

ANNALS OF SURGERY

VOL. 120

DECEMBER, 1944

No. 6



WOUNDS OF THE HEART

COL. DANIEL C. ELKIN, M.C., A.U.S.

FROM THE WHITEHEAD DEPARTMENT OF SURGERY, EMORY UNIVERSITY, ATLANTA, GA.

IN NOVEMBER, 1940, I made a report concerning 38 patients who had been operated upon for wounds of the heart or intrapericardial portions of great vessels.¹ All of these patients were operated upon in the Emory University Division of Grady Hospital, Atlanta. Since that time 23 patients have been operated upon in the same clinic for similar conditions, and these latter cases are here reported in abstract, with further observations upon this condition, particularly as regards its treatment.

With the exception of Case 1 the patients in this latter series were operated upon by members of the Resident Staff, and to them should go full credit for the continued interest in this field of traumatic surgery. Of these 23 patients there were five deaths, a mortality of 22 per cent, whereas, in the previously reported 38 patients 16 died, a mortality of 42 per cent—a combined mortality in the 61 patients of 34 per cent. It is believed that this reduction in death rate was due to several factors. The resident surgeons who performed these operations have gone through a period of graduated preparatory training during which time they are allowed to assist in and perform procedures of this type on their own responsibility and, as a result, become more skillful in the performance of such operations. Moreover, they are constantly on the alert to make a proper diagnosis and in proceeding with treatment with the least possible delay.

In the first series seven deaths were recorded as due to infection; pericarditis, pneumonia, and bacteriemia. In the latter series there were no deaths from infection, and those patients who did not recover either died on the operating table, or shortly thereafter, presumably from hemorrhage or from the effects of tamponade. The reduction in mortality from infection was not due to the use of sulfa drugs since in the second series it was only used in one case (Case 1) for the treatment of postoperative pneumonia. In no instance has it been placed in the wound. I believe that the reduction in infections is, in the main, due to a more meticulous technic and in careful preoperative preparation. In no instance of the latter series has careful preparation and operative technic been sacrificed for speed and haste.

Another factor which may be of considerable importance has been the giving of intravenous fluid prior to operation. I was formerly of the opinion, which was largely based upon the work of Beck,² that *in the presence of*

tamponade, the giving of blood or any other fluid intravenously was of no value since the tamponade would prevent its reaching the heart. The experimental work of Cooper, Stead, and Warren³ presents evidence that the rapid intravenous infusion, with subsequent increase in blood volume, enables a dog to withstand a considerably higher intrapericardial pressure. Based upon this conclusion, intravenous infusions were given to the last eight patients, and in each there was a clinical improvement preoperatively.

All the patients in this series, as well as those previously reported, were operated upon since in each there was definite evidence of cardiac tamponade. This diagnosis was based upon the lowered arterial pressure and increased venous pressure; and the presence of a quiet heart as noted on fluoroscopic examination. This latter diagnostic point was first described by Bigger,⁴ and has since been emphasized by others. Of all signs leading to a diagnosis of tamponade this is the most important and is the one least likely to lead to a mistaken diagnosis.

Venous pressure readings are not only of value in the diagnosis of tamponade but are of considerable prognostic importance. If the venous pressure is high, that, in itself, is evidence that the heart is carrying on its functions and that the cardiac output is at least sufficient to produce such pressure. On the other hand, a low or lowered venous pressure in the presence of tamponade is evidence of a failing heart and of a greatly reduced cardiac output. In this connection, it is interesting to note that Case 9, with a venous pressure of 120 mm. of water, died two hours after operation; that Case 16, with venous pressure of 150 mm. of water, died on the table, and that Case 21, with venous pressure of 210 mm. of water, died on the table.

It will be noted that in all patients there was a definite lowering of the arterial pressure, and in 17 of the 23 blood pressure readings could not be recorded. In those patients who recovered there was an immediate rise in arterial pressure following the release of the tamponade.

Some type of general anesthesia in which positive pressure can be used for inflation of the lung is preferable to local anesthesia. The difficulties of heart suture require that the patient be quiet, and these patients are usually excited or may become so with the release of the tamponade and, unless completely anesthetized, their movements may interfere with the operation at the most inopportune time.

As previously pointed out, the approach to the heart is made on the left side of the sternum with the incision placed about one intercostal space below the external wound. In most instances a transverse incision extending from about two centimeters outside the nipple line and carried well across the sternum has been used. By this approach one or two ribs can be removed, and, if necessary, the adjacent costal cartilages cut and a portion of the sternum removed. The pectoralis major muscle is separated in the direction of its fibers and can be retracted from the surface of the three ribs. Every care should be taken to prevent opening the pleura since such a complication adds materially to the shock which the patient has already undergone. The

WOUNDS OF THE HEART

TABLE I
SUMMARY OF 23 CASES OF CARDIAC WOUNDS

No.	Operator*	Sex	Age	Instrument	Duration from Injury to Operation	H ₂ O Venous Pressure	Arterial Pressure on Admission	Arterial Pressure after Operation	Tamponade	Location	Complications	Amount of Blood Given	Result
1.	D.C.E.	F.	27	Ice pick	80 mins.	250 mm.	0/0	110/70	+	R. auricle	Pneumonia	750 cc.	Recovery
2.	C.S.W.	M.	33	Knife	60 mins.	200 mm.	60/40	120/80	+	R. ventricle	L. hemothorax	300 cc.	Recovery
3.	C.S.W.	M.	27	Knife	60 mins.	220 mm.	80/55	130/70	+	Pul. conus	L. hemothorax	500 cc.	Recovery
4.	C.S.W.	M.	28	Knife	60 mins.	270 mm.	0/0	110/80	+	R. ventricle	L. hemothorax	1000 cc.	Recovery
5.	W.C.W.	M.	25	Knife	60 mins.	230 mm.	50/35	120/70	+	Pul. conus	L. hemothorax	600 cc.	Recovery
6.	R.F.M.	F.	31	Knife	75 mins.	190 mm.	0/0	110/80	+	L. ventricle	None	600 cc.	Recovery
7.	R.F.M.	M.	23	Ice pick	90 mins.	210 mm.	0/0	100/50	+	L. ventricle	None	600 cc.	Recovery
8.	F.W.C.	M.	28	Knife	40 mins.	190 mm.	0/0	100/60	+	R. ventricle (ant. and post.)	R. hemothorax	1000 cc.	Recovery
9.	F.W.C.	M.	40	Knife	90 mins.	120 mm.	0/0	110/70	+	Pul. artery	Pneumonia.	1000 cc.	Died—2 hrs.
10.	W.C.W.	F.	19	Knife	90 mins.	200 mm.	0/0	0/0	+	R. ventricle	Died	800 cc.	Died—2 hrs.
11.	W.C.W.	M.	24	Knife	90 mins.	160 mm.	0/0	110/70	+	R. ventricle	R. hemothorax	1000 cc.	Recovery
12.	W.C.W.	M.	18	Knife	80 mins.	110 mm.	50/0	100/80	+	R. ventricle	L. hemothorax	1000 cc.	Recovery
13.	F.W.C.	M.	41	Knife	60 mins.	250 mm.	0/0	160/80	+	L. ventricle	L. hemothorax	1000 cc.	Recovery
14.	C.M.H.	M.	26	Knife	45 mins.	190 mm.	0/0	0/0	+	Pul. artery	Died	500 cc.	Died—10 mins.
15.	W.C.W.	M.	22	Knife	120 mins.	180 mm.	0/0	160/60	+	R. ventricle	None	600 cc.	Recovery
16.	W.C.W.	M.	27	Knife	90 mins.	150 mm.	0/0	0/0	+	L. auricle	Died	1000 cc.	Died on table
17.	C.M.H.	M.	44	Knife	60 mins.	190 mm.	80/50	110/70	+	Aorta	None	1500 cc.	Recovery
18.	W.H.P.	M.	43	Knife	60 mins.	210 mm.	0/0	120/70	+	R. auricle	L. hemothorax	1500 cc.	Recovery
19.	C.M.H.	M.	36	Knife	60 mins.	200 mm.	70/40	130/70	+	R. ventricle	Pericardial effusion	1500 cc.	Recovery
20.	W.H.P.	M.	29	Knife	60 mins.	190 mm.	0/0	120/70	+	Pul. artery (2 openings)	L. hemothorax	2000 cc.	Recovery
21.	W.H.P.	F.	33	Knife	120 mins.	120 mm.	0/0	0/0	+	Undetermined	Died	1000 cc.	Died on table
22.	W.H.P.	M.	52	Ice pick	120 mins.	210 mm.	0/0	120/60	+	Pul. artery	L. hemothorax	1500 cc.	Recovery
23.	W.H.P.	M.	50	Knife	90 mins.	220 mm.	0/0	110/70	+	Pul. conus	Pneumonia	1000 cc.	Recovery

* The operating surgeons referred to by initial in the summary of these cases were Doctors Charles S. Ward, W. Cleve Ward, Robert F. Mabon, F. W. Cooper, Chas. M. Harris, and Wm. H. Proctor.

