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Teaching basic cardiac anatomy and physiology to first year medical students by echocardiography

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ABSTRACT

Introduction: Human anatomy is being taught now by cadaveric dissection. In echocardiorpahy, which is dynamic and realtime cardiac study, students can be taught gross cardiac anatomy as well as basic cardiac physiology.
Aim: To compare the conventional teaching method of cardiac anatomy and physiology in a cadaver to the innovative teaching method in live beating heart by echocardiography and to ascertain the efficacy of two methods from students point of view.
Methodology: Preclinical medical students from our medical college were chosen for this study. First they were taught cardiac anatomy and physiology by conventional didactic methods. Later they were taught the same in a live beating heart by echocardiography. By means of questionnaire they were asked to compare the two methods of learning cardiac anatomy and physiology.
Results: It was observed that the study of cardiac anatomy and physiology by live, real-time, dynamic echocardiographic study was better appreciated and understood by majority of students (89.6%).
Conclusion: In order to make budding doctors better and efficient physician, radiology should be incorporated at all semesters of MBBS course-like anatomy, physiology, pathology, clinical medicine etc. The feedback received from the students will be helpful in further refinement of the course for future implementation.

1. Introduction

The anatomy studied by preclinical medical students is mainly from cadaver or specimen.

Human physiology is studied by conventional didactic lectures and some lab.experiments.

In echocardiography, we study anatomy and physiology in a live, beating heart in real-time dynamic motion. It is a new method of teaching that is being encouraged in our medical college hospital. It is thrilling experience to students to see various parts of heart structure in real time— valves opening and closing; rthymically contracting myocardium., etc. Various events of cardiac cycle-systole and diastole occur in a clockwise-precision and are a visual treat. It is easy for the student to appreciate the basic concepts of cardiac anatomy and physiology by this new method. Based on the ventricular volume and other measurements various LV functions could be estimated –like stroke volume, Cardiac output, Left ventricular ejection fraction, etc.. In this study cardiac anatomy and physiology are demonstrated, live in a beating heart, to a group of first year medical students.

2. Basic Essential Echocardiography

Echocardiography (ECHO) – the use of ultrasound to examine the heart – is a safe, non-invasive, non ionising and painless diagnostic imaging technique, for imaging the heart

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for study of structure and function of beating, live heart. In areal-time dynamic fashion.

ECHO makes use of ultrasound waves (waves in the frequency range from 1.5 MHz -7.5MHz for diagnostic purpose.

Ultrasound is generated from certain crystals which show piezo-electric effect. These crystals are kept inside a specialised structure called transducer or probe. The probe is placed over the anterior chest wall of patient, after applying specialised gel as a coupling medium.

The transducer or the probe, from which ultrasound beam is generated, is placed over certain standard position in patient's anterior chest wall. Common transducer positions are shown in Figure 1. The various planes used for optimally visualising various cardiac structures are shown in Figure 2. The cardiac anatomy displayed and the physiological function assessed by various planes is shown in the (Table 1). Imaging Plates 1 to 5 show the basic B-MODE (B- brightness) images of the heart showing various structures –cardiac chambers, valves, Interventricular septum, pericardium, etc. Imaging Plates 6 to 11 show the M-MODE (M-motion) tracing of various structures, where common measurements can be made easily and accurately. Table 2 shows summary of cardiac anatomy, physiology and some eg.pathology revealed by ECHO.

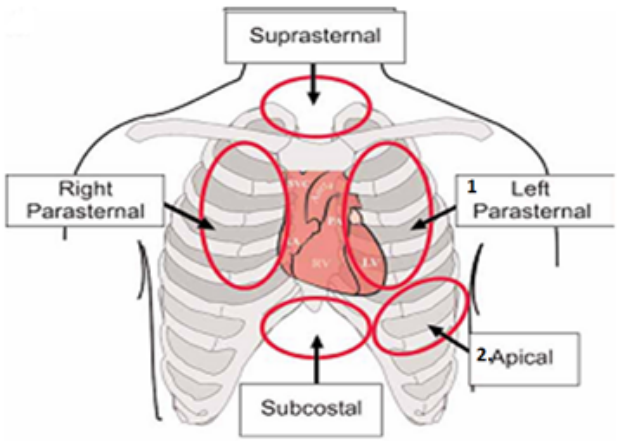

Fig. 1: Common transducer position for viewing the heart (only positions 1 and 2 are used in our study)

2.1. Technique of ECHO for obtaining cardiac images

There are a number of standard positions on the chest wall for the transducer where there are 'echo windows' that allow good penetration by ultrasound without too much masking and absorption by lung or ribs. For our study purpose we used only left parasternal long axis (PSLAX) and left parasternal short axis (PS-SAX) and apical 4 chamber view (A4CV).

