STAB WOUNDS OF THE HEART

By Siew-Chey Ong, M.D., and Christopher G. Thevathasan, M.B., B.S., F.R.A.C.S.

(From the Professorial Surgical Unit, General Hospital, Singapore)

Stab injury of the heart in the present day is quite amenable to treatment if the patient survives long enough to reach the hospital. Exsanguination from the heart wound and cardiac tamponade are the usual causes of death. The two complications, however, do not usually occur together. If the pericardial wound allows free escape of blood into the pleural cavity, there may be massive blood loss without significant tamponade. On the other hand, if the blood is trapped in the pericardial sac, cardiac tamponade is the usual result. The blood accumulated in the pericardial sac may clot and prevent further hemorrhage, and this may prove lifesaving if not accompanied by severe tamponade. Tamponade of a severe degree, by greatly impeding cardiac filling, is rapidly fatal.

In 1963 and 1964, four cases of stab wounds of the heart, including one with a non-penetrating wound, were encountered in the Professorial Surgical Unit of the Singapore General Hospital. All four cases were successfully treated by thoracotomy and cardiorrhaphy. In the same two-year period, nine patients with stab wounds of the heart were brought in dead to the Singapore General Hospital. The injury was penetrating in each case. The autopsy records show that the left ventricle alone was involved in four cases, the right ventricle alone in two cases, both the left and right ventricles in one case, and the right atrium alone in one case. In four patients, the main mechanism of death appeared to be cardiac tamponade. The amount of blood accumulated in the pericardial sac varied from 200 c.c to 550 c.c. The remaining five patients appeared to have died from massive hamorrhage from the heart wounds and associated injuries. A review of autopsy records did not disclose any case of stab wound of the heart in a patient who died after admission in the same period.

The four cases of stab wounds of the heart admitted alive are reported here.

CASE REPORTS

Case No. 1

A 16-year-old male was admitted on February 22, 1963, with a stab wound of the right chest in the third intercostal space at the right sternal border. He was pale and dyspnoeic. The admission blood pressure was 100/50 and pulse rate 120/min. Physical examination disclosed some shift of the trachea to the left and evidence of a right hemothorax. There was no venous distension of the neck. A chest X-ray film confirmed a sizable hemothorax on the right. Shortly after admission, 1,000 c.c. of blood was given without much improvement of his clinical condition. It was evident on percussion of the chest that his hemothorax was increasing.

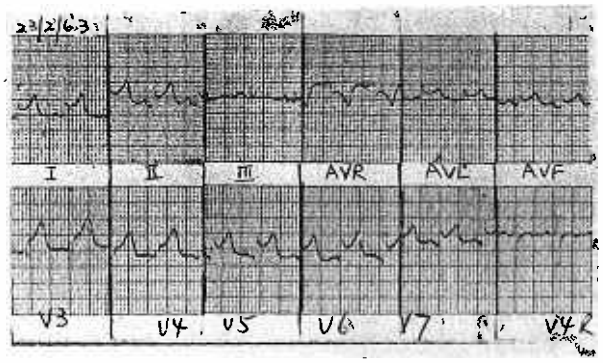


Fig. 1. Case No. 1. EKG tracings on the 1st postoperative day showed a pattern of myocardial injury.

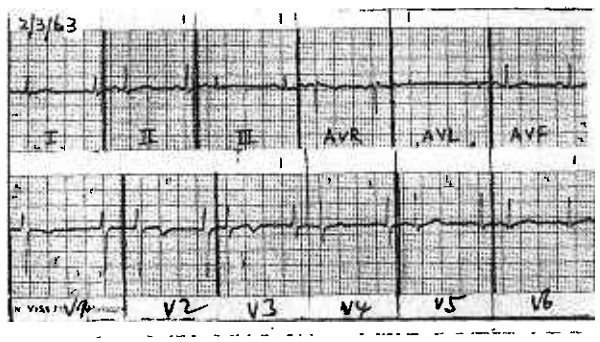


Fig. 2. Case No. 1. EKG tracings on the 10th postoperative day were essentially normal.

