Sono4You - peer-assisted ultrasound tutorials for undergraduate medical students

Poster No.: C-2546  
Congress: ECR 2013  
Type: Scientific Exhibit  
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Keywords: Ultrasound, Ultrasound-Colour Doppler, Ultrasound-Spectral Doppler, Education  
DOI: 10.1594/ecr2013/C-2546

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Purpose

Ultrasound is a growing part of radiology and a non-invasive diagnostic modality which does not use ionizing radiation. The European Society of Radiology (ESR) has underlined this important role of ultrasound as a useful imaging procedure in clinical diagnostics. The best time for starting education on ultrasound is a widely discussed topic (Butter et al, 2007).

Again the ESR has recently stated that modern curricula with more contact and early exposure of medical students to radiology in preclinical years is described as an important task. Therefore, the earlier students are introduced to ultrasound and learning of the basic skills during their studies, the more this furthers their education and preparation for their work as a resident in various medical specialities.

Education to ultrasound skills is often in the postgraduate curriculum, when residents lack time and should already be trained in ultrasound.

Medical students lack education in ultrasound, and most have little familiarity with it. Workshops can give them sufficient knowledge to start with a package of skills to enable further training.

The Sono4You project was initiated in 2007 by Peter Pokieser, Medical Media Services and Radiology of the Medical University of Vienna (MUVI) together with a small group of committed medical students with Titus Pawlowski as its student head.

A peer-teaching approach was chosen with trained medical students supporting other students in learning ultrasound on themselves and practicing it.

It has been shown that peer-teaching is a useful learning concept from educational theory and the practical point of view. Several advantages are that students often feel more motivated with a near peer teacher compared to a senior expert and optimize their learning progression because of the narrow age and experience gap between teacher and student. The peer teachers themselves benefit from the processing of information during preparation, the delivery of education, and a higher motivational level.

There are several reasons to apply peer-teaching. Four key reasons to use peer-teaching derived from ten Cate 2007 are:

- It offers education to students on their own cognitive level
- It prepares physicians for their future role as educators
• It creates a comfortable and safe educational environment
• It trains leadership skills and confidence

In anatomy dissection courses, peer-teaching is a well known and practiced concept. Student teachers gain or have enough knowledge and command low wages. They are often more motivated or enthusiastic and can be more flexible with their time schedules. In the case of ultrasound, Kelly et al. showed in a prospective randomized trial that peer-teaching can be an effective protocol for bedside ultrasound. It represents a useful concept for preclinical medical students.

Medical students at the MUVI are educated in basic ultrasound skills such as standard techniques and standard planes but have few possibilities to practice these skills due to the time limitations of the university teaching staff. Still, there remains a high demand on practical experience and training possibilities. The students' commitment resulted in an offer of basics and practicing tutorials in abdominal ultrasound for every student, regardless of the year the students were in.

A small room and an ultrasound machine were provided to initiate the project. In addition, an abdominal ultrasound manual, written by students under supervision of radiologists, supports the participants in the tutorials during their first steps with ultrasound.

The first goal of this study is to present our experience with peer-assisted tutorials in various ultrasound topics in undergraduate education at MUVI.

The second is the implementation of the project with four hands-on workshops for international medical students at the ECR 2012. Using this approach, we explore and evaluate the feasibility and international acceptance of peer-assisted ultrasound training in undergraduate education.

**Methods and Materials**

**1) Sono4You at MUVI**

One basic tutorial, e.g. in the upper abdomen, consists of two to three afternoon sessions. Students are able to practice ultrasound whenever they want, as long as they request a practical tutorial with Sono4You providing its ultrasound room and tutor.

Tutors are experienced students from 4th to 6th year on a voluntary basis, trained intensively by radiologists and cardiologists.
The tutors can practice ultrasound at every time and determine their learning progress with their personal commitment. Medical discussions under colleagues are promoted in the tutorials. Tutors and participants are encouraged to try ultrasound skills as early as possible in the preclinical years. Training sessions once a week by experienced tutors for other tutors and training sessions on request from different medical doctors ensure a high standard in the tutorials.

