Original Research Article

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

B Varadharaju1, Hemakumar2, Balachandran3,*

1 Dept. of Physiology, Saveetha Medical College, Chennai, Tamil Nadu, India
2 Dept. of Biomedical Engineering, Pondicherry Engineering College, Pondicherry, India
3 Dept. of Radiodiagnosis, Sri Lakshmi Narayana Institute of Medical Science Medical College & Hospital, Pondicherry, India

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; rhythmically 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...
for study of structure and function of beating, live heart. In a real-time dynamic fashion.

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

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 (PS-LAX) and left parasternal short axis (PS-SAX) and apical 4 chamber view (A4CV).

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                            |
|         | All four chambers-LA, RA, LV, RV                                                          | LVESV                            |
|         | Both septum-IAS, IVS. Valves-mitral, tricuspid. LV free wall                              | Any abnormal backflow (regurgitate jet) at mitral, tricuspid, aortic valve level |
| A-4-C   | Papillary muscle                                                                          | Global and regional LV analysis  |
| PS-SAX  | LV cross-section                                                                          | 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), Rhymic 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 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 constrains 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. 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, chordae tendineae | 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.    | Rhythmic 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, chordae tendineae | 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.    | Rhythmic 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. Michael J. Griksaitis suggested, by their study, that both cadaveric section and ultrasound are equally effective methods for teaching gross anatomy of the heart. D. Patten found that the Students were extremely positive about their experience in new method of learning.

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.

Hammoudi N et al. 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 cooperation of radiologist and pre-clinical teachers is required.

8. Source of Funding

None.
9. Conflict of Interest

None.

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Author biography

B Varadharaju, Associate Professor

Hemakumar, Assistant Professor

Balachandran, Professor

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