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Cardiac Pacemaker in a Cadaver: A Case Report

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Abstract:
Introduction: *Artificial cardiac pacemakers are indicated for patients whose heart beat too slow or beat too fast. There is increasing use of this medical equipment in recent time. A good knowledge of anatomy is essential for carrying out the procedure. Method: A cardiac pacemaker was observed during routine dissection of a female cadaver. The pulse generator was present in the right infraclavicular region. Leads were tracked till it pierced the wall of a vein. Thoracotomy was done and the heart was removed with the pacemaker in-situ. Composite structure was radiographed to ascertain the position of the tip of leads followed by dissection. Result: Leads entered the right subclavian vein, traversed right brachiocephalic vein, superior vena cava, right atrium and finally the tip resting in the right ventricle. Discussion: A pacemaker retrieved from cadaver can be reused. Non removal of pacemaker before cremation can cause bursting of the equipment and a major catastrophe. Conclusion: A thorough knowledge of anatomy is necessary by a cardiothoracic surgeon for a successful implantation. Hence, students could be taught clinical anatomy with such cadaver with medical instrument. It is assumed that similar cases of medical equipments could be considered as a new perspective for teaching clinical anatomy.*
Key words*: Pacemaker, cadaver, clinical anatomy, cardiovascular system*

I. Introduction

Permanent cardiac pacemakers are electronic devices that give electrical impulses, delivered by insulated wire leads. The pulse generator consists of a stainless steel case containing lithium-iodide battery. The pulse generator is implanted under the skin of the infraclavicular area mainly on the right side because of the short course of the right subclavian vein to the heart. The leads are connected from the pulse generator to the ventricular trabeculae, usually of the right ventricle. They are most commonly used for patients whose heart beats are either too slow or would stop beating completely if not stimulated electrically (demand type of pacemaker). It is also for patients whose heart beats are too fast (implantable cardiofibrillator). With the increasing use of this modern equipment in medical science, the students of anatomy need to be equipped with the desired knowledge to understand the anatomical basis of emergency medicine and surgical procedures. Findings of medical equipments in cadaver assist the students in learning anatomy with a realistic approach to the particular area of human body where the equipment is introduced and kept in situ. It is noteworthy that clinical anatomy makes the anatomy more interesting. The present case report, a pacemaker in cadaver, is used as a new perspective for teaching clinical anatomy.

II. Materials and methods

During a routine dissection by medical students of upper limb in a female cadaver of about 60 years, a pulse generator was discovered in the right pectoral region just below the clavicle. Leads from the pulse generator were tracked by meticulous dissection till a vein is pierced. Thoracotomy & hemi- section of sternum were done. Fibrous pericardium was incised and the heart removed with the pacemaker in-situ. The heart, along with pacemaker, was radiographed to ascertain the tip of the leads. Finally the hearts was dissected to expose the passage of the leads.

III. Result

Pulse generator was lodged inside a pouch of superficial fascia of right pectoral region just below the clavicle (Fig 1). Two leads were discovered inside the tissue pouch. Both the leads pierced the right subclavian vein adjacent to one another just above right first rib. To track the leads, the right half of sternum was sawed and removed along with costal cartilages. The fibrous pericardium and the outer (parietal) layer of serous pericardium were incised vertically in line with superior vena cava. The heart with the pacemaker in-situ was removed along with the great vessels. Composite structure was radiographed. After ascertaining the position of the leads, the anterior walls of the right atrium and ventricles were incised (Fig 2) to visualize the tips of leads ending amongst the trabeculae carnae of right ventricle (Fig 3). Only one of the leads was functioning, one at the time of death and the other lead was a non-functioning old lead.

Figures

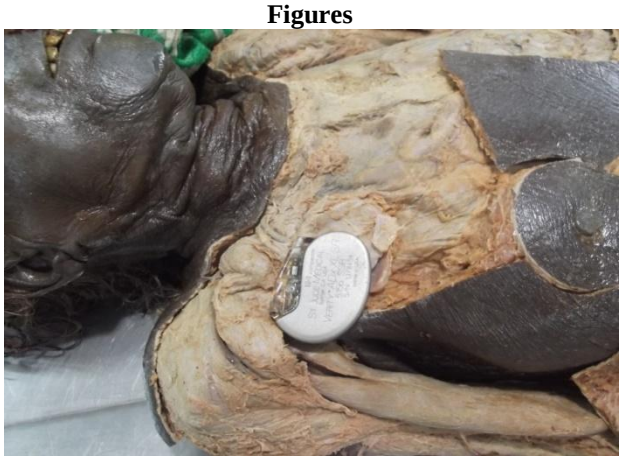

FIG 1: Pulse generator dissected from the pocket in superficial fascia overlying pectoral region

