

## EDUCATION

# Improvement of anatomical knowledge and surgical skills in head and neck region – An interdisciplinary hands-on course for clinical students<sup>☆</sup>



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## ABSTRACT

**Introduction:** Anatomical knowledge and manual skills are required for every surgical procedure. During the regular study the students only have few opportunities to practice their surgical skills actively. To improve this situation, an interdisciplinary hands-on-course for head and neck anatomy and surgery has been set up at the RWTH Aachen University.

**Materials and methods:** The new course has been devised for one week with a full-time schedule. A special anatomical region has been studied each day. After an anatomical lecture, dissections under tutorial instructions took place. According to the anatomical region, a clinical lecture was given. Afterwards, surgical techniques were demonstrated and put into practice on fresh cadaver heads.

To check the students' knowledge and the knowledge acquisition during the course, participants had to pass a pre- and post-test. The course was finished with an anonymous written evaluation of the course and an open feedback.

**Results:** The evaluations revealed a very high satisfaction of the students with the course. The post-test showed significant better results in anatomical and clinical knowledge than the pre-test. The mean result of the test was raised from 6.8 to 10.0 ( $p < 0.001$ ) for the anatomical questions and from 5.9 to 10.5 ( $p < 0.001$ ) for the clinical questions.

**Conclusion:** The new interdisciplinary hands-on course is an effective method to consolidate anatomical knowledge and to link this awareness to a better understanding of head and neck surgery. The students improve their manual skills and get more interested and more open-minded for oral and maxillofacial surgery.

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## 1. Introduction

Several medical and dental students are already particularly interested in surgery during their studies at the medical school. To become a good surgeon and to perform a surgical procedure successfully, good manual skills and exact anatomical knowledge are required in daily professional activity (Arráez-Aybar et al., 2010). For hundreds of years, cadaver-based instructions have been the main instructional tool for gross anatomy (Estai and Bunt, 2016). Retrospectively, surgeons consider cadaveric dissection the most beneficial method of teaching anatomy (Sheikh et al., 2016).

Usually, the knowledge of anatomy is taught during the preclinical part of medical and dental education. Most of the time during these classes, the anatomy is detached from the clinical context, so that the students have problems to determine the practical relevance of the anatomical lessons. These classical structures can lead to one-dimensional and superficial learning (Ahmed et al., 2012; Böckers et al., 2014; Scheven, 2012). During their clinical courses and their work life later on, the students then have trouble to apply the anatomical knowledge (Guttman et al., 2003; Obrez et al., 2011). To avoid these drawbacks, vertical integration can be applied. It is defined as a combination of basic and clinical sciences (Vidic and Weitlauf, 2002), which have been proven to be a successful method to increase motivation and improve learning outcome (Böckers et al., 2014; Rafai et al., 2016; Wijnen-Meijer et al., 2010).

At most German universities, only the students of dentistry have the chance to dissect the complex head and neck region on their own during their classes. These classes are usually concentrating on

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**Table 1**

Results of the requirement analyses at the RWTH Aachen University. The questions were answered by the medical students (n=97) on a six-point scale, 1 indicating 'fully agree' and 6 'totally disagree' and for the dental students (n= 17) on a five-point scale 1 indicating 'fully agree' and 5 'totally disagree'.

	Mean value	Standard deviation
Medical students		
1. I would like to participate in a hands-on-course for Head and Neck Anatomy and Surgery.	2.71	0.16
2. I consider such a course as dispensable.	5.06	1.17
3. The course content is already sufficiently represented in the medical curriculum.	4.67	0.75
Dental students		
1. I would like to participate in an hands-on-course for Head and Neck Anatomy and Surgery.	1.53	0.32
2. I consider such a course as dispensable.	4.71	1.10
3. The course content is already sufficiently represented in the medical dental curriculum.	3.94	0.41

the anatomical basics without pointing out the clinical relevance. Although the students of dentistry have these intensive courses, a major part of the students in the clinical term feel insecure about determining practical relevancies of the anatomy. The dental students confirmed the need for an additional class to improve their knowledge about head and neck anatomy and oral surgery further according to our requirement analyses (Table 1).

For our medical students the head and neck region is mainly demonstrated and the anatomy taught theoretically. They do not get the chance to dissect the complex head and neck region on their own. Therefore, the medical students cannot sufficiently consolidate their knowledge in this particular region and more than half of them would like to participate in such a course according to our requirement analyses (Table 1). Since the requirement analyses has only been performed at our university, it would be interesting if the same conclusions could be drawn at other universities as well.

Furthermore, manual skills can only be practiced in anatomy classes by cadaver dissections or in some optional courses in the medical skills lab. There is a need for more practical advice in general, since the students only get few chances to improve their surgical skills actively before they finish their studies. In our requirement analysis, medical students confirmed that head and neck anatomy is not being given enough attention during the classical courses and that they would like to have a special dissection course for the head and neck region in combination with surgical practice.

These results of the requirement analysis show that the current concept of education for medical and dental students is not sufficient. More classes with vertical integration are needed.

**Table 2**

Schedule of the interdisciplinary course.