In groups of a minimum of 2 to a maximum of 6 participants, students perform scans themselves under the guidance of an experienced student tutor. One tutorial session lasts 2 hours; depending on the motivation of the tutor and the participants, they can last up to 4 hours. During the sessions, students should learn the basic principles of ultrasound, including the physical principles of ultrasound, orientation at the monitor view, and the standard planes of the particular region; for example, the standard planes of the abdomen of the Austrian Society of Ultrasound in Medicine (ÖGUM). These standard planes are based on the recommendations of the European Federation of Societies for Ultrasound in Medicine and Biology (EFSUMB). They should also gain experience in the main functions and handling of the ultrasound machine and have as much time as possible for practicing standard planes. The tutorials are held by two tutors, so that direct communication with each other was possible during and after the tutorial.

There are standard planes for five different tutorials available (Table 1). These contents are presented in two or three afternoon sessions, approximately two hours each. Students practice on each other such that every participant has equal time to practice in a quiet non-stress atmosphere. To memorize the knowledge the script of abdominal ultrasound of the project is recommended to the participants and was written by students under supervision of radiologists. It should display the basic knowledge of the physical principles of ultrasound, main functions and handling of the ultrasound machine and the standard planes of the abdomen.

A "Pocket Card" (Figure 1) was also provided to the participants. This card was designed under the supervision of senior radiologists and based on the guidelines of the ÖGUM. It represents a useful summary of the standard planes, measurements, basic diagnostic findings and helpful short explanations of imaging techniques.

The participation is regardless of the year of study; only basic knowledge in anatomy is required.

To inform fellow students about the offering, the concept of a tutorial was presented with live ultrasound in the lecture hall. In approximately one hour, live ultrasound was performed and viewable simultaneously on the screen in lecture hall. The intention was to describe the content of a standard tutorial and to stimulate interest for ultrasound. These sessions were held monthly. In a pilot project, live ultrasound in the lecture hall together
with established 5th year rounds from unified patients a similar session was combined with three medical cases, already summarised with emphasis on ultrasound imaging. Direct comparison between healthy anatomy and obvious pathology in the cases was demonstrated.

The tutorials were planned by 20 tutors in close cooperation with the Austrian Student Association (ÖMU). There were regular information newsletters of the course offering and other news. A weekly update of the homepage with a link to subscribe to a tutorial online or on demand to the project's email was provided. The homepage is the access point for courses, information and case histories. Organization of disposable items for the tutorials was provided in cooperation with the Department of Radiology.

### Abdominal ultrasound

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Standard plane</th>
<th>Important structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Longitudinal view, right flank</td>
<td>Liver, kidney, psoas major muscle, Morison's Pouch</td>
</tr>
<tr>
<td>2</td>
<td>Subcostal longitudinal view</td>
<td>Gall bladder, vena cava</td>
</tr>
<tr>
<td>3</td>
<td>Subcostal transverse view</td>
<td>Gall bladder, portal vein bifurcation, liver veins</td>
</tr>
<tr>
<td>4</td>
<td>CPC view</td>
<td>Vena cava, portal vein, common bile duct</td>
</tr>
<tr>
<td>5</td>
<td>Subxiphoid longitudinal view</td>
<td>Aorta and branches, vena cava</td>
</tr>
<tr>
<td>6</td>
<td>Subxiphoid transverse view</td>
<td>Mesenteric superior artery, pancreas, splenic vein</td>
</tr>
<tr>
<td>7</td>
<td>Intercostal view, left flank</td>
<td>Spleen, kidney</td>
</tr>
<tr>
<td>8</td>
<td>Suprapubic longitudinal view</td>
<td>Urinary bladder, prostate or uterus and ovary</td>
</tr>
<tr>
<td>9</td>
<td>Suprapubic transverse view</td>
<td>Urinary bladder, prostate or uterus and ovary</td>
</tr>
</tbody>
</table>