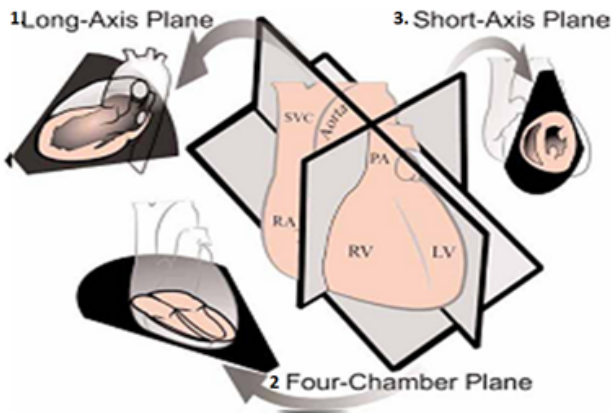

Fig. 2: Common imaging planes used in our study
Note: 1. Left parasternal long-axis plane (PS-LAX); 2. Apical four chamber plane (A-4-C-); 3. Left parasternal short axis plane (PS-SAX)

3. Aims and Objectives

1. Live demonstration by echocardiography in a beating heart the basics of cardiac anatomy and physiology in real dynamic time.
2. Exposure to first year students the basic of ECHO and value of ECHO.
3. To compare the conventional teaching method of cardiac anatomy and physiology in a cadaver to the teaching method in live beating heart. And to ascertain the efficacy of two methods from students point of view.

4. Materials and Methods

60 preclinical students from our medical college were chosen for this study. Initially they were taught, basic cardiac anatomy and physiology, by conventional method of learning like–dissection, didactic lecture etc. by an anatomy and physiology teachers.

They were then given a Pre-test questionnaire to test their background knowledge and understanding of the subject of basic cardiac anatomy and physiology after the conventional method of teaching. Students were asked to answer about their observation.

Later they were given an introduction to radiology by a radiologist.

They were also introduced to ECHO, how it can help in showing the cardiac anatomy and physiology in a live, beating heart by power point presentation. Later they were taken to Echocardiography room to show the ECHO equipment and how images are acquired.

They were shown the various cardiac structures seen in ECHO-like cardiac chambers, valves, IAS, IVS., Papillary muscles, Myocardium, pericardium., etc.

Table 1: Various planes commonly used for imaging the heart

Plane	Structures shown (anatomy)	Functions Assessed. (physiology)
PS-LAX	Left atrium, left ventricle, mitral valve, aortic root and valve, Interventricular septum, Part of RV cavity	LVEDV LVESV LV Function.- SV, EF, FS
A-4-C	All four chambers-LA,RA, LV, RV Both septum-IAS, IVS. Valves-mitral, tricuspid. LV free wall	Any abnormal backflow (regurgitate jet) at mitral, tricuspid, aortic valve level)
PS-SAX	LV cross-section Papillary muscle MV in cross-section	Global and regional LV analysis MV orifice diameter

Table 2: Summary of cardiac anatomy, physiology and some pathology revealed by ECHO

Anatomy	Physiology	Pathology e.g.
Heart chamber, morphology and size	Chamber function (systolic and diastolic)	Valve fibrosis, calcification.
Valvular apparatus	Valvular motion and function	Valvar stenosis and pressure gradients) by Doppler echo.
Endocardium	Direction of blood flow and haemodynamic information	Regurgitation across valves
Myocardium	Global, regional LV function.	Intracardiac and extracardiac masses
Pericardium		Fluid collection-Pericardial effusion

Later they were shown the cardiac cycle in live, in a living person.- Atrial systole and diastole, ventricular systole and diastole, valve opening and closing (corresponding to heart sounds), Rthymic contraction of myocardium keeping pace with the intrinsic conducting system.

Various measurement were made to show common left ventricular function –like Stroke volume, cardiac output, ejection fraction and fraction shortening, which all indicate normal LV function.

At the end of new teaching session, they were given the same questionnaire as Post-test survey. This is to ascertain their understanding the cardiac and anatomy by a new, live dynamic study method.

After the study was over the students met all the faculties and discussed about the pros and cons of new method of learning cardiac anatomy and physiology.

5. Observation

All the sixty students took part in Pre-test, Post-test questionnaire. They all answered all the questions. They also took part in post-test survey.

