MEDICAL INTELLIGENCE

CLOSED-CHEST CARDIAC MASSAGE IN THE TREATMENT OF VENOUS AIR EMBOLISM*

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VENOUS air embolism is a dreaded complication of a variety of surgical, therapeutic and diagnostic technics. In one series it accounted for 1 in 108 operating-room deaths.[1] It is almost always the result of human error.[2]

The diagnosis is usually made by the detection of the "mill-wheel" murmur, said to be pathognomonic of the condition.[3] The murmur represents the right ventricle beating against the bubbles of air, and this sign is frequently the precursor of cardiovascular collapse.

Previous treatment has consisted of placing of the patient in the left lateral decubitus position to dislodge the bubble of air from the outflow tract of the right ventricle.[4] Oxygen under positive pressure and vasopressors are then administered, followed in some cases by thoracotomy, manual massage and aspiration of air from the heart.[5,6]

We have collected 93 cases from the literature in which these methods of therapy were employed (Table 1). It should be noted that 93 per cent of the untreated patients died, and it will also be seen that the most successful treatment was the use of the left lateral decubitus position along with oxygen and vasopressors.

It is apparent, however, that certain surgical situations prevent placing the patient promptly in the left lateral decubitus position. It was during just such a neurosurgical procedure, the patient being in reverse Trendelenburg position with the dura open, that one of us (J.E.) initiated the use of closed-chest compression of the heart for the treatment of air embolism with cardiovascular collapse as an alternative to the standard treatment. The patient responded to this procedure promptly, and we resolved to institute closed-chest cardiac massage in future patients in an effort to evaluate its place in the treatment of venous air embolism. Since that time we have encountered 6 more patients, 4 of whom have been treated with closed-chest cardiac massage. The results of this treatment are summarized in Table 2.

TABLE 1. *Treatment of Air Embolism in 93 Collected Cases.**

TYPE OF TREATMENT	NO. OF CASES	NO. OF DEATHS	MORTALITY
			%
Oxygen & vasopressors	16	14	88
Oxygen & vasopressors with left lateral position	27	9	33
Oxygen & vasopressors with left lateral position & open-chest cardiac massage	10	8	80

*There were 68 deaths (73%), 40 untreated, with 37 deaths (93%), & 53 treated, with 31 deaths (58%).

CASE REPORTS

The 7 patients in this series ranged in age from two and a half to seventy-five years. All were scheduled for elective craniotomy in the head-up position. In all 7 patients anesthesia was maintained with a mixture of halothane, nitrous oxide and oxygen administered in a semiclosed system with a circle absorber. In 4 patients the air embolism occurred as the skull was being opened with a nitrogen-driven drill, shortly after the procedure was begun. The other 3 suffered their air emboli one to two hours after the beginning of the procedure. All patients, however, had tolerated their procedures well up until the time of the embolus.

The diagnosis of air embolism was made in each case by the auscultation of the typical mill-wheel murmur over the precordium, accompanied or followed by a sudden cardiovascular collapse. In Cases 1-5 closed-chest cardiac massage was begun at once along with the administration of 100 per cent oxygen, and this was sufficient to restore an adequate cardiovascular status within three to five minutes, although further support with vasopressors was necessary in 4 of the 5 cases. Of these 5 patients 3 are doing well at the present time. One died on the sixth postoperative day of metastatic carcinoma of

TABLE 2. *Results in 7 Cases.*

CASE NO.	CLOSED-CHEST MASSAGE	EFFECT OF THERAPY	SURVIVAL	COMMENT
1	Yes	Resuscitation	Yes	
2	Yes	Resuscitation	Yes — to 6th postoperative day	Death, with metastatic tumor
3	Yes	Resuscitation	Yes	Craniopharyngioma
4	No	Resuscitation	No	Death 4 hr. after operation
5	Yes	Resuscitation	Yes	
6	Yes	Resuscitation	No	Death 6 hr. after operation, with massive right-sided intracerebral hemorrhage
7	No	Resuscitation	?	Patient sent to nursing home

