after the instillation of 100,000 units of penicillin and 1gm. of streptomycin. At the concluding of the operation, the blood pressure was 130/80 with a pulse rate of 110.

The vital signs showed their maximum deviation from normal about 24 hours later when the temperature was 103 degrees rectally, with pulse rate of 118 and respira-
tory rate of 55. The temperature remained at or below 98.6 degrees after the thirteenth post-operative day. A pericardial friction rub was audible with varying degrees of intensity from the first through the fourth post-operative days. Heart sounds were considered to be of good quality at all times and no murmur was ever heard by any observer. The heart size was enlarged for about 10 days, and then gradually returned to normal. Pericardial tap on the 10th post-operative day yielded only 20cc. of liquid bloody fluid. A small sterile pleural effusion developed bilaterally, but yielded only 200cc. by thoracentesis. At least part of the fever was considered to be due to a left pneumonitis, which developed early. Alpha streptococci were demonstrated in the sputum. Response of this to penicillin was considered satisfactory. The patient was discharged in good condition on the 31st post-operative day on a restricted activity program, which he completely disregarded.

Four hundred mgm. Pronestyl was given intravenously in divided doses during surgery and in doses varying from 100 mgm. intravenously every 4 hours to 250 mgm. orally three times a day almost to the time of discharge. Except for the very brief period of ventricular fibrillation during surgery, the cardiac rhythm has remained completely regular to the present time. None of the digitalis or quinidine alkaloids were ever given or considered indicated. Ammonium chloride was given for a few days beginning on the eighth post-operative day. Except for penicillin, no other drug was used. The patient has been followed to the present time and his exercise tolerance has remained normal. The heart has remained normal in size, with normal auscultatory findings. Progress chest fluoroscopy and radiography have revealed no abnormality.

Serial electrocardiographs were taken daily for the first eight days after surgery. Thereafter graphs were taken every three days until discharge from the hospital. The figure shows only the electrocardiographs which demonstrated changes as they appeared. The early graphs did not have all the precordial leads because of the surgical dressings.

The graphs revealed early S.T. elevations in Leads 1 and 2 for four days before inversion of T waves appeared. Symmetrical inversion of the T waves in the precordial leads appeared on the second post-operative day and made progressive changes throughout the convalescent period. All precordial leads showed the changes. Note-worthy is the prompt appearance of Q3 within two days. Within eight months after ligation of the descending branch of the left coronary artery and vein, the electrocardiograph was entirely normal. The series is typical of an acute anterior myocardial infarction.

Numerous papers, discussions and reports concerning open trauma of the heart are to be found in the literature. However, cardiac trauma, requiring coronary ligation or with direct injury to the coronary vessels themselves, apparently is not common. Davenport reported closing a 5mm. puncture wound of the right ventrical in the upper part of the middle one-third of its anterior wall, requiring ligation of the interventricular branch of the left coronary artery and vein. The patient, a 44-year-old white male, was ambulatory on the thirteenth post-operative day and returned to work two weeks later.

Davenport, Blumethal and Cantril also reported survival of a 32-year-old colored male after suture of a wound of the left ventricle near the apex with ligation of the
coronary vessels. He returned to work as a truck driver without disability 1 month after injury.

In 1931, Eikin and Phillips reported repair of a wound in the right ventricle with severance of the anterior descending branch of the left coronary artery at about its mid-point. The patient, an 18-year-old colored male, survived closure of the wound and ligation of the coronary artery. A pericardial friction rub was audible between the third and sixth post-operative days with x-ray evidence of pericardial effusion and pneumonia on the fourth day. The authors also reported a colored male, age 25, with a 1.5cm. laceration of the left ventricle just to the left of the coronary vessels in their distal one-third. The wound was sutured without injury to the vessels and the patient recovered. Pericardial effusion and pneumonia also developed on the fourth post-operative day.

Porter and Bigger reported a colored male, age 23 years, with a 1cm. stab wound through the descending branch of the circumflex artery into the left ventricle about 5cm. from the apex. The wound was closed and the artery ligated without difficulty. The patient was discharged in good condition on the sixteenth post-operative day and subsequently returned to work as a laborer. Follow up physical examination, chest x-ray and electrocardiographs were all normal.

Olim and Hughes closed a 1.5cm. laceration of the left ventricle 5cm. from the apex in a moribund 24-year-old colored male. The coronary vessels were ligated as the wound was closed. No cyanosis of the distal cardiac muscle was observed. The patient made a complete recovery. Beginning on the third post-operative day, a loud systolic murmur with apical systolic thrill was audible and persisted throughout the period of observation. There was no accompanying cardiac dilatation. The authors thought there might have been an injury to a valve leaflet, a chorda tendina, or a papillary muscle. This is the only report of post-operative murmur that we have encountered.

Badertscher has reported 3 cases of cardiac compression due to acute dilatation of the heart resulting from cardiac wounds. One of these was a 20-year-old colored female with a 6mm. laceration of the right ventricle immediately adjacent and parallel to the left anterior descending coronary vessels. The wound was closed without direct ligation of the vessels, but was occluded by an inverting effect of the muscle sutures, which were placed rapidly because of very severe hemorrhage. Increasing cyanosis of the heart muscle progressing toward the apex was noted. The patient's general condition improved rapidly, however, and the incision was closed. As the skin was being sutured 25 minutes later the blood pressure became imperceptible. Fearing recurrence of the hemorrhage, the incision was reopened and the heart fairly popped out of the pericardial sac under great tension due to enormous dilatation, but with no suggestion of bleeding. The blood pressure immediately rose to 160/120. Cardiac action became tumultuous causing several lacerations of the anterior surface of the organ on the overlying rib edges. Hemorrhage from these lacerations was uncontrollable and death occurred 45 minutes after the coronary occlusion.