An emergency anterolateral thoracotomy was performed. About 2,000 c.c. of partly clotted blood was found in the chest cavity. Two openings were seen in the pericardium, each measuring about 2 cm. long, from which blood was oozing. On entering the pericardium, two stab wounds of the heart were noted a right atrial

wound measuring 1/2 cm. in length and a right ventricular wound just below the atrioventricular groove, measuring 1 ½ cm. in length. Both wounds were penetrating but not bleeding severely. Very little blood was found accumulated in the pericardial sac. The cardiac wounds were sutured with silk.

The patient made an uneventful recovery from the operation.

Comments

There was no cardiac tamponade in this case. The indication for thoracotomy was massive hemothorax and near circulatory collapse not improved by blood transfusions. The blood from the heart wounds escaped freely through the pericardial openings into the pleural cavity. Bleeding persisted, though at a slow rate, because of absence of tamponade.

Case No. 2

A 35-year-old man was admitted on April 25, 1963, with a stab wound of the left chest in the 4th intercostal space at the left sternal border. On admission, the systolic blood pressure was 80 mm. Hg. and pulse rate 100/min. The patient appeared moderately dyspnoeic. There was evidence of a left hemothorax. The neck veins were not distended and heart sounds not appreciably muffled. 500 c.c. of dextran and 500 c.c. of blood were given without much improvement of his condition.

The patient was then taken to the operating room. When the thoracotomy incision was begun, the patient became pulseless. The left chest was hurriedly opened through the 4th intercostal space. A large amount of blood was found in the pleural cavity. When the pericardial sac was entered, there was a gush of blood and clots. A severe cardiac tamponade had apparently occurred. Cardiac massage successfully restored the heart beat. The anterior descending branch of the left coronary artery was found to be spurting blood, and it was ligated. It then became clear that the knife had entered the pericardial sac directly from the chest wall wound, incised the left ventricular myocardium transversely just below the atrioventricular groove, penetrated the left side of the pericardium, and finally had injured the medial part of the lingular lobe. The 2-inch long ventricular wound severed the anterior descending branch of the left coronary artery and traversed almost the entire thickness of the left ventricular myocardium, stopping just short of entering the ventricular chamber. The heart wound was sutured with silk and the minor lung injury repaired.

The post-operative course was complicated by wound infection and pleural and pericardial effusion, necessitating thoracentesis and pericardicentesis. Five weeks after the operation, the patient was discharged at his own request. He had been afebrile and ambulatory. A mild tachycardia, however, persisted. EKG tracings were consistent with an anterior myocardial infarction. The patient was lost to subsequent follow-up.

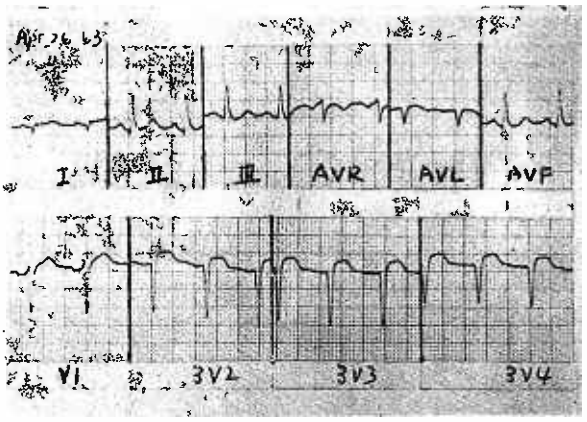


Fig. 3. Case No. 2. EKG tracings on the 1st post-operative day were consistent with an acute anterior myocardial infarction.

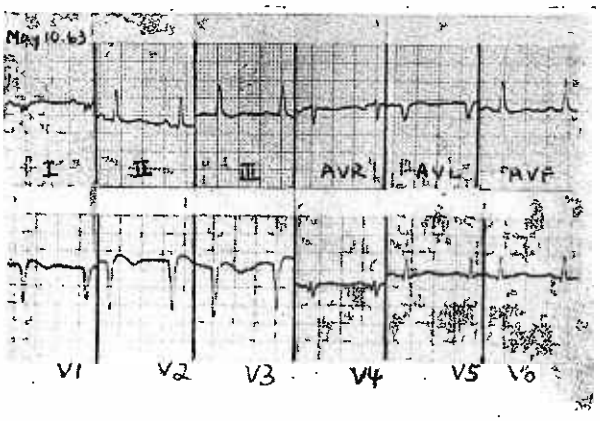


Fig. 4. Case No. 2. EKG tracings on the 14th post-operative day showed persistent changes of anterior myocardial infarction.