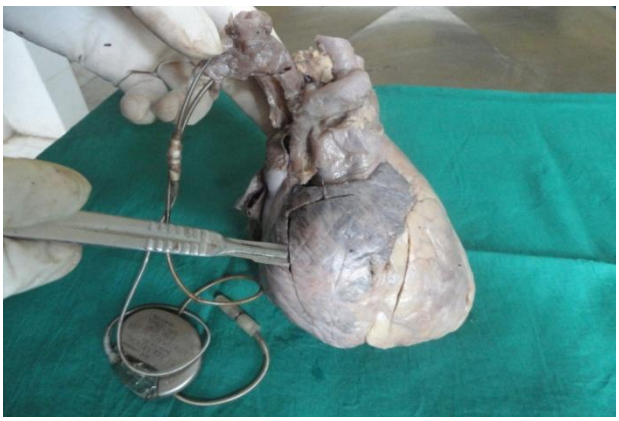

FIG 2: Anterior wall of heart incised to expose the position of the tip of leads

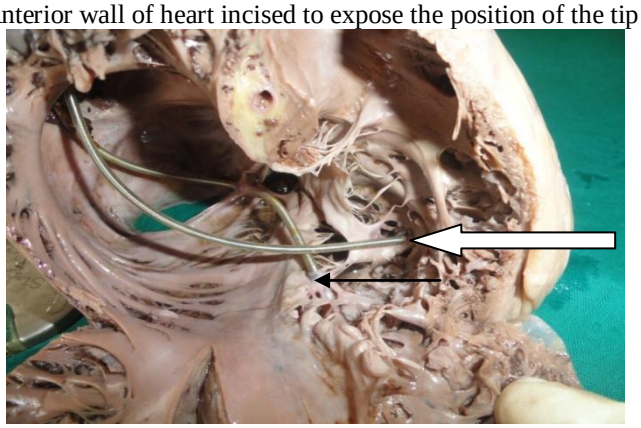

FIG 3: A dissected view of the right-sided implantation of ventricular electrode.
Tips of the leads amongst the trabeculae carnae (line arrow at the tip of old lead & broad arrow at the tip of new lead)

IV. Discussion

Clinical anatomy is taught by citing examples, by showing photographs, illustrations or by medical images. The present trend to utilize clinical imaging to assist conceptualize anatomical structures, effectively transforms anatomy into a different entity. New imaging technologies like ultrasonography, 3D visualization, multiaxial computerized image reconstruction, multiplanar magnetic resonance imaging have improved our understanding of anatomical structural organization. The burning question which remains is "Is cadaver-based learning in the dissecting room relevant or essential for tomorrow's doctors?"[1] In medical course, cadaver is the first patient and the study of anatomy is never fulfilling without it. Hands on cadaver teaching is the first step towards interpretation of 3D structural organizational organization of body[2]. Also, lecture-demonstration with in- situ medical equipments in cadavers facilitate students' hand - on experience of usage of instrument and the possible complications. Extensive search in the pubmed failed to find a comparable study with emphasis on clinical anatomy based on medical appliances in cadaver. In the present context of pacemaker in a cadaver, teaching of clinical anatomy can be embarked from the general anatomy of skin, superficial fascia, superficial vein, deep fascia, muscles, deep veins and artery and finally the anatomy of heart and its covering, thus completing the major portion of cardiovascular system in a short period of time. The procedure could be explained in the following way:

i. The importance of superficial fascia in the pectoral fascia is emphasized as it houses the pulse generator in a pocket created in the superficial fascia, which otherwise is a neglected structure in the dissection as a fatty layer. The deep fascia called the pectoral fascia of the region lies posterior to the equipment. The deltoid fascia lies laterally covering the deltoid muscles. The cephalic vein lies in the deltopectoral groove and pierces the clavipectoral fascia to drain into axillary vein. This superficial vein is chosen by the cardiac surgeons to introduce the leads[3] or deep veins like subclavian vein[4]. Preference of right or left subclavian vein for introduction of lead depends upon the cardiothoracic surgeon. They opine that left subclavian vein is preferred because of a simpler anatomic position of the subclavian vein as well as easier organization of work in case only a cardiologist performs an operation without the help of a surgeon. However, in case of right-sided implantation of a cardiac pacemaker, the position of an electrode is in the form of letter "S", which means that the electrode bends in two contralateral curves which are in contrast to left- sided implantation where the electrode has only one curve on its path from the generator to the peak of the heart. Nonetheless, these two curves of the electrodes give better stability and fewer number of post-operative dislocations[5].