Table 3 gives the response, given by students, for the questionnaire for conventional method of study.

Table 4 gives the response, given by students, for the questionnaire for live, echocardiographic method of study.

Table 5 gives the comparison of responses by two methods of study.

We found that the study of cardiac anatomy and physiology by live, real-time, dynamic echocardiographic study was better appreciated and understood by majority of students (89.6%).

There was mixed response for the same study by conventional method-some felt it was good (49.1%) and some felt it was somewhat good (38.3%).

The percentage of ‘not good’ response was more for conventional method of study (12.5%), compared to live mdynamic real time echocardiographic study (1.6%).

The reasons for’ not good were not clearly spelt out, they were mostly subjective.

In the feed back form there were 54 (90%) affirmative answers for the new method of teaching. Only 6 students answered in the negative (10%).

6. Discussion

The best method of teaching human anatomy is by dissection. Unlike in the past, now there are so many constriants in getting bodies for dissection. Further the syllabus for anatomy and the time period for learning by dissection has been drastically. Despite the emergence of innovative teaching methods, including interactive multimedia resources, students’ perception of the importance of dissection remains intact. A recent study compared cardiac anatomy teaching using live ultrasound imaging and dissection and showed substantial improvement of students’ knowledge.[1] Wittich et al. implemented an echocardiography training program using

Table 3: Questionnaire for assessing acquired knowledge of basic cardiac anatomy and physiology -based on conventional study (Dissection, Cross-section of specimen, Didactic lectures)

S.No.	Observation	Good	somewhat better	Not good
1.	Identification of pericardium	-	45	15
2.	Identification of myocardium	30	30	-
3.	Identification of cardiac valve apparatus	35	25	-
4.	Identification of papillary muscles, chordaetendinae.	10	35	15
5.	Identification of atria and ventricles.	50	10	-
6.	Major events in cardiac cycle	45	15	-
7.	Mechanism of valve closure and opening.	40	15	5
8.	Generation of heart sounds	40	15	5
9.	Rthymic myocardial contractility.	40	15	5
10.	Measurement of cardiac function.	5	25	30
	Total	295	230	75

Table 4: Questionnaire for assessing acquired knowledge of basic cardiac anatomy and physiology based on live echocardiographic study

S.No.	Observation	Good	Somewhat good	Not good
1.	Identification of pericardium	60	-	-
2.	Identification of myocardium	55	5	-
3.	Identification of cardiac valve apparatus	60	-	-
4.	Identification of papillary muscles, chordaetendinae.	60	-	-
5.	Identification of atria and ventricles.	60	-	-
6.	Major events in cardiac cycle	50	10	-
7.	Mechanism of valve closure and opening.	48	7	5
8.	Generation of heart sounds	40	15	5
9.	Rthymic myocardial contractility.	45	15	-
10.	Measurement of cardiac function.	60	-	-
	Total	538	52	10

Table 5: Comparison of results of two methods of teaching

Method of study	Good	Somewhat good	Not good
Conventional teaching method	295 (49.1%)	230 (38.3%)	75 (12.5%)
By live echocardiographic study	538 (89.6%)	52 (8.6%)	10 (1.6%)

handheld ultrasound devices in the core curriculum of Cardiovascular Gross Anatomy. The program was taught for first-year medical students to image and identify cardiovascular structures by using a parasternal long-axis (PLAX) ultrasound projection.[2] Michael J. Griksaitis suggested, by their study, that both cadaveric section and ultrasound are equally effective methods for teaching gross anatomy of the heart.[3] D. Patten found that the Students were extremely positive about their experience in new method of learning.[4]

Wildhaber et al. showed a Software compatible to Windows, has been newly developed. Testing was performed during a full term of physiological lecturing to medical and biology students. A user-friendly interactive computer programme that has proved to be useful in teaching the basic physiological principles of heart mechanics.[5]

Hammoudi N et al.[6] showed that Cardiac anatomy and physiology teaching using ultrasound is feasible for undergraduate medical students and enhances their motivation to improve their knowledge. Student and teacher feedback on the course was very positive.

7. Conclusion

At the end of the study we strongly feel that we have achieved our aim and objective of this study. In order to make budding doctors an efficient physician in future radiology should be incorporated at all semesters of MBBS course-like anatomy, physiology, pathology, clinical medicine etc. For success of such programme close co-operation of radiologist and pre-clinical teachers is required.

8. Source of Funding

None.

9. Conflict of Interest

None.

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