### Ultrasound of the neck and head region

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Standard plane</th>
<th>Important structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Neck overview</td>
<td>Vessels, muscles, thyroid gland, oesophagus, vagus nerve</td>
</tr>
<tr>
<td>2</td>
<td>Thyroid gland longitudinal view</td>
<td>Thyroid gland</td>
</tr>
<tr>
<td>---</td>
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</tr>
<tr>
<td>3</td>
<td>Thyroid gland transverse view</td>
<td>Thyroid gland</td>
</tr>
<tr>
<td>4</td>
<td>Common carotid artery longitudinal and transverse Anatomy, flow profile, color doppler</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Internal carotid artery longitudinal and transverse Anatomy, flow profile, color doppler</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>External carotid artery longitudinal and transverse Anatomy, flow profile, color doppler</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Vertebral artery Anatomy, flow profile, color doppler</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Salivary glands Parotid gland, submandibular gland, sublingual gland</td>
<td></td>
</tr>
</tbody>
</table>

**Echocardiography**

- Parasternal long axis view Mitral valve, aortic valve, septum, overview
- Parasternal short axis views Mitral valve, aortic valve, papillary muscles
- Apical 4-chamber view Mitral valve, tricuspid valve, measurements
- Apical 5-chamber view Aortic valve
- Coronary sinus view Coronary sinus
- Apical 2-chamber view Left ventricle and atrium, mitral valve
- Apical 3-chamber view Left ventricle and atrium, mitral valve, aortic valve
- Subcostal view Vena cava, heart chambers and valves
- Suprasternal view Aorta

- All views are shown with color Doppler and flow profile of the valve.
• Five abdominal cases and 30 short echocardiography cases were implemented to give participants an opportunity to test their knowledge on normal anatomy and transfer it to straightforward clinical cases.

**FAST / E - FAST (emergency ultrasound)**

1. Liver / kidney, right flank  
   Morison’s pouch
2. Subcostal view  
   Haemorrhage, pericardial effusion
3. Douglas' pouch  
   Haemorrhage
4. Spleen, left flank  
   Haemorrhage
5. Intercostal view, parasternal long axis view  
   Pleural effusion, haemorrhage
6. Intercostal views  
   Pneumothorax, pleural effusion

**Ultrasound of the brachial plexus / supraclavicular nerves**

1. Neck overview  
   Thyroid gland and vessels
2. Scalene muscles overview  
   Anatomy
3. Plexus root C4  
   Tubercles and nerves
4. Plexus root C5  
   Tubercles and nerves
5. Plexus root C6  
   Tubercles and nerves
6. Plexus root C7  
   Tubercles and nerves
7. Plexus root C8  
   Nerve
8. Phrenic nerve  
   Peripheral Nerve
9. Long thoracic nerve  
   Peripheral Nerve

**Table 1:** Five different tutorials were evaluated and performed in designated standard planes during the project

68 tutors provided 292 tutorials for 1471 participants in five years; thus an average of 30 tutorials were offered to students every semester. An average of 150 students from different years of studies participated during this time in the tutorials. 10 tutors in a semester represent the active team providing the tutorials on a voluntary basis.
On the basis of this experience, the Sono4you project was published at the ECR 2011 as an oral presentation in the "Radiology in Undergraduate Education" category.

2) Hands-On Workshops at ECR 2012

The presentation of the Sono4you project was awarded at the ECR 2011 and further supported by the ESR with an implementation of the project during the ECR 2012 with four hands-on workshops for 200 international students. The methods of the project should be transferred to an international platform with the goal of making the international students aware what ultrasound is capable of. Therefore various tutorials were combined in a two-hour workshop to concentrate on six different stations based on peer-teaching. In a rotation system, the basics of a certain area were presented to the participants to clarify the potentials of ultrasound imaging.

Ultrasound was performed on the following anatomic regions:

- Carotid artery
- FAST / E-FAST - emergency ultrasound
- Supraclavicular nerves - plexus brachialis
- Abdomen - the kidney
- Musculoskeletal Ultrasound - N. radialis
- Turkey station (Ultrasound guided punction)

Certain parts of the standard tutorials were transferred into each station with focus on feasible content in a short time of presentation.

In the "Turkey station" ultrasound-guided interventions were simulated. The tutors worked out a concept with impressive examples in self made models, and they set up a station where participants learned how to perform an intervention (Figures 2 and 3).