	Monday	Tuesday	Wednesday	Thursday	Friday
Themes	Parotid gland; lateral parotidectomy	Paranasal sinuses and Regio sublingualis; osteoplastic maxillary sinus surgery, mucoperiosteal flap	Trigonom submandibulare and caroticum; neck dissection	Weber-Dieffenbach approach and hemi-maxillektomy	Repetition
Morning	Introduction pre-test, anatomical lecture Anatomical dissection	Anatomical lecture Anatomical dissection	Anatomical lecture Anatomical dissection	Clinical lecture Demonstration of surgical technique	Completion of anatomical preparation Anatomical demonstrations
Lunch	Break	Break	Break	Break	Break
Afternoon	Clinical lecture Demonstration and practice of surgical technique	Clinical lecture Demonstration and practice of surgical techniques	Clinical lecture Demonstration and practice of surgical technique	Practice of surgical technique	Post-test evaluation Feedback discussion

Therefore, an interdisciplinary hands-on-course for head and neck anatomy and surgery has been set up at the RWTH Aachen University. The purpose of this course was to enable students to refresh their anatomical knowledge during their clinical studies and to improve their manual skills. Besides the establishment of the course, the aim of this study was to prove the hypothesized knowledge gain and to increase the motivation for a surgical career.

## 2. Materials and methods

### 2.1. Study design

In summer 2017 all dental and medical students of the clinical terms at the University RWTH Aachen were invited to apply for the interdisciplinary hands-on course. A total of 16 students, five male (31.25%) and eleven female (68.75%), were chosen for this course by the date of registration and the study semester. Five (31.25%) of the volunteers were medical students and eleven (68.75%) were dental students. The course took place at the anatomical dissection hall. Written informed consent to publish images from the participating persons was obtained.

The course lasted for one week with a total duration of 36.5 h in August 2017. During the entire time four qualified lecturers, two anatomical and two surgical lecturers, were supervising the course. At the beginning of the course, during the introduction session, the participants pointed out their expectations and motivation for the course in an open discussion.

On each of the first three days, different anatomical regions were treated as listed in Table 2, i.e. parotid gland, paranasal sinuses, Regio sublingualis, Trigonom submandibulare and caroticum as well as the lateral neck region. Day four was addressed to the Weber-Dieffenbach approach and hemimaxillektomy (Ferguson, 1842; Dieffenbach, 1845; Weber, 1865). The last day of the course served as a repetition of the previously learned content and completion of anatomical preparation.

Each day, before starting with the practical hands-on course in the morning, an anatomical lecture was given about the selected preparation area. Then the according preparation of formalin-fixed heads of body donors took place, as shown in Fig. 1. The dissections were made in teams of two, preferentially one medical student with one dental student, on the left or right half of the head. In the second part of the day a clinical lecture was given about surgical interventions in case of tumors or other disorders in this special anatomical area. The according surgery techniques were then demonstrated step-by-step on a fresh cadaver. The live demonstration of the surgical skills was supported by video transmission on high-resolution screens, to obtain a good view on the operative field for all participants. Besides that, the videos of the demonstrations were assembled, edited and uploaded online as an e-learning tool.



**Fig. 1.** Formalin fixed cadaver head after completion of the preparation of the parotid gland.



**Fig. 4.** Working conditions during the course. The previously demonstrated techniques are put into practice by the students on fresh cadaver heads under qualified supervision.



**Fig. 2.** Live demonstration of a surgery during the course supported by video transmission on high resolution TV-screens.



**Fig. 3.** Stepwise demonstration of the surgical technique using appropriate instruments. Piezosurgery was used for opening the Sinus maxillaris.

Then the students were able to practice the surgical technique on their own on fresh cadaver heads under qualified supervision, as shown in [Figs. 2–4](#).

All preparations were done with surgical instruments of the company Aesculap AG, Germany. In addition, the instrument Piezosurgery® (Mectron, Italy) was used for bone segmentation.

A test before and after the course has been performed to evaluate the knowledge. To preserve data protection, the tests were labelled with a pseudonym chosen by the participants so that pre- and post-tests could be assigned. The pre-test took place on the first day during the introduction session. Its purpose was to assess the baseline knowledge. After completion of the course the post-test was

presented. Both tests consisted of 30 multiple-choice questions, 15 of anatomy and 15 of surgery.

Each correct answer was assessed with one point. There were no half points or minus points. The maximum score for the anatomy questions and for the clinical questions were 15 points each, resulting in a maximum score of 30 points for the entire test. The content of the pre- and post-tests was similar, although the questions were not identical. Each test consisted of five anatomical questions and three surgical questions about the parotid gland, five anatomical questions and five surgical questions about the paranasal sinuses and Regio sublingualis, five anatomical questions and four surgical questions about the Trigonum submandibulare and caroticum. Besides that, each test contained three questions about the hemimaxillectomy. The content of the tests was approved by the course leaders.

The course was finished with an anonymously written evaluation of the course. The evaluation questions were answered on a six-point scale, 1 indicating ‘fully agree’/‘very good’ and 6 ‘totally disagree’/‘deficient’. Apart from that an open feedback group took place.

## 2.2. Statistics

The obtained data were structured and statistically analyzed using MS Office Excel 2016® (Microsoft Corporation, Redmond, Washington, USA). Statistical analyses were conducted using SAS® (SAS Institute, Cary, North Carolina, USA). A paired *t*-test was used to compare the results of the tests.  $p \leq 0.05$  was considered statistically significant.

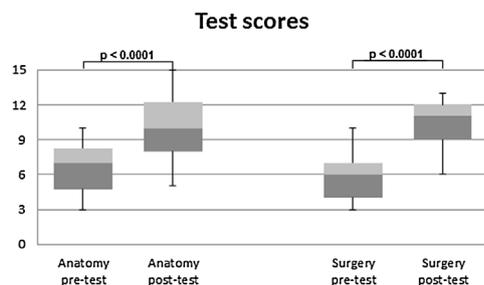
## 3. Results

The open discussