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Multidimensional approach to teaching anatomy—Do gender and learning style matter?

Gertraud Gradl-Dietsch[a,*,1], Tabea Korden[a,1], Ali Modabber[b], Tolga Taha Sönmez[b], Jan-Philipp Stromps[c], Bergita Ganse[a], Hans-Christoph Pape[a], Matthias Knobe[a]

[a] Department of Orthopaedic Trauma, University of Aachen, Pauwelstrasse 30, 52074 Aachen, Germany
[b] Department of oral and maxillofacial surgery, University of Aachen, Pauwelstrasse 30, 52074 Aachen, Germany
[c] Department of Plastic Surgery, Hand and Burns Surgery, University of Aachen, Pauwelstrasse 30, 52074 Aachen, Germany

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ABSTRACT

Background: The aim of this study was to assess the impact of two teaching interventions (ultrasound and arthroscopy) in a peer teaching (PT) environment on anatomy examination scores and also to examine the influence of gender and learning style on these scores.
Methods: We randomly assigned 484 second year medical students to one of three groups: musculoskeletal ultrasound (MSUS), arthroscopy (ASC) and control (CON). The MSUS- and the ASC-group attended two additional training sessions in ultrasound or arthroscopy; the CON-group received no additional lessons. Students were asked to complete Kolb's Learning Style Inventory test. We assessed differences in anatomical knowledge (multiple choice (MC) exam) and subjective evaluation with respect to gender and learning style.
Results: There were no relevant differences between the three groups regarding the MC exam. Acceptance of the peer teaching concept was good. All students preferred ultrasound to arthroscopy and thought that they learned more from ultrasound despite the fact that they rated the instructors as less competent and needed more time to gain in-depth knowledge. There was no significant effect of gender on evaluation results. Arthroscopy was best enjoyed by accommodators according to Kolb's Inventory and least by divergers, who found that they had learned a lot through ultrasound. The improvement in spatial conceptualization was greatest for accommodators and worst for assimilators.
Conclusion: Gender and learning style had no impact on quantitative parameters.
Qualitative analysis, however, revealed differences for learning style and further evaluation is warranted to assess the impact on medical education.

1. Introduction

Dissection-based anatomical teaching has been used in teaching anatomy for more than 400 years (Turney, 2007). Effectiveness and popularity with students have been demonstrated in several studies (Azer and Eizenberg, 2007; Lempp, 2005). Anatomy-learning, on the other hand is a process that is characterized by initial learning, forgetting, restructuring and applying (Smith and Mathias, 2011) and medical students often do not feel that they have sufficient anatomical knowledge to practice competently (Fitzgerald et al., 2008).

In daily practice there is a strong link between applied anatomy and radiologic imaging (Smith and Mathias, 2011). Results of previous studies indicated that students benefit from introducing imaging techniques such as ultrasound into teaching anatomy (Arger et al., 2005; Wright and Bell, 2008).

The addition of short educational units of arthroscopy to the macroscopic dissection course using a simulator has also proven to be effective in terms of knowledge gain and student motivation (Knobe et al., 2012a).

In order to train students effectively it is of paramount importance not only to consider the "what" but also the "how" (Romanelli et al., 2009).

The use of peer teachers has been proven to be effective for teaching ultrasound to students with a certain level of expertise in musculoskeletal anatomy as opposed to novices (Knobe et al., 2010a,b, 2012a).

* Corresponding author. Tel.: +49 20869825991; fax: +49 20869825971.
E-mail address: ggradl-dietsch@posteo.de (G. Gradl-Dietsch).
[1] G. Gradl-Dietsch and T. Korden contributed equally to this work.

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Based on positive experience with the peer teaching (PT) concept for ultrasound training (Knobe et al., 2012), we introduced it to the "Musculoskeletal System" course in the second year for both ultrasound and arthroscopy.

In addition to considering the "what" and the "how", recognition of the individual student and her or his learning style preferences may improve teaching and subsequently learning. Kolb's Learning Style Inventory was first introduced in 1984 (Kolb, 1984) and has been applied to students and trainees of various fields (Engels and de Gara, 2010). Kolb's model is associated with the Learning Style Inventory instrument (LSI). The LSI focuses on learner's preferences in terms of concrete versus abstract, and action versus reflection (Romanelli et al., 2009). The learning styles within the model can therefore be categorized as follows:

Divergers: perceive information through concrete experience and process through reflective observation.