Twelve experienced and active tutors were chosen to take part as workshop instructors from the entire tutoring team. Dividing in groups of two for each station, two tutors were working out the content that should be impressive, educational and feasible for their region of interest in about five minutes.

In the weekly meetings of the project organization, these groups started to present their area to other tutors. Ultrasound technique, precise views, and correct technical terms were trained with direct feedback. Every five-minute presentation was videotaped once to simulate the workshop situation.
Furthermore, every group designed four pages in a document with content of their workshop station by giving an overview, standard planes and illustrative images. This worksheet was given to every participant as a review of the most important content. In addition it should motivate each participant to try to practice the certain region at his self directed learning attempts further on.

High-quality ultrasound machines, disposable items and other basic requirements were organized together with the European Society of Radiology (ESR) in cooperation with six different companies, providing standard ultrasound machines: GE Healthcare, Chalfont St Giles, Great Britain; Toshiba, Tokio, Japan; Siemens Healthcare, Erlangen, Germany; Philips Healthcare, Amsterdam, The Netherlands; Hitachi, Tokio, Japan; Esoate, Genoa, Italy.

**Concept and procedure of one workshop**

With a maximum of 50 participants one of four workshops took 90 minutes. In a room of 200 m² was equipped with 12 ultrasound machines, where the 12 tutors were building up 6 different stations. After a short introduction the participants were divided 12 small groups of 3 to 4 participants, rotating from station to station every 15 minutes. The two tutors of one station explain the content based on peer-teaching to each group simultaneously or in cooperation and split up after.

Tutors gave the most important views and planes on their region and explained anatomic structures. The tutor-student ratio was established at 1:2 to 1:4 with small distance between the tutor and the student, depending on the number of participants in the particular workshop.

During the hands-on workshops up to 200 participants, evaluation sheets with four different questions and improvement wishes were given to each participant. Following questions were asked:

- How likely will the workshop change your working method in the future?
- How would you rate your learning experience during this session?
- How do you rate the practical training?

The first and second question was rated on a 4-point Likert Scale ("poor" = 4, "fair" = 3, "good" = 2, "very good" = 1). The third question was rated on a 3-point Likert Scale ("unlikely" = 3, "likely" = 2, "very likely" = 1). The question: "Should the topic be repeated in a future ECR?" could be answered with "yes" or "no". Finally, free text comments to the question "Do you have any suggestions for improvements?" were collected. The evaluation sheets were analyzed with descriptive statistical methods (Microsoft Office Excel 2007).
Fig. 1: Pocket Card - Abdominal Ultrasound
Fig. 2: Self made phantom for practicing ultrasound-guided interventions
Fig. 3: Setting for ultrasound-guided interventions
Results

1) Sono4You at the MUVI

As results from five years of the project Sono4You, tutorials were realized on a voluntary basis and adapted to the learning content in the medical curriculum. Courses on a regular basis in the upper abdominal, echocardiography, head and neck region, FAST / E-FAST and supraclavicular nerves/ brachial plexus were established.

Providing the courses was dependant on winter or summer semester. In the summer semester the interest and time for learning and practicing ultrasound was low because students were preparing for the yearly exams. Organization during a semester was strict and time-consuming for a project on a voluntary basis similar to an organized curriculum.

The near atmosphere from the student teacher to learner was comfortable. Enough time to practice stimulated the level of processing information. In addition, student teachers trained and prepared for educational skills. Early confrontation with practical skills helped both student teacher and learner to understand the ability of ultrasound in daily clinical practice. Teaching and practicing ultrasound in undergraduate education inside the curriculum was accepted.

The methods of these five successful years of experience in the project Sono4You were presented in the category "radiology in undergraduate education" within the student abstract submission of ECR 2011. The abstract was chosen from more than 200 abstract applications and invited to the "TOP 20" at the congress.

"Sono4You - Ultrasound tutorials for students by students" received an award for the best presented student lecture and undergraduate project.

2) Evaluation of Hands-on Workshops at the ECR 2012

Four Hands-on workshops for up to 200 participants were performed at the ECR 2012 with the methods from the tutorials. All in all, 104 of 150 evaluation sheets were returned. The following numbers represent the data from these 104 sheets.