The other 2 cases were stab wounds of the left anterior chest with signs of cardiac tamponade, but without evidence of penetration of the pericardium or heart. Both were relieved clinically by opening the pericardial sac alone, and both recovered.
Zerbini treated a 6-year-old male, who was injured by an iron splinter, with pneumothorax and cardiac tamponade. The right ventricle and anterior descending branch of the left coronary artery were wounded 4cm. from the apex. Repair was carried out without difficulty and recovery was very smooth. Progress electrocardiographs showed evidence of pericarditis but not of infarction. The child was well one year later with no evidence of diminution of cardiac reserve.

This is the only case on record without evidence of infarction, either clinically or by electrocardiograph, that we have encountered. As a matter of fact, clinical infarction not uncommonly follows cardiac trauma without associated coronary injury. Zerbini feels that this is due to the anatomic and functional condition of the capillary network at the time of injury, since the coronary arteries are purportedly end arteries. Injection studies have shown small anastomotic vascular channels between adjacent branches of the same coronary artery, between the coronary arteries and coronary veins, and between branches of the coronary veins themselves. In addition, there are venous channels which empty directly into the cardiac chambers, the thebesian veins or vena cordis minima. More recently, direct connections between the coronary arteries and cardiac chambers, or so-called arterio-luminal vessels, have been described. Therefore, if these vessels were to dilate, a free collateral coronary circulation would be established. Such dilatation conceivably would occur more easily in a 6-year-old child than an adult. Probably the coronary arteries do act as end arteries in the usual sudden occlusion with infarction. That dilatation of anastomotic channels does take place with gradual coronary occlusion is well known. This was particularly well shown by two cases of complete occlusion of both coronary arteries at their aortic origins by syphilis, reported by Leary and Wearn. These patients were able to carry on active lives.

Beck and Mako have studied this problem experimentally in dogs. They injected solutions into the right and circumflex coronary arteries after ligation of the anterior descending branch of the left coronary. Good filling in the distal portion of the occluded artery was demonstrated in all hearts surviving ligation. Better filling was noted after ligation of both artery and vein than after ligation of the artery alone. They were able to reduce the average mortality of 80%, if the accompanying vein were simultaneously ligated.

We were impressed with the survival and relatively smooth course of our patient from the standpoint of the level of ligation, which is possibly the most proximal ligation with survival yet reported. Graham and Laforet have reported two ligations of the main left coronary artery in the atrioventricular groove. One of these patients died immediately, the other in 36 hours, of a cerebral embolus. Both ligations were occasioned by accidental tears of the left auricle into the atrioventricular groove during finger valvuloplasty for mitral stenosis. At autopsy the first case showed an early infarct at the apex; the second an early infarct of the wall of the left ventricle.

Allen and Laad have shown nicely that the mortality rate following sudden occlusion in the dog is inversely proportional to the number of arterial branches proximal to the occlusion. They have also shown that the mortality is directly proportional to the percentage of blood flow of the total coronary circulation carried by the occluded artery. In the human, the left anterior descending branch of the left coronary apparently
does not carry a critical flow, as judged by the survival of all patients cited above except the one in which case death was actually due to exsanguinating hemorrhage from the ventricle itself.

Perhaps this amazingly low mortality was also influenced by the anesthesia. Manning, McEachern and Halpin have shown that the high mortality following acute occlusion of one branch of a coronary artery in the conscious dog cannot be accounted for by the extent of the experimentally produced infarct. They suggest that this mortality is the result of a relatively large area of ischemia brought about by spasm of collateral arterial branches. For example, ligation of the left anterior descending branch of the left coronary one-half inch from the aorta in the anesthetized dog resulted in 6% mortality in their hands, while ligation at the same level in the conscious animal produced a 32% mortality. Figures for ligation of the circumflex branch were 26% and 75%, respectively.

The absence of cardiac pain following coronary ligation in our patients was surprising. Other observers have mentioned this in relation to both coronary trauma and to wounds of the heart musculature. Porter and Bigger noted it in their two patients. They felt that while myocardial ischemia was of major importance in the pathogenesis of pain, it would not occur if the ischemic area contained muscle that had lost its power of contractility, as would be produced by an incised wound or by the sutures in closing such a wound. With severance and ligation of a coronary artery, one would
expect a latent period to intervene between the trauma and loss of contractility, during which typical heart pain would be manifest. Perhaps pain fibers travel in close relationship to the coronary vessels and are interrupted by such trauma. The possibility of such a neurogenic basis is suggested by the observations of Sutton and Lueth (cited by Porter and Bigger) who found that pain was not produced in dogs if the continuity of the vessel or even its adventitia was broken.

SUMMARY: A case of successful ligation of the anterior descending branch of the left coronary artery in a 29-year-old male is presented. After pericardiocentesis, the patient was taken to the operating room where a 1 cm. wound of the right ventricle just below the conus arteriosus and immediately adjacent to the anterior descending branch of the coronary artery was found. The coronary artery and vein were ligated in continuity and the ventricular wound closed. The patient made a complete clinical recovery and has returned to heavy physical labor. Serial electrocardiographs showed a typical anterior myocardial infarction with return to normal in 8 months.

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411 Professional Bldg., Phoenix, Arizona