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the breast, the disease for which her craniotomy had been performed. The other patient died six hours after operation with a massive intracerebral hemorrhage. Before death the patient had been alert and responding for approximately four hours after the conclusion of the procedure, and it was believed that she suffered no sequelae from the air embolus in the immediate postoperative period. Case 6 apparently suffered two episodes of air embolism during his procedure, and both times he was treated by being placed in the left lateral decubitus Trendelenburg position. On the first occasion the mill-wheel murmur cleared almost at once, and the blood pressure was gradually restored. On the second occasion, an hour later, although the blood pressure was again restored when he was placed in the head-down position, the murmur did not disappear. He did not respond well at the conclusion of the procedure, and had increasing difficulty with labored respirations and pulmonary secretion. He was digitalized, and an attempt was made at tracheostomy, but cardiac arrest occurred before this could be completed and all resuscitative measures were of no avail. Autopsy revealed bilateral pulmonary edema and pleural effusion. No air could be demonstrated in the heart. Case 7 was noted to have a mill-wheel murmur although her vital signs remained normal. Before any therapeutic measure could be undertaken, the murmur gradually and spontaneously cleared. The procedure was completed with the patient in good condition.

Discussion

Apparently, the chief factor in successful treatment of air embolism is the speed with which resuscitative measures are begun. Herein lies the advantage of closed-chest cardiac massage. It can be rapidly started with the patient in a variety of positions and when the surgical conditions make it difficult to place the patient in a head-down position. Indeed, it is possible to begin massage before time is taken even to establish the diagnosis while the surgical procedure is allowed to continue. It can certainly be said that of the 7 patients discussed above, 5 were successfully resuscitated by means of closed-chest cardiac massage. The 1 death in this group was probably the result of the patient's disease and not of air embolism. Of the 2 patients who were not treated with closed-chest massage, 1 died four hours after operation in heart failure, to which the air embolism that he suffered probably contributed.

Whether closed-chest cardiac massage is better than the standard means of treatment we cannot say from such a small series. However, closed-chest massage can be instituted rapidly and is apparently successful without resort to aspiration of the right ventricle. Success has not been common in the emergency treatment of air embolism, and we consider it fortunate that we were able to use this technic to good effect in the cases presented.

Lastly, it is to be emphasized that air embolism is rapidly fatal unless treatment is begun at once. The keystone to successful treatment is early diagnosis. A high index of suspicion and a precordial stethoscope are mandatory in operations upon the head and neck, in which the patient is in the reverse Trendelenburg position or pressure-driven instruments are to be used.

Summary and Conclusions

Seven cases of venous air embolism occurring during craniotomy are reported. Five of these patients were successfully resuscitated by means of closed-chest cardiac massage. It is believed that closed-chest cardiac massage is a valuable tool in the treatment of air embolism.

References

1. Dornette, W. H. L., and Orth, O. S. Death in operating room. *Anesth. & Analg.* **35**:545-569, 1956.
2. Bailey, M. Air embolism. *J. Internat. Coll. Surgeons* **25**:667-688, June, 1956.
3. Shivpuri, D. N., Viswanathan, R., Sharma, M. L., and Singh, P. P. Pre-symptomatic diagnostic sign of venous air embolism. *Indian M. A. J.* **33**:86-88, 1959.
4. Durant, T., Long, J., and Oppenheimer, M. J. Pulmonary (venous) air embolism. *Am. Heart J.* **33**:269-281, 1947.
5. Stallworth, J. M., Martin, J. B., and Postlethwait, R. W. Aspiration of heart in air embolism. *J.A.M.A.* **143**:1250-1253, 1950.
6. Nicholson, M. J., and Crehan, J. P. Emergency treatment of air embolism. *Lahey Clin. Bull.* **9**:239-248, 1956.

HAZARDS TO HEALTH

Scopolamine Poisoning*

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Scopolamine is now being sold to the public without control or restriction in a sleeping preparation called "Sominex." Each tablet contains 0.25 mg. of scopolamine. Advertisements emphasize the "harmless" and "safe" character of the product.

Six cases of severe scopolamine poisoning have been reported from Natrona County Memorial Hospital in the past six months. All were suicide attempts. A detailed description of one will suffice.

Case Report

A 55-year-old woman was admitted to the hospital after having taken a dozen of the tablets in a suicide attempt. She was stuporous, rousing intermittently to a semicoherent state. The extremities jerked in clonic convulsions at frequent intervals. The pupils were dilated; the mouth was dry, the skin hot, and the pulse rapid. Extreme irritability was apparent: the patient reacted wildly to minor stimuli.

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