

MULTI DETECTOR COMPUTED TOMOGRAPHY (MDCT) AS A TEACHING AID OF HUMAN ANATOMY

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ABSTRACT: OBJECTIVES: Teaching human anatomy has undergone profound changes in the recent years. These days, with lots of new medical schools getting established, there is acute shortage of cadavers and cadaveric bones to teach the students. However, the new radiological imaging techniques are replacing the traditional cadaveric dissection in learning human anatomy. Among them, development of multi detector computed tomogram scanner has been one of the most important recent advances of medical imaging. Objective of the present study is to describe the scientific community about usefulness of multi detector computed tomogram in teaching human anatomy to medical students. **METHODS:** The multi detector computed tomogram films which were available at the radiology department of our institution were used for the present study. The anatomical structures were evaluated on a 64 slice multi detector scanner. **RESULTS:** By observing the transverse, sagittal and three dimensional images simultaneously, it was much easier to understand the organ anatomy. The present study had addressed, one of the new opportunities provided by 64-slice multi detector computed tomogram in teaching human anatomy to the medical students. **CONCLUSION:** This method enables us to offer a good anatomical science education. We suggest that, this assisted teaching method is a useful option not only for clinical discussion but also for medical education.

KEYWORDS: cadaver, human anatomy, MDCT, radiologic, teaching, three dimensional.

INTRODUCTION: The gross anatomical dissection is a time honored part of medical education, regarded as the integral component of medical curriculum, a sound knowledge of human anatomy prepares the medical student for his or her future training at clinical level.⁽¹⁾ Teaching anatomy also helps in further development of medical professionalism.⁽²⁾ However, teaching of human anatomy in the new millennium is facing significant changes.⁽³⁾ It was reported that, teaching anatomy to undergraduate medical students is in the midst of a downward spiral.⁽⁴⁾ The traditional anatomy teaching based on didactic lectures and dissection of cadaver has been replaced by multiple ranges of study modules like computers and other teaching tools. The use of cadavers for dissection has been identified by some as an expensive, time-consuming and potentially hazardous to health.⁽⁵⁾ It was reported that some medical schools have discarded the cadaveric dissection, seeking alternative approaches to the anatomy teaching, including use of diagnostic images.^(4, 6)

The greatest contributions to human anatomy, which were made in the recent years, have come from radiology. Radiology has made it possible to visualize the normal relation, action and variability of many organs of the body.⁽⁷⁾ The development of multi detector computed tomography (MDCT) scanner has been one of the most important recent advances in the CT

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technology.⁽⁸⁾ In the present study, the objective was to describe the usefulness of MDCT in teaching human anatomy, including radiological anatomy, which will be easier for the student and make knowledge more useful for clinical practice.

METHODS: The MDCT DICOM films (Figs. 1-3) which were available at radiology department of our institution were used in the present study. The images were made by means of image processing software. In our institution, at the department of radiology, a 64 slice multi detector CT scanner (Brilliance 64, Philips Medical Systems, and Netherlands) is available. All the anatomical structures demonstrated in the present study were evaluated by this scanner.

Scanner specifications: Table 1 show the details about the MDCT scanner which was used in the present study. The scanner has got a maximum operating potential of 140 kiloVolt peak (kVp) and maximum tube current of 500 mille Ampere second (mAs). The machine has been equipped with solid state detector and medical grade imaging system (monitor) for viewing the clinical images. It could acquire a maximum of 64 slices per rotation.

The contrast images (Fig. 3) were used to demonstrate the vascular system. Various three dimensional post processing techniques were employed in the present study to obtain the quality images from the axial CT raw data. Among many available reconstruction algorithms, the volume rendering and maximum intensity projection were most commonly employed in the present study. The number, size, course and relationships of structures were easily demonstrated by using the real-time interactive editing and organ anatomy was viewed from different perspectives by rotating the images.

