



# EFSUMB History of Ultrasound

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**Student ultrasound education (SUSE)**

**Ultrasound should be integrated in teaching anatomy as early as possible**

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## **Ultrasound should be integrated in teaching anatomy as early as possible**

Ultrasound (US) is an extension of physical examination in medicine. The modern transducers enable a real-time imaging avoiding the potential risk of ionizing radiation [(1)]. The interpretation of US pictures depends on a solid knowledge of gross anatomy. Therefore are the questions, when and by whom should US be taught in a medical school.

### **The relevance of gross anatomy in medicine**

There is no doubt that knowledge of gross anatomy is essential to diagnose and treat diseases in patients. However, there are continuous discussions how to teach and learn gross anatomy in particular after electronic models became easily available. Many anatomists argue for a hands-on dissection course of the human body by medical students. It is not surprising that anatomists support their own subject.

From my point of view, it is of much greater relevance how medical students grade the dissection course in its relevance to the clinic in comparison to lectures and courses on other subjects of the curriculum. We have asked medical students in a detailed questionnaire to grade the relevance of anatomy to work as a physician. These students were asked at the end of their first-year undergraduate training. There was a response rate of 90% [(2)].

The four criteria were fundamental, necessary of little relevance and superfluous. Medical terminology was marked of least relevant followed by biomathematics. At the top was gross anatomy graded as fundamental 91% and 8% essential. These results were higher than internal medicine and pharmacology.

The following study [(3)] was of greater importance. Medical doctors were asked after they had finished the several years long specialization e. g. surgery, internal medicine etc. This was about 7 years after the final examine at the medical school. There were about 60%, who graduated at other medical schools than Hannover. The most important question was about the relevance of lectures and course in all subjects a student has to learn in the medical curriculum. The results were top internal medicine 88%, gross anatomy 86%, physical examination 82%. The four subjects at the bottom of relevance were: biomathematics 2%, medical physics 4%, medical chemistry 4% and public health 6%. A few years later another group of German scientists asked 1029 candidates at the time of the specialization examination of former students of five the medical faculties in Nordrhein-Westfalia [(4)]. The answers of the questions resulted in a very similar pattern to our study in Lower Saxony. The

very low graded subjects for the everyday clinical praxis were physics, chemistry environmental medicine and biomathematics. On the other hand gross anatomy, physiology, internal medicine and pharmacology were graded of very high relevance. In conclusion young medical doctors' grade gross anatomy of a high clinical relevance. During the recent Covid-19 pandemic, the students of Hannover Medical School strongly insisted in having dissection course in presence, in physics and chemistry electronic presentation were sufficient.

### **Concept of teaching anatomy at the Medical School of Hannover**

In nearly all medical faculties in Germany medical students have the dissection course on embalmed cadavers in their second year. In contrast, in Hannover anatomy starts already in an integrated form at the beginning of the first semester. The curriculum starts with a week of lectures on the back, the following week all students dissect the back. The next week a colleague from the orthopedic clinic and a neurosurgeon present a patient and clinical problems and document their operation procedures by video or slides. In addition, a colleague from the department of radiology presented x-ray, CT pictures of vertebral column. Michael Gebel gave an impressive lecture on ultrasound in the diagnostics of the abdominal cavity. The following week the students returned to the dissection room and repeated the topographical anatomy of the abdomen. In the eighties of the last century H. Lippert and R. Pabst offered an additional course of living anatomy (1/3 of the students participated in it). After I had passed a course in ultrasound of the abdominal cavity, I organized an ultrasound machine from the gastroenterology department, when they got a new recent machine and bought a duplex transducer. Thus, these students in groups of two were instructed in ultrasound diagnostic of the abdominal cavity. The pelvis was only studied in special groups when the students were interested in it. At the end of the course, I always asked which region was of our most interest. This was nearly always the cross-section of the upper abdomen either deep at inspiration and followed by holding the breath. The students have dissected the inferior vena cava often filled with clotted blood and now the vena cava disappeared nearly completely in deep inspiration. The course was not evaluated, but all students participated until the end with enthusiasm. When a seminar in anatomy became compulsory in all medical faculties, the course living anatomy became one alternative. There were always more students interested in living anatomy that places were enable.

## **Doppler transducer**

The following arteries were documented: common, internal and external carotid, superficial temporal artery, supraorbital artery (as a branch of the internal carotid artery) of the forearm and arteries of the foot (dorsal tibial and dorsal pedis). These arteries were also checked when we initiated an arteriosclerotic artery of the femoral artery by obstruction of this artery by a tourniquet. The students were in particular impressed by the different noises of the carotid artery.

The group of Berens von Rautenfeld offered a course on ultrasound in living anatomy ~~was~~ in Hannover. One group had a 2 h version and to other 6 h version. Nearly 50% of the students agreed that their topographical knowledge of the abdomen had improved. There was no statistical difference between both groups [(5)]. Many years later Knudsen et al [(6)] compared two students' groups of the first year of their curriculum in Hannover. The hands-on ultrasound groups were not better in multiple choice questions at the end of the course and 6 weeks later was not different. However images based questions were equidistantly better answered by the hands on groups.

## **Theoretical background of ultrasound**

The essential knowledge it taught on the lecture of physics. In Hannover the students have also two afternoons of practice. **A.** To explain the relevance of the frequency as a basis to understand, why two different transducers are necessary when the liver or thyroid are to be examined. **B.** The other afternoon is the US of the abdominal cavity. The major problem is the lack of medical trained instructors in the Department of Physiology and Physics in medicine in Hannover.

## **Ultrasound in an atlas of human anatomy**

In addition to lectures and textbooks an atlas of human anatomy is essential for learning anatomy in a dissection course. Reinhard Putz and I became the editors of the 20. Edition in 1993 at the Sobotta Atlas of human anatomy [Table 1].

**Table 1      Ultrasound pictures in Sobotta Atlas of human anatomy, 14. Edition (7).**

	<b>Organ</b>	<b>Section</b>
1.	Thyroid glands	oblique image ventrodorsal dissection, inferior view
2.	Heart	trans esophageal left atrium left ventricle
3.	Hepatic veins	opening of the hepatic veins into the inferior vena cava, inferior view
4.	Hepatic portal vein	division of the portal vein into the main branches, inferior view
5.	Pancreas	pancreas and adjuvant large vessels in deep inspiration, oblique inferior view
6.	Abdominal Aorta	sagittal plane aorta with celiac thermic and superior mesenteric artery
7.	Kidney	ventroinferior to dorsosuperior, right lateral view
8.	Uterus with embryo 8. week of pregnancy	lateral view right
9.	Uterus with fetus 28. week of pregnancy	lateral view left
10.	Hand of a fetus 18. week of pregnancy	lateral view left

We included many pictures of surface anatomy and new cross sections of the body with CT and MRT pictures next to these and also US pictures. Table 1 shows all US figures in the 14. English edition). The Sobotta "Atlas of Human Anatomy" was published in 23 languages. Thus, we have influenced the learning of human anatomy worldwide and stressed the clinical relevance of US in these students. In parallel to the atlas, students could buy a CD ROM called "Sobotta interactive" [(8)]. There were video sequences of ultrasound of the abdomen, heart etc.

### **When should US be taught in the medical curriculum?**

The anatomical understanding was significantly improved by an elective US course as part of the radiologic training in the 4. and 5. year of the curriculum [(9)]. Also, as parts of the radiology course (3rd and 4th year) medical students were evaluated in written and aorta scan test with significant increase in the results [(10)]. There is an overview available for the situation in European medical schools on US curricula in Europa [(11)]. In this study 46 universities in 17 European countries answered. However, the question remains, how representative are these universities for their countries e. g. for Germany Ulm is described. This department of anatomy, however, is known for a modern clinically oriented anatomy teaching. The advantage of this review is that the reactions for implementation of US is documented e. g. useful to learn lectures in praxis helps students learn anatomy, US teaching is from graded as "very important". The obstacles are also mentioned as the lack of funding the equipment or lack of time in the curriculum. In the medical faculty of Münster in Germany has been described [(12)] the experience with an interdisciplinary teaching project over 10 years. Thus, US plays a major role in their tutor-based teaching system.

An often-neglected aspect in medical education is the training of the teachers of the students. Jurjus et al [(13)] compared the effect whether clinicians or anatomist (after trained by US experts for 2 hours) didactic and hands-on US both groups were effective in the learning outcome in nearly all parameters. In conclusion, the often expressed arguments that there are no or two few anatomists are basic scientist is not relevant as long as anatomists are trained. In Germany, however the total numbers of students per faculty is calculated by the number of scientists in the departments e. g. anatomy and including clinicians can result in an increase

of teachers with more students in total. When there is a “model curriculum” as at the Medical School in Hannover it is no problem.

Recently Edwards et al [(14)] evaluated the perception of the integration of portable wireless ultrasound imaging in undergraduate anatomy education with excellent results: e. g. 93% marked important of their anatomical understanding, 94% improved clinical relevance of anatomy. Thus, this is a further new technique to be recommended.

### **Summary**

Ultrasound is a very effective tool in diagnostic medicine and depends on a basic knowledge in topographical anatomy. Including ultrasound, teaching in early in the anatomy curriculum stimulates the interest in learning anatomy and its clinical importance. Trained anatomists are nearly as effective in teaching US as clinicians. The enormous importance of US is also stressed by including US pictures in an atlas of human anatomy. There are 23 translations available of the Sobotta in thus worldwide the clinical relevance of anatomy is stressed by US teaching.

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