

Use of ultrasound in teaching Anatomy and Forensic Medicine

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Abstract

Objectives: The use of ultrasound is now widely used for teaching purpose for pre-clinical medical graduate during their anatomical session. The modality of ultrasound can be used in forensic medicine to find out the final cause of death. It should be carried out soon after the deceased because putrefaction could occur.

Materials and methods: This study is carried out in the department of forensic medicine, Hamdard College of Medicine & Dentistry. During the posting of medical students in the forensic medicine department the use of ultrasound in Forensic Medicine was taught to the student. Potential uses of ultrasound in the post-mortem setting may involve sonographic evaluation of various organs, pleural air and pleural effusions, cardiac and pericardial abnormalities (including pericardial tamponade), hemoperitoneum, and even skeletal injuries of medico-legal interest. This technique is useful on cadavers to solve different questions of medico legal interest. In reporting medico-legal cases, use of ultra sound may be helpful especially in cases where naked eye examination always remain doubtful. Injuries of skull, intra-cranial haemorrhages, foreign bodies like bullet, concealed bleeding, accumulation of blood in body cavity, and assessment of depth in case of stab wound are few examples.

Results: Use of ultra sound in postmortem imaging through imaging autopsy by ultra sound we can determine, Cause of death, Sex in difficult cases, Height of the body with internal features identification, like internal fixation, artificial prosthesis, Identifying distinct foreign bodies—retained bullets, blades, etc., Identification of injuries; depth of wound, wound tract of a bullet, assessment of accumulated blood in closed wound, and different intracranial injuries

Conclusion: A full autopsy certainly is a gold standard for correct diagnosis of the cause of death, but scanning the cadaver ultrasonographically, prior to autopsy can yield helpful information, like volume of urine in the bladder, suspected pregnancy in cadavers, any internal injury in body with no external wound, and finding deviated bullet in the body.

Keywords: use of ultrasound in forensic medicine, ultrasound on autopsy, suspected pregnancy in cadavers, concealed haemorrhage, pericardial tamponade autopsy, hemoperitoneum in autopsy

Introduction:

We report our experience of using Ultrasound in teaching of Anatomy and we propose that this technique can also be useful in teaching of Forensic Medicine.

Ultrasound equipment is unique. The equipment has become miniaturised, palm size, can be carried everywhere and anywhere, is non-invasive, devoid of hazards of radiation and is economical as compared to other imaging techniques like

Computerised Axial Tomography (CT scan) and Magnetic Resonance Imaging (MRI).

Use of Ultrasound in Anatomy:

Use of ultrasound teaching was commenced in the department of Anatomy, Hamdard College of Medicine and Dentistry, in November 2015. A student survey of Second Year MBBS was done after completion of two semesters and before the final year examination in 2016. The sur-

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vey focussed on the abdominal ultrasound and student responded encouragingly seeing live images of abdominal organs.¹

A number of studies have revealed usefulness of introducing ultrasound teaching in medical colleges at an undergraduate level particularly in USA. Many medical schools have realised the usefulness of this technique as an aid in teaching of anatomy, physiology, pathology and physical diagnosis.²⁻⁴ With the advent of point of care, Ultrasound technique has become of tremendous value in clinical subjects like obstetrics and gynaecology, surgery and internal medicine, offering diagnosis at the bedside, in the ward, in OPD, even at home.

Use of Ultrasound in Forensic Medicine:

Potential uses of ultrasound in the post-mortem setting may involve sonographic evaluation of various organs, pleural air and pleural effusions, cardiac and pericardial abnormalities (including pericardial tamponade), hemoperitoneum, and even skeletal injuries of medico-legal interest. This technique is useful on cadavers to solve different questions of medico legal interest.

In decomposed body, the use of ultrasound has been restricted due to formation of gas. The gas acts as a bar for ultrasound waves and does not allow the waves to penetrate inside the body. In 4-5 days due to decomposition gases, ultrasound does not show any useful images on the cadaver, but before accumulation of putrefied gases in body, ultrasound is helpful and used in cases of medico legal interest in various parts of world.

A country like Pakistan where socially and religiously post-mortem examination is not accepted by its people, this method of non-invasive autopsy can be a good replacement. Evidence is now accumulating that ultrasound can be useful if used within few days after death. Pakistan is a country where death is reported immediately because of close emotional ties in family & culture. Ultrasound in most of the cases can be performed before sufficient amount of gases accumulates in the dead body.

Ultrasound use in Cadaver:

During showing live images on the volunteer to the students, we were interested to know whether ultrasound can be used to show the images on the cadaver too! Literature search revealed a study done to compare four imaging technique – Ultrasound, Radiography, CT scan and MRI on cadaver. The results revealed the quality of Ultrasound and Radiography images were poor. Computed tomography (CT Scan) and Magnetic Resonance Imaging (MRI) have a superior image quality in comparison to ultrasound and radiography and offer suitable methods for imaging embalmed human cadaver as a valuable addition to dissection course.^{5,6}

Ultrasound use in early Post Mortem examination:

However we were encouraged to read the experience of using ultrasound in early days of autopsy, before the body has decomposed significantly.

Uchigasaki,⁷ points out that there is a misconception that it is impossible to obtain any significant ultrasound images from the corpses. Surely useful post mortem ultrasound images are impossible to obtain in the case of highly decomposed body. However, it is possible up to 4 to 5 days after death to get images from the corpse that provide important forensic pathological findings, giving valuable hints toward the most probable cause of death. The timings of doing ultrasound examination in post mortem examination is the key factor- for access to any useful information with ultrasound examination, the ultrasound should be done as early as possible after death and not later than 4-5 days of death.⁷

Imaging in Forensic Medicine:

Permission for performing an autopsy, to ascertain the cause of death, may prove to be too difficult in certain parts of the world. The reasons may be related religious or social attitude or as a mark of respect for the dead, not to mutilate the body. Are there any alternative other than autopsy which can help in making a proper decision for the cause of death and acceptable in the court of law. Studies have revealed that diagnostic imaging like Radiography, Sonography,

CT-Scan and MRI can be helpful and reveal meaningful findings in determining the cause of death.⁸

For diagnostic imaging technology to be available in post-mortem facility, a huge investment is required to install the equipment. In addition to the financial budget, skilled technician personals will have to be employed for proper handling of the equipment and patients. It is next to impossible to take a corpse to busy radiological facilities for CT scan and MRI, a place where live human beings and their relatives are present and waiting for their turns.

The story with ultrasound equipment is very different. The equipment has become much miniaturised, can be grasped in the palm of the hand, does not emit any radiation and is economical. The equipment does not require any specific infra structures like specialised room for the CT scan and MRI. No technician may be required to operate the equipment. With training and short courses, the autopsy personals can be trained to perform ultrasound and interpret the images. The training will focus mostly on gross images interpretation and may not be as comprehensive as required for a sonographer.

Use of Ultrasound in medico-legal cases:

In reporting medico-legal cases use of ultrasound may be useful especially in cases where naked eye examination always remain doubtful. Injuries of skull, intra-cranial haemorrhages, foreign bodies like bullet, concealed bleeding, accumulation of blood in body cavity, and assessment of depth in case of stab wound are few examples.

In Pakistan, injuries are categorised as SHUJJA or GHAYR JAIFA according to Qisas & Diyat Ordinance. According to severity and nature of injury punishment varies. A precise assessment of wound becomes very important to minimize the chances of error. Assessment of wound by ultrasound can minimize that error.

Ultrasonography in cadaver and pathological conditions:

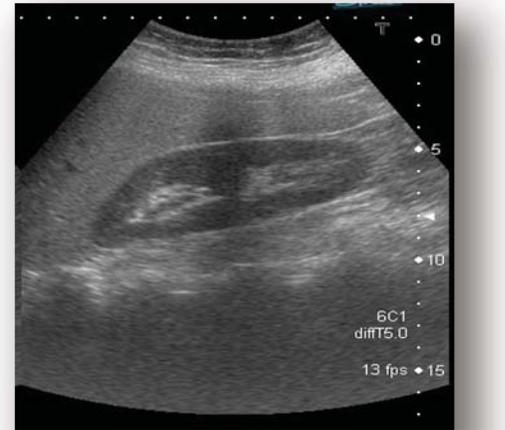


Figure-1: Fatty liver appearance more echogenic

Findings of ultrasound in living patient and freshly dead body are the same. For instance, the fatty liver appearance is same- the liver shadow is brighter (more echogenic) as compared to the kidney (Figure-1).

If the cadaver has been refrigerated, ultrasound examination is preferably done about 1 to 2 hours after the corpse was taken out of the cooling apparatus. During refrigeration, hardening of adipose tissue may occur, resulting in difficulty of interpreting images. In a very obese corpse, ultrasound will have a very limited application.

Ultrasound probe can be placed on the corpse in the same place as in the living person. In a decomposed body of some days, due to putrefied gases, liver and diaphragm may be displaced superiorly. No useful images can be obtained by placing the probe on the wall of the abdomen- in such cases the probe may be placed laterally or dorsally.