Self-assessed quality of practical training and the overall learning experience were consistently rated between "very good" and "good". Influence of the workshop on changing the working method in the future were consistently rated between "very likely" and "likely" (see Tables 2 and 3). In 90 out of 91 questionnaires, participants suggested repeating the workshop during a future ECR venue.
### Table 2: Detailed data of evaluation questions 1 - 3 of the number 1 and 2 workshops at ECR 2012. n = number of evaluation sheets. The first and second questions were rated on a 4-point Likert Scale ("poor” = 4, “fair” = 3, "good” = 2, "very good” = 1). The third question was rated on a 3-point Likert Scale ("unlikely” = 3, "likely” = 2, "very likely” = 1).

<table>
<thead>
<tr>
<th>Workshop</th>
<th>Workshop 3</th>
<th>Workshop 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Standard Deviation</td>
</tr>
<tr>
<td>How do you rate the practical training?</td>
<td>1.14</td>
<td>0.34</td>
</tr>
<tr>
<td>How would you rate your learning experience during this session?</td>
<td>1.36</td>
<td>0.48</td>
</tr>
<tr>
<td>How likely is it that the workshop will change your working method in the future?</td>
<td>1.64</td>
<td>0.55</td>
</tr>
</tbody>
</table>
Table 3: Detailed values of evaluation questions 1-3 of the workshops number 3 and 4 at ECR 2012. n = number of evaluation sheets. The first and second question was rated on a 4-point Likert Scale ("poor" = 4, "fair" = 3, "good" = 2, "very good" = 1). The third question was rated on a 3-point Likert Scale ("unlikely" = 3, "likely" = 2, "very likely" = 1).

To the free text question "Do you have any suggestions for improvements?" participants answered:

- This workshop in more locations (1x)
- Many initiatives similar to this (1x)
- More time, more time, more time to practice (16x)
- Tutorial on equipment and tools (1x)
- Learning channel in youtube.com (1x)
- Compensation for the tutors (2x)
Conclusion

Peer-teaching for practical ultrasound in different fields of attention is reasonable to be established in undergraduate education. The realization of this approach and the feasibility as well as the international acceptance of ultrasound in undergraduate education could be consistently demonstrated over a long period of time. During five years of peer-assisted tutorials, continuity in the procedure of tutorial requests, the tutorials themselves and student leadership of the project was ensured. The aim was to show students ultrasound basics for the best possible preparation for clinical training. In conclusion, our tutorials were based on proper use of technical equipment, basic planes and clearly defined insights into common pathologies.

In the ECR workshops the intentions of teaching stayed the same as in the tutorials in the local curriculum. Evaluation results of the workshops at the congress showed that all except one participant voted for repeating these kinds of workshops. The huge interest and demand from students of different countries represents in our opinion the lack of the possibilities to practice ultrasound during their studies in a regular way. The positive voting of the participants demonstrated the high scientific and practical level of the tutor team (Figure 4) and their presentations during the workshop.

Ultrasound tutorials help students in medical clerkships, radiology meetings equal to the medical field or in their work in the practical year. From students and tutors who took part in several tutorials during the five years of the project, progress in learning and the educational experience is better than in untrained colleagues, similar to results of different short-term projects from papers mentioned in the references.

The whole development of the project Sono4You and its increasing growth, interest and scientific basis shows the huge demand of students to learn and practice ultrasound as early as possible and frequently. In our opinion it elucidates that ultrasound in undergraduate education is a teaching goal, prepares students better for postgraduate work and enhances their knowledge to anatomy and ultrasound strongly.

Implementation of the project "Sono4You" in five different universities in Europe is a pilot project together with ESR. For this project and improvement of ultrasound in undergraduate education it needs the motivation and dedication of young students as well as senior experts.

Images for this section:
Fig. 4: Tutor team of the hands-on workshops at ECR 2012
References


**Personal Information**

Alexander Sachs is the medical head of Sono4You.
Besides sonography of the abdomen and echocardiography, his main interests are high resolution sonography of peripheral nerves and the musculoskeletal system.

Furthermore he invests a lot of energy in undergraduate education projects by peer teaching and dissemination.

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