Comments

In this case, the ventricular chamber was not entered. The non-penetrating wound severed the anterior descending branch of the left coronary artery, giving rise to severe bleeding. The blood at first was able to escape from the peri-

cardial sac through the left pericardial wound into the pleural cavity and also out through the chest wall wound. However, at the beginning of thoracotomy, perhaps because of clot formation, free escape of blood was hindered, and a near fatal cardiac tamponade ensued. It appeared unlikely that the patient could have been saved by non-operative means.

Case No. 3

An 18-year-old male was admitted on July 10, 1964, with a knife stab wound of the left chest. On admission, the patient was in circulatory collapse with a systolic blood pressure of 40 mm. Hg. There was a V-shaped stab wound at the left 7th intercostal space just medial to the nipple line. There were signs of a left hemothorax with a marked shift of the trachea to the right. The neck veins were not distended.

Rapid transfusion of blood and dextran brought the blood pressure up to 100/70 but failed to maintain it at that level. Accordingly, surgery was embarked upon.

An anterolateral thoracotomy was carried out with removal of the 6th rib. About 2,500 c.c. of partly clotted blood was found in the chest cavity. There was a half-inch puncture wound in the lower lobe of the lung. A half-inch incised wound of the pericardium was found with blood emerging. On entering the pericardium, an actively bleeding penetrating wound of the right ventricle just medial to the descending branch of the left cornonary artery was noted. Little blood was found accumulated in the pericardial sac. The heart wound was sutured with silk with care to preserve the continuity of the coronary vessels.

The patient recovered steadily from the operation. A thoracentesis was necessary in the post-operative period to relieve a pleural effusion of 300 c.c.

Comments

Again in this case, the pericardial wound allowed free escape of blood, and there was no cardiac tamponade. The indication for thoracotomy was massive hemothorax with evidence of persistent blood loss. It was clear from the severity of bleeding from the cardiac wound that the patient was saved only by a timely thoracotomy.

Case No. 4

A 23-year-old male was admitted on July 15, 1964, with a stab wound of the left chest. On admission, the blood pressure was unobtainable and pulse very feeble. Heart sounds were faint. There was moderate distension of the neck veins. There was a stab wound at the 4th intercostal space just beneath the nipple.

A pericardial tap was immediately carried out, but it yielded nothing. Within half an hour after admission, the patient's condition further deteriorated. He was taken immediately to the operating room while emergency blood was being administered. Before the skin incision could be made, the pulse became absent. On entering the chest, no heart beat was felt. About 100 c.c. of blood was present in the pleural cavity. There was a 3-cm. wound in the pericardium. The pericardial wound was extended and a large amount of clotted blood removed from the pericardial sac. Thereupon, the heart began to resume beating. Spurts of blood were seen to issue forth from a 3-cm. penetrating left ventricular wound just lateral to the anterior descending branch of the left coronary artery. Bleeding was controlled by digital compression of the heart wound while it was being sutured. Continuity of the coronary vessels was preserved. Just prior to closure of the chest, the heart went into a standstill but responded immediately to cardiac massage.

The post-operative course was uneventful. There was no evidence of any brain damage.

Comments

In this case the development of cardiac tamponade prevented massive blood loss from the heart wound. The escape of blood into the pleural cavity was limited. The pre-operative negative pericardial tap is explained by the fact that the blood in the pericardial sac had clotted. The cardiac tamponade was of such a severe degree that had the thoracotomy been delayed for a few minutes, the patient would not have been saved.

DISCUSSION

The treatment of stab wounds of the heart is controversial. Surgeons all agree that the initial treatment should include replacement of blood loss and an attempt at pericardicentesis, under

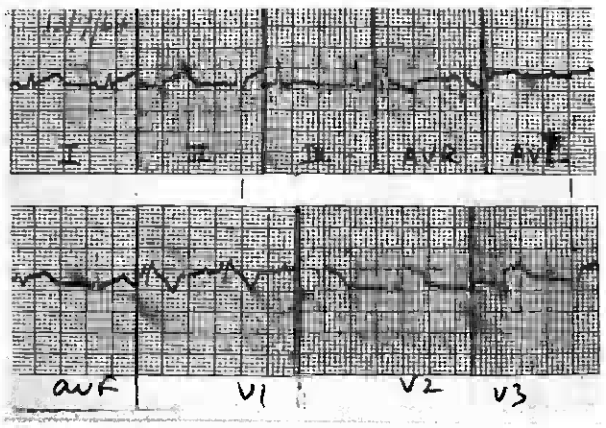


Fig. 5. Case No. 3. EKG tracings taken on the 3rd post-operative day showed injury pattern in leads I, II, AVR, V1, V2, V3.