internal mammary vessels must be carefully isolated and ligated. They may not bleed before the tamponade is released, but later hemorrhage from them may be fatal unless proper ligation has been performed. The pleura on the left is displaced from the pericardium by gauze dissection and held out of the wound by a wet pack. As a rule, the pericardium will be tense, and its pulsations weak or imperceptible. If the wound in the pericardium is seen it should be enlarged or, if not readily found, it is opened between stay-sutures. Occasionally the heart wound can be located before the blood and clots are removed and before the heart starts beating actively, and under such conditions it can be readily sutured. More often the heart wound is not disclosed until blood and clots are removed by suction. When the intrapericardial pressure is relieved the bleeding becomes marked and contractions of the heart increase in force. When the wound is located, and it is most often found in the right ventricle, its closure is facilitated by placing the left index finger over it. In this way the bleeding will be impeded sufficiently to allow the passage of a suture directly under the finger. This is left untied for the moment and is held in the left hand for traction hemostasis while other sutures are placed and tied. Should the wound be behind the sternum or on the posterior surface of the heart a stay-suture passed through the apex, as advocated by Beck,⁵ is of great value. By this means the wound may be rotated into a favorable position for suture. It is to be noted that there were two instances of double wounds; one of the pulmonary artery with recovery, and one in the anterior and posterior surface of the right ventricle, which recovered. In this second case the use of the apex stay-suture was of particular value in rotating the heart into a position where the posterior wound could be successfully sutured. Wounds of the coronary vessels may require ligation but are not necessarily fatal. Beck² has recently devised an ingenious method of suturing wounds in the vicinity of the coronary vessels without injuring them. The pericardium should be closed loosely to allow the escape of pericardial fluid, but the chest wall should be sutured with careful approximation of the anatomic layers. Details concerning the suture of wounds of the auricles and great vessels have been previously described.¹

The opinion was expressed by me in a previous paper¹ that operation should be carried out as soon as the diagnosis of a heart wound is established. In view of the reports from other clinics on this subject this opinion should probably be modified to include some form of conservative treatment if conditions are not urgent and operation does not seem to be immediately demanded. Bigger,⁶ Strieder,⁷ and Blalock⁸ have emphasized the value of aspiration of the pericardium as a preliminary to operation, and in some instances it has been found that aspiration alone is the only operative procedure necessary, since some wounds, particularly those which do not penetrate the cavities of the heart, have sealed, and aspiration of the blood relieving the tamponade is sufficient to bring about a cure. Blalock⁸ advocates that in cases of tamponade where there is no bleeding into the chest or to the

WOUNDS OF THE HEART

outside, that the pericardium be aspirated, but that "all facilities should be available for immediate operation if it becomes necessary." He further states that "if blood reaccumulates rapidly following aspiration, it is agreed that exposure and suture of the heart wound is indicated." He also makes a statement that "if one has good reason to believe that an auricle rather than a ventricle has been injured, one may more safely defer operation." I do not believe there is any method whereby it may be determined whether an auricle, a ventricle, or the intrapericardial portion of a great vessel is the point of injury. The direction of the knife-thrust or a bullet wound is notoriously misleading, and the position of the cardiac wound cannot be determined by the wound of entrance, and the symptoms of tamponade are the same no matter what the source of the bleeding. It would seem then that the only modification of the advocacy of immediate suture would be continued improvement following aspiration without recurrence of the signs of cardiac compression.

CONCLUSIONS

Twenty-three patients operated upon for wounds of the heart are presented in abstract. These are in addition to 38 cases of similar nature previously reported from the Department of Surgery, Emory University, Grady Hospital, Atlanta. The mortality rate in the latter series was 22 per cent as compared with 42 per cent in the first series.

Conjectured reasons for this lower mortality rate are presented.

It is believed that the giving of intravenous infusions prior to operation has a beneficial effect by increasing blood volume and, hence, cardiac output.

While immediate operation was undertaken in all patients of this series, and carried out as soon as diagnosis was made, it appears evident from the reported cases of other clinics that aspiration of the pericardium, both as a temporary and definitive method of treating cardiac tamponade may be properly employed. Operation should not be delayed if there is evidence of bleeding into the pleural cavity or through the external opening.

REFERENCES

- ¹ Elkin, D. C.: The Diagnosis and Treatment of Cardiac Trauma. *ANNALS OF SURGERY*, **114**, 169, August, 1941.
- ² Beck, C. S.: Further Observations on Stab Wounds of the Heart. *ANNALS OF SURGERY*, **115**, 698, April, 1942.
- ³ Cooper, Fred W., Jr., Stead, Eugene A., Jr., and Warren, James V.: The Beneficial Effect of Intravenous Infusions in Acute Pericardial Tamponade. *ANNALS OF SURGERY*, **120**, 822, December, 1944.
- ⁴ Bigger, I. A.: Wounds of the Heart and Pericardium. *South. Med. Jour.*, **25**, 785, 1932.
- ⁵ Beck, C. S.: Wounds of the Heart. *Arch. of Surg.*, **13**, 205, 1926.
- ⁶ Bigger, I. A.: Heart Wounds: Report of Seventeen Patients Operated upon in Medical College of Virginia Hospitals: Discussion of Treatment and Diagnosis. *Jour. Thor. Surg.*, **8**, 239, 1939.
- ⁷ Strieder, J. W.: Stab Wound of the Heart. *Jour. Thor. Surg.*, **8**, 576, 1939.
- ⁸ Blalock, Alfred, and Ravitch, Mark M.: A Consideration of the Nonoperative Treatment of Cardiac Tamponade Resulting from Wounds of the Heart. *Surg.*, **14**, 157, August, 1943.