ii. In the present case, we observed introduction of leads in the right subclavian vein. This right-sided procedure, from anatomical point of view, would be easier and less time consuming because the right subclavian vein is shorter than the left subclavian vein. Subclavian veins are the continuation of axillary veins. They extend from the outer border of the first ribs of respective sides to the medial border of scalenus anterior, where they are joined by internal jugular vein to form the right and left brachiocephalic veins. It then unites with the right and left brachiocephalic vein to form the superior vena cava. During the course of dissection cum demonstration of the case, the relationship with the subclavian artery could be impressed upon as it could be punctured because of its close proximity and the impending danger thereafter.

iii. Clinical procedure of subclavian vein is cannulated with the needle towards the suprasternal notch and necessary care is taken to avoid downward direction of the needle, which may cause a pneumothorax because of adjacent relation with lungs[6].

iv. While sawing the sternum, in the present case, the attachment of fibrous pericardium to the posterior surface of the sternum by the superior and inferior sternopericardial ligaments could be explained as they fasten the pericardium and maintain the general thoracic position of the heart and serve as the 'cardiac seat belt[7]. Presence of thymus in the region could be demonstrated too.

v. Pericardium is the covering of the heart. Its layers could be explained by showing the attachment of the fibrous pericardium at the roots of great vessels. In the present case, the heart was removed along with the visceral pericardium leaving the fibrous layer. The space where the hand was inserted to remove the heart is the pericardial cavity which in the living lie apposed to each other and separated by a film of fluid.

vi. Upon opening of the chambers of the heart, orientation of the right heart, left heart, the valves and chordae tendinae, papillary muscles and trabeculae carnae could be demonstrated and explained. Importance of the trabeculae carnae in the present context is the trapping of the tip of the leads. The electrode tip of the non-functioning lead was found adherent to the endocardium. Old leads get adhered to the enodocardium or myocardium hence posing a risk of injury and death if lead is extracted. Therefore, only the pulse generator is replaced or removed but the non-functioning electrode lead is not extracted.

Normally, the life span of a pulse generator is 10 years. After this period the pulse generator is to be replaced by a new one either of the previous company or another company. In the present case, old pulse generator could have been of different company and the new one being St Jude Medical make, hence the two leads. Rare discovery of medical equipments in cadaver could be an excellent aid for teaching clinical anatomy to medical students. Merits and demerits of discovering such medical equipment in cadaver must be known.

Firstly, Pacemaker has explosive potential when heated. In 1976, incidence of explosion was first reported[9]. An article on the frequency and consequences of pacemaker explosion in crematoria highlighted that explosion of pacemaker can cause massive destruction like causing serious injury to the cremator and breaking doors or brickwork. The noise of an explosion may cause distress too. The reason being, the lithium-iodide battery operating the pacemaker gets heated during cremation to a temperature of about 1300^0C (2400^0F) for 90 minutes, iodine forms a gas that expands and causes pacemaker casing to burst[9]. In the United Kingdoms, a statutory question on the cremation form asks the attending physician whether the deceased had a pacemaker and if so whether it has been removed[10]. The majority of Indian population comprising of Hindu faith cremate the dead body in pyres. On the basis of aforementioned reports, before disposal of the dead body of a Hindu, there is a point to ponder upon. Needless to say, pacemaker must be removed before cremation to avoid a disaster.

Medical equipments in a dead body on the other-hand could also be a boon for the needy patients too. Pacemaker can be recycled from one body to another. However, there are myriad reports of reuse of pacemakers ranging from safety[11], ethical[12] and legal implications[13].

V. Conclusion

The pacemaker implantation procedure depends completely on anatomical structure of the cardiovascular system hence a good knowledge is essential for a successful surgery. Pulse generator should be removed in case of Hindus who are undergoing cremation. It is assumed that such cases of medical equipment in cadaver could be a new perspective for teaching clinical anatomy.

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