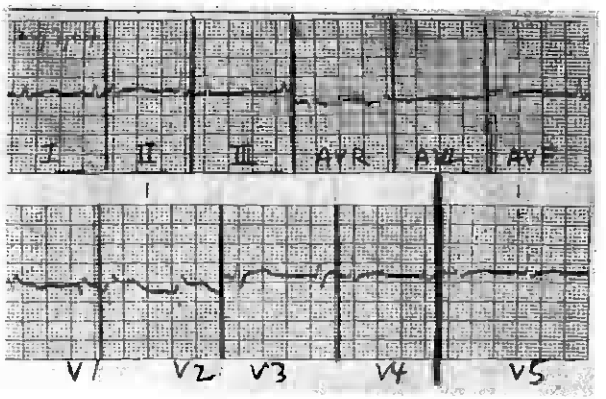


Fig. 6. Case No. 3. Reversion toward normalcy of EKG tracings taken on the post-operative day.

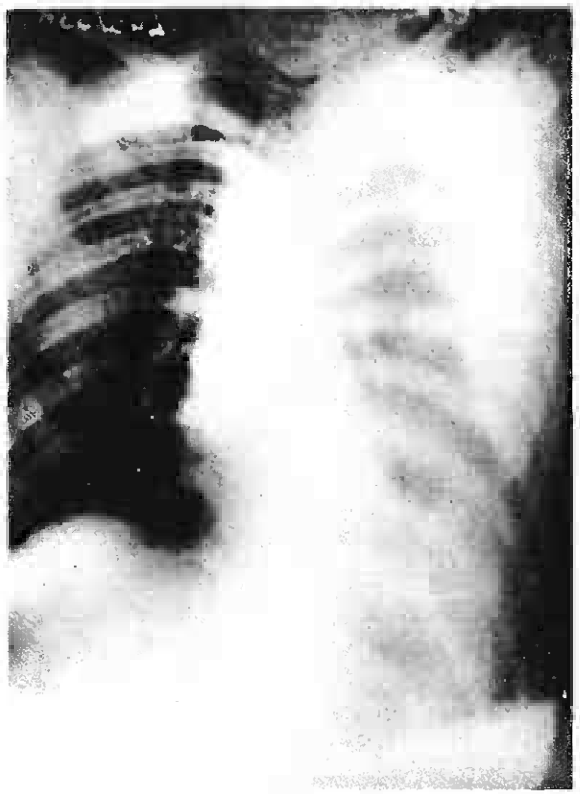


Fig. 7. Case No. 3. Admission chest x-ray film showed massive left hemothorax.