Assimilators: perceive information through abstract conceptualization and process through reflective observation.

Convergers: perceive information through abstract conceptualization and process through active experiments.

Accommodators: perceive information through concrete experience and process through active experiments.

According to Terrell, anatomy classes should therefore provide clinical examples for divergers; visual aids, models or cadavers for assimilators. Teaching strategies should include case-based or problem-based learning to engage Convergers and educators should provide enough time for buzz groups or group discussions to engage accommodators (Terrell, 2015).

In addition to learning style, gender and associated gender roles are reported to have an impact on learning and skills acquisition (Garg et al., 2001; Guillot et al., 2007; Thorson et al., 2011). With rising numbers of female medical students, these differences warrant further evaluation (Mooij et al., 2011).

Based on the results of a previous trial we repeated the evaluation of supplemental imaging techniques in teaching anatomy in a peer teaching environment with a larger group of participants and an emphasis on gender and learning style.

We were further interested in the students perception and evaluation of the teaching concept.

2. Materials and methods

2.1. Study design

This was a single-center prospective randomized trial. Institutional Review Board approval was granted before initiation of this study (EK 178/09), and strict confidentiality guidelines were followed.

2.2. Subject selection

Eligible participants were all second year medical students that took the compulsory "Musculoskeletal System" course.

All students were recruited at one single university between October 2012 and October 2013.

2.3. Course description

The compulsory Musculoskeletal System course is an interdisciplinary course that comprises the dissection course and lectures and seminars on anatomy, neuroanatomy, trauma and orthopedic surgery.

2.4. Randomization

Participants were randomly assigned following simple randomization procedures (computerized random numbers) to one of the three groups: musculoskeletal ultrasound (MSUS, $n = 181$), arthroscopy (ASC, $n = 142$) and control group (CON, $n = 161$).

2.5. Teacher training

Peer teachers were recruited from senior courses (third and fourth year). Peers received information regarding the course concept as well as extensive literature on the subject two weeks in advance. In a "teach the teacher" course (4 trainings, 120 min each) we repeated the technical basics of ultrasound and arthroscopy and provided a sound didactics training. The theoretical part was followed by several practical sessions given by experienced Orthopedic Trauma surgeons.

2.6. Intervention

In addition to the dissection course, students in the MSUS group received two training sessions of 75 min each on the knee and shoulder joint. Between eight and ten students formed a training group and shared an ultrasound device (Toshiba Medical System GmbH, Nemio XG, Neuss, Germany, 10 MHz-linear transducer). The training started with a short introduction to sonography including basic principles such as spatial orientation and interpretation of images, choice of transducer and handling of the device. The peer teachers than demonstrated the standard planes for each joint. Students than had enough time to practice the scans on each other. We hereby used the following six standard sectional planes of the shoulder defined by the German Society for Medical Ultrasound (DEGUM): ventral transverse, ventral longitudinal, lateral transverse, lateral longitudinal, dorsal transverse and dorsal longitudinal (7, 9 and 10). Four standard sectional planes of the knee joint were practiced (defined by DEGUM): suprapatellar longitudinal, infrapatellar longitudinal, lateral longitudinal and medial longitudinal.

In the arthroscopy group, training was performed on models of the shoulder and knee joint (Arthrex Medical Instruments GmbH, Karlsfeld, Germany). The basics of arthroscopy as surgical approach, anatomical structures, spatial orientation, possibilities and limitations were explained using a video presentation (7). Then the peer instructor demonstrated the procedure and each student performed a shoulder or knee arthroscopy simulation on the model on his own (under peer supervision).

The Control group attended the dissection course but received no additional training.

All participants were asked to complete Kolb's Learning Style Inventory test at the time of the exam.

2.7. Examination

After one week, students took a 15 item multiple choice (MC) exam with a single correct answer question type. Six questions related to the shoulder region, four to the knee region and five questions focused on other joints such as the ankle, hip and elbow joint. Half of the questions contained images or anatomic drawings.

There was a cross-over between groups after the exam and the control group received both arthroscopy and ultrasound training, ensuring that all students had equal access to learning resources. However, this trial ended with the MC exam.

2.8. Evaluation

The students were asked to evaluate the arthroscopy and ultrasound course separately using two identical 15 item

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