RESULTS: The MDCT has demonstrated anatomical structures with a better clarity and views. By observing the transverse, sagittal and three-dimensional (3D) images simultaneously, it was made much easier to understand the anatomy. The MDCT images helped to study the anatomy of muscles (Fig. 1), bones (Fig. 2) and other structures which included the cartilages, ligaments and visceral organs. Contrast films interpreted the vascular structures (Fig. 3) in detail. By using this educational support system, anatomy could be taught using the living persons instead of cadavers. The clinically oriented anatomy can also be taught by using this technique, anatomical variations could be showed to students. In addition to routine clinical applications of MDCT, possibilities for medical education as well as patient education are truly enhanced.

DISCUSSION: In clinical science training, the understanding of human anatomy is essential. In medical teaching, dissection has been labeled as the 'royal road' and cadaver as 'first patient'.⁽¹⁾ However at many medical schools, those days are gone. It was reported that, recruiting, storing and maintaining the cadavers is an expensive business and with a decrease in the volunteers to donate the body, there is no choice but to find alternatives.⁽⁹⁾ There are difficulties in procurement of the cadavers. Unlike in United States where there is a successful body donation programme, many medical colleges in the world are facing difficulties in obtaining the cadavers for teaching human anatomy.⁽¹⁾ Moreover there are increasing ethical and safety concerns about handling the dead human tissue, particularly after the discovery of new dangerous pathogenic

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microorganisms.⁽⁹⁾ There are also a few problems associated with the dissection, which include increased time duration required to study anatomy. The current trend is to downsize anatomy course in the face of expanding curriculum, which has been termed as 'best medical education'.⁽¹⁰⁾

The cadaver, by definition, can offer only a static postmortem anatomy, in which the shape and texture of organs, tissues necessarily differs from their premorbid state. Some educationists disagree with the critics that dissection is a necessary part of medical teaching. They opine that, a cadaver does not bear much resemblance to the living body. It was reported that the chemicals which are used to preserve cadavers, when combined with post-mortem changes, make the consistency of tissues and organs different from living organs.⁽¹¹⁾ It was also reported that, even within the anatomists association, there are differing viewpoints to agree that, new methods of teaching anatomy would be better than traditional use of cadaveric dissection.⁽¹⁾

It was reported that, in North American medical schools, though dissection is still the major teaching method, with radiologic anatomy averaging about 5% of total teaching time, it was opined that most directors anticipate a decrease in teaching time over the next 5 years. There is a chance of increasing the use of digital methods and teaching radiologic anatomy.⁽³⁾ This increases the role of radiological aids in the future anatomy teaching. In recent years, the clinical application of computed tomography (CT) and magnetic resonance imaging (MRI) have been increased. We believe that, medical education also needs to be reformed in order to take the advantage of these innovative technologies.

Development of MDCT scanner is one of the most important recent advances in radiologic technology. The MDCT can obtain multiple images with the single rotation of X-ray tube, making it possible to get thinner slices within a short span of time. The image-processing technology provides sagittal, dorsal-plane (multi-planar reconstruction) and 3 dimensional images.⁽¹²⁾ Hiatt et al.⁽¹³⁾ reported that, MDCT has improved the imaging of arteries and veins, particularly at the lower extremities. According to them, the advantages of this novel technology include the faster scan time, high spatial resolution, increased anatomic coverage, capability to generate high-quality multi planar reformations and three-dimensional renderings from raw data.

The clinical applications of this technology include evaluation of peripheral vascular occlusive and aneurysmal disease, patency and integrity of bypass grafts and arterial injury owing to trauma. For the detailed vascular interpretation, imaging could be done after injecting the radio contrast dye. The added clinical advantages and applications of this system include volume rendered imaging (VR), advanced vessel analysis (AVA), CT endoscopy (virtual bronchoscopy and colonoscopy), dental application (Denta scan), multi planner reformation (MPR), cardiac application (comprehensive cardiac calcium scoring), brain perfusion, lung density and lung nodule assessment. Current reforms of medical curriculum and establishment of new medical schools at the United Kingdom further underline the prospects for an expanding role of imaging in medical education.⁽⁶⁾ The veterinarians also reported that MDCT can enhance veterinary student's understanding and interest in animal anatomy.⁽¹²⁾ They believe that, this method has offered them a quality veterinary medical education.

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In the past, the 3-dimensional rendering was reserved only for CT angiography and orthopaedic applications. However coupled with advancements in MDCT hardware, now the 3-dimensional volume rendering has become an essential tool to assess the range of organ systems including the pulmonary, hepatobiliary, genitourinary and gastrointestinal applications. The 3D volume rendering can also provide valuable diagnostic information about the skin, subcutaneous tissue and muscle.⁽¹⁴⁾ Understanding the 3D positions of organs in vivo is difficult as this knowledge has been handed over from generation to generation as an 'oral tradition'. In the present study, we have made an attempt to explain the advantages of MDCT in medical education. This educational support system which uses the computer-aided device along with MDCT and an image-processing workstation will be of help in studying three dimensional anatomical structures. The ability to create 'CT physical examination' with this MDCT provides a unique diagnostic advantage. MDCT also provides valuable information about anatomy of skin and subcutaneous tissue and their pathology to facilitate characterization (e.g. ulcer and cellulitis).

The radiology provides an excellent forum to teach some of the most basic principles of medical reasoning.⁽¹⁵⁾ In a traditional anatomy class, the superficial anatomy is stressed, but little is taught about the actual three dimensional positions of organs, which is especially important in clinical practice. It is with the radiology that most physicians are expecting to observe the internal anatomy of their patients.⁽¹⁶⁾ The MDCT, in addition to its routine clinical applications, also helps in medical education. As the CT continues to evolve and as new advanced rendering algorithms are developed, we could look forward for improved image resolution and fidelity, which could certainly help in teaching human anatomy. By MDCT imaging, the anatomical structures could be explained in living patients. This method permits in vivo visualization, offers physiologic as well as anatomic insights and represents the context in which contemporary practicing physicians frequently encounter their patients.⁽¹⁶⁾

It was opined that, despite its important strengths, radiology cannot simply substitute for cadaveric dissection. The best models for teaching gross anatomy will incorporate both cadaver dissection and radiological imaging.⁽¹⁶⁾ For this method of integrated teaching, there should be an active cooperation between the departments of anatomy and radiology. This type of integrated teaching will be obviously going to benefit the students in understanding gross, surgical and radiologic anatomy.

CONCLUSION: The present study had addressed one of the new opportunities provided by 64-slice MDCT. This system can enhance the medical students understanding and interest in human anatomy and thus enable us to offer them a quality medical education. We conclude that MDCT assisted teaching is a useful option not only for clinical discussion but also for medical education. We believe that, it is incumbent on anatomists to educate students in the manner in which they will view anatomy as future health care providers (that is radiologic imaging) and state-of the art image acquisition and 3D rendering are useful in anatomy education.

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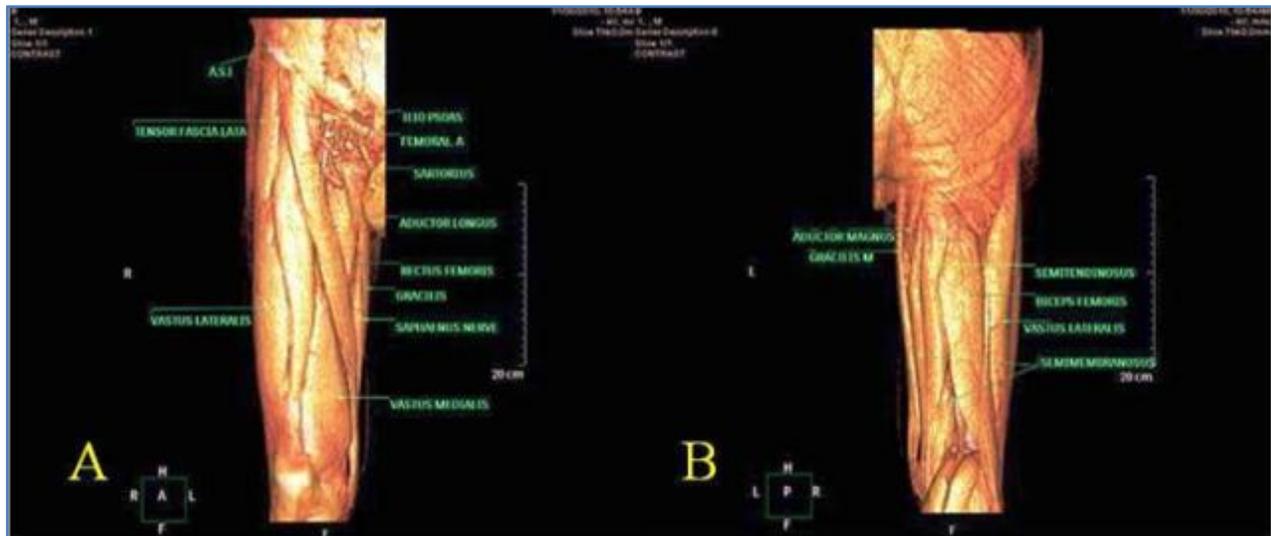


Fig. 1: Plain MDCT film of a patient showing the muscular anatomy (A - muscles of front of thigh; B – hamstring muscles)

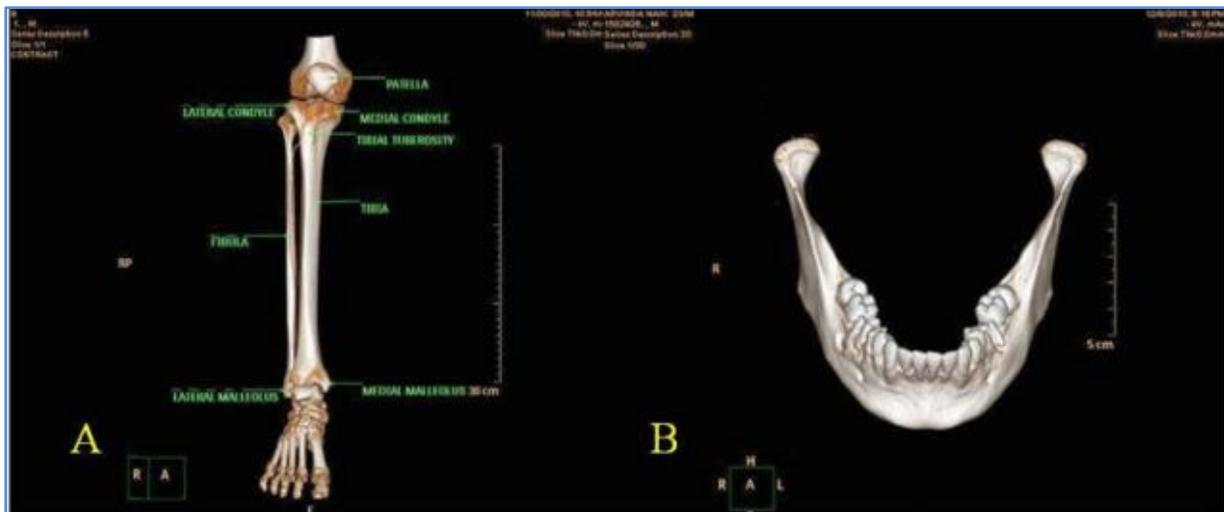


Fig. 2: Plain MDCT film showing the osseous anatomy (A – bones of the leg; B – mandible)



Fig. 3: Contrast MDCT film of a patient showing the vascular anatomy (arteries of the lower limb)

operating potential	120 kVp
tube current	200-300 mAs
source to image receptor distance	70 cm
scan speed	0.4 to 2 sec
slice thickness	0.5 to 12.5 mm

Table 1: Showing the details of MDCT scanner

(KVp - kiloVolt peak; mAs - milliAmpere second)

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