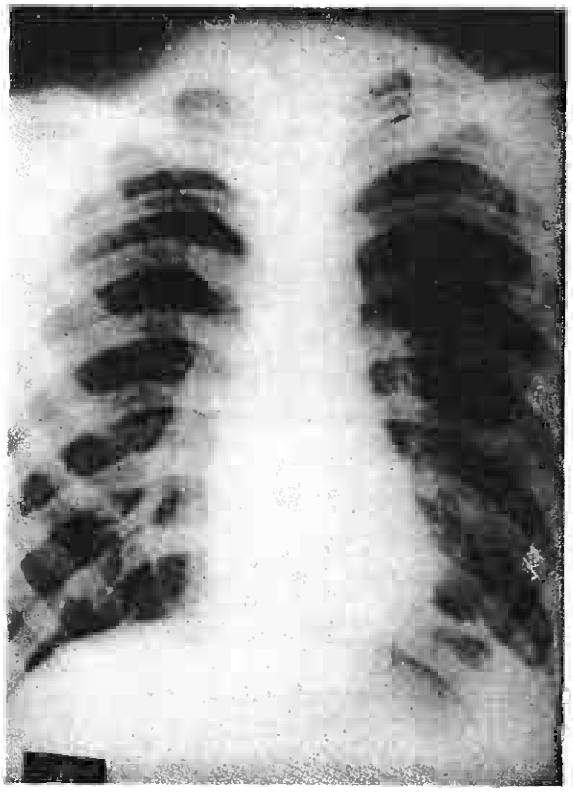
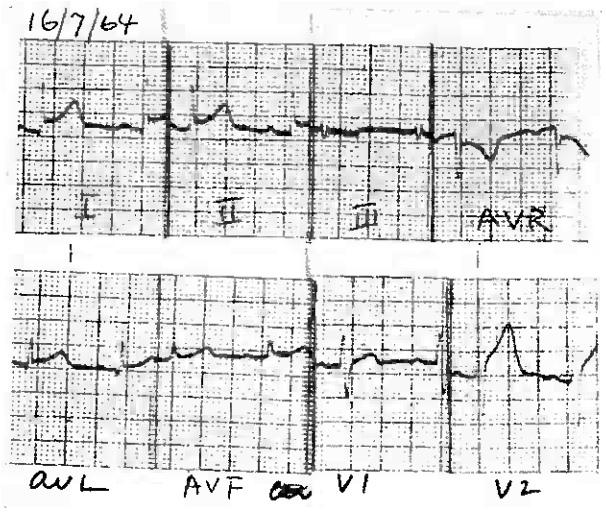
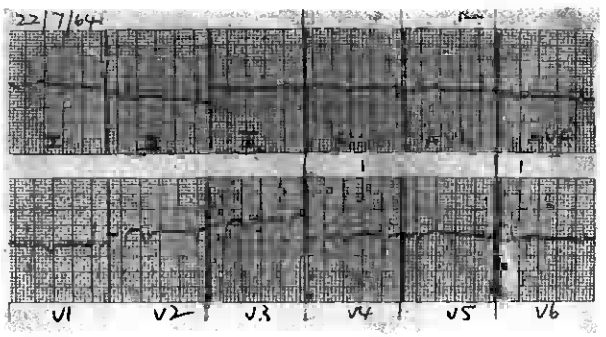


Fig. 8. Case No. 3. Essentially normal chest x-ray film on the 10th post-operative day.





Figs. 9 & 10. Case No. 4. EKG tracings taken on the 1st and 7th post-operative days showed a myocardial injury pattern and its reversion toward normalcy.

fluoroscopic control if feasible, when cardiac tamponade is present. The controversy lies in the ultimate and definitive treatment of the patient.

Pericardicentesis was popularized by Blalock and Ravitch (2) in 1943, and it has since been adopted by a great many surgeons as the definitive treatment of cardiac stab wounds with tamponade. Thoracotomy with cardiorrhaphy had long been the mainstay of treatment of stab wounds of the heart until 1940's when pericardicentesis became popular. Non-operative management appears well justified by its low mortality of less than 10%, as reported by Elkin (4), Cooley (3), and Ravitch (10). On the other hand, the mortality rate of cardiorrhaphy a few decades ago was quite prohibitive, being around 50% or higher (1, 7, 9). Although in subsequent years the mortality rate has decreased considerably, it has remained around 25% (5, 6, 8).

The reported high survival rate of non-operative management may be misleading. The high mortality rate of cardiorrhaphy should not be taken as evidence against operative treatment. Two factors should be taken into consideration in the evaluation of the treatment. First, there is the inevitable factor of selectivity. At least in some cases, the patients who may recover with the definitive treatment of pericardicentesis may recover anyway with only supportive measures. Indeed, in Elkin's series (4) of 18 cases managed successfully by conservative means, no pericardicentesis was done in 6 cases. On the other hand the patients who are subjected to thoracotomy and cardiorrhaphy may be extremely poor risks who have other serious associated injuries or who have deteriorated to a moribund state. Second there is the question of accuracy of diagnosis in the non-operative cases. Without a thoracotomy it is difficult to be sure of the true state of injury. Even the aspiration of incoaguable blood by a blind pericardial tap is not absolutely diagnostic of hemopericardium as one may be tapping a hemothorax.

Maynard (8) is perhaps among the staunchest advocates of operative treatment in stab wounds of the heart. He pointed out that in at least 50% of the cases the blood in the pericardial sac was clotted and defied withdrawal by needle aspiration. He also stressed the possibility of rapid clinical regression after aspiration. Apparently bleeding may recur following removal of the tamponade effect.

In our Case No. 4 the blood in the pericardial sac was clotted. Pericardicentesis would have been negative even if done through the open chest. Furthermore, it was observed that severe bleeding occurred following removal of the clots. It is apparent that the patient would not have been saved by any other method of treatment.

In our Cases No. 1 and 3 there was no accumulation of blood in the pericardium. The problem in these two cases was massive blood loss through the pericardial wound into the pleural cavity. In Case No. 3 persistence of conservative treatment would certainly have proved fatal to the patient.

Case No. 2 was unusual in that massive bleeding from the cardiac wound was later followed by the development of cardiac tamponade. The initial free escape of blood from the pericardial sac subsequently became impeded, perhaps by clot formation. Again this patient was saved because of a timely thoracotomy.

We are of the opinion that thoracotomy with cardiorrhaphy is mandatory in certain cases of cardiac stab wounds and that the considerable mortality of this treatment is inherent in the type of cases rather than in the treatment itself. When a cardiac stab wound gives rise to severe exsanguination without cardiac tamponade the problem confronting the surgeon is one of stab wound of the chest with persistent massive haemorrhage. It would appear that in such a case, whether or not the precise diagnosis is made or suspected thoracotomy should constitute the less radical approach. When cardiac tamponade complicates the stab injury, immediate pericardicentesis may be a temporary life-saving measure. Whether one should then proceed to a thoracotomy or repeat pericardicentesis as necessary is the main point in the controversy of treatment. We feel that with modern anesthetic facilities and improved techniques of reviving the arrested heart there is much to be said for thoracotomy and cardiorrhaphy as the definitive treatment where a significant cardiac tamponade is clinically present.

SUMMARY

Four cases of stab wounds of the heart, including one with a non-penetrating wound all treated successfully by cardiorrhaphy, are reported. Two of the cases presented with massive hemothorax. One case was complicated by

severe cardiac tamponade. The remaining case initially presented with massive hemorrhage and subsequently developed a cardiac tamponade. The controversy of definitive treatment of stab wounds of the heart is briefly discussed. The authors favour thoracotomy and cardiorrhaphy as the definitive treatment where there is massive exsanguination or cardiac tamponade.

ACKNOWLEDGEMENTS

The authors wish to thank Mr. N. K. Yong senior lecturer in surgery, University of Singapore for his advice, Mr. J. J. Murugasu, surgeon at the Singapore General Hospital, for permission to include his case, and Dr. K. K. Tan, pathologist at the Singapore General Hospital, for his help in reviewing the autopsy records.

REFERENCES

1. Bigger, I.A. (1931): "Heart Wounds", J. Thoracic Surg. 8, 239.
2. Blalock, A. & Ravitch, M.M. (1943): "A Consideration of the Non-operative Treatment of Cardiac Tamponade resulting from Wounds of the Heart", Surg. 14, 157.
3. Cooley, D.A., Dunn, J.R., Brockman, H.L. & Debakey, M.E. (1955): "Treatment of Penetrating Wounds of the Heart: Experimental and Clinical Observations, Surg. 37, 882.
4. Elkin, D.C. & Campbell, R.E. (1951): "Cardiac Tamponade: Treatment by Aspiration, Ann. Surg. 133, 623.
5. Griswold, R.A. & Drye, J.C. (1954): "Cardiac Wounds, Ann. Surg. 139, 783.
6. Maguire, C.H. & Griswold, R.A. (1947): "Further Observations on Penetrating Wounds of the Heart and Pericardium", Am. J. Surg. 74, 721.
7. Maynard, A.D.L., Cordice, J.W.V., Jr., & Naclerio, E.A. (1952): "Penetrating Wounds of the Heart, a Report of 81 Cases", Surg. Gynec. & Obstet. 94, 605.
8. Maynard, A. D. L.: (1958): "Current Surgical Management", page 355, W. B. Saunders Co. (Phila.).
9. Peck, C.H. (1909): "The Operative Treatment of Heart Wounds", Ann. Surg. 50, 100.
10. Ravitch, M.M. & Blalock, A. (1949): "Aspiration of Blood from Pericardium in the Treatment of Acute Cardiac Tamponade after Injury", Arch. Surg. 58, 463.