The term 'echopsy' has been used to describe the ultrasound findings in corpses as opposed to classical 'autopsy'.⁹

Use of ultra sound in postmortem imaging:

Through imaging autopsy by ultra sound we can determine;

1. Cause of death
2. Sex in difficult cases

3. Height of the body with internal features identification, like internal fixation, artificial prosthesis
4. Identifying distinct foreign bodies—retained bullets, blades, etc.
5. Identification of injuries; depth of wound, wound tract of a bullet,
6. Assessment of accumulated blood in closed wound, and different intracranial injuries.¹⁰

Ultrasound imaging in Forensic Pathology Practice:

The findings of ultrasound can help in determining the underlying cause of death or could be the cause of death. In the case of infant, if anterior fontanelle is still open (usually closes at 18 months), it is possible to scan the brain. Intracranial haemorrhage can be assessed with open anterior fontanelle in infanticide cases (Figure 2).

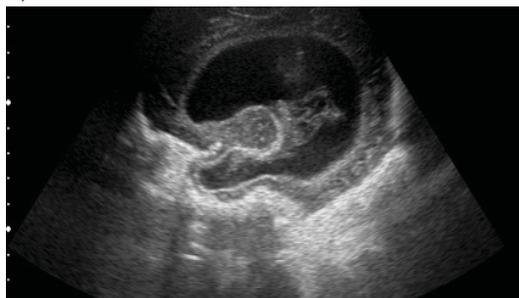


Figure 2: Eight months child with Hydrocephalous

In bone fractures, such as cervical vertebra fracture in a deceased with no injuries to outer body surface, this image finding could indicate the necessity to perform a forensic autopsy.

A full autopsy certainly is a gold standard for correct diagnosis of the cause of death, but scanning the cadaver ultrasonographically, prior to autopsy can yield helpful information, like volume of urine in the bladder, suspected pregnancy in cadavers, any internal injury in body with no external wound, and finding deviated bullet in the body.

Pathological findings detectable by Ultrasound examinations:

Uchigasaki⁷ described following pathological conditions by ultrasonography in dead body (Table-1).

Table 1: Pathological conditions by ultrasonography in dead body

Cardiac Hypertrophy	Fatty Liver
Pericardial Tamponade	Bile Stones
Aneurysm of abdominal aorta	Renal Cysts
Pleural effusion	Diverticulum of urinary bladder
Subphrenic abscess	Foreign Substance (implant)
Ascites or Internal Bleeding	myoma uteri
Liver Metastasis	Intracranial Hemorrhage in infants
Liver Cirrhosis	Bone Fractures



Figure-3: Haemorrhage in the muscle

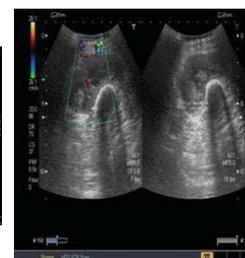


Figure-4: Dorsum of foot showing oedema

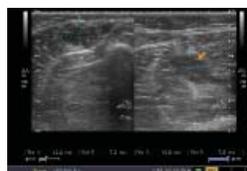


Figure-5: Multiple masses in leg



Figure-6: Cirrhotic liver



Figure-7: Splenic



Figure-8: Pleural effusion

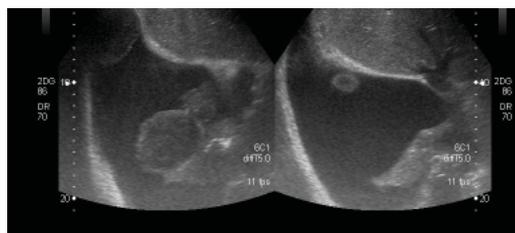


Figure-9: Pleural effusion with multiple masses

Conclusion:

Ultrasound awareness in use of Forensic Medicine is little known. With the knowledge of ultrasound usefulness in the first 3 to 4 days of death, one can achieve a reasonable cause of death and other pathology without opening up the corpse. The ultrasound equipment has become minia-

turised, hand held and does not require a heavy infrastructure like CT Scan and MRI for imaging the corpses. The sound waves have proved to be safer and not harmful as opposed to radiation hazards with other imaging technique. The training required for the use of ultrasound is not necessarily a training sonographer goes through. With motivation, a necropsy operator can be trained within few weeks for using ultrasound equipment on cadaver.

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Role and contribution of authors:

Dr Tasir A Mumtaz, MBBS, FCPS(Radiology), HOD, Department of Radiology, Hamdard College of Medicine and Dentistry (HCM&D), Hamdard University Hospital, collected the data and references and wrote the initial writeup

Prof Zakiuddin Ahmed, MBBS, MCPS, PhD, HOD Department of Forensic Medicine, HCM&D, critically review the article and made changes in the introduction and discussion.

Prof Zakiuddin G. Oonwala, MBBS, FRCS (Edin.), FICS(Hon.), Visiting Professor of Clinical Anatomy, HCM&D, critically review the ar-

ticle and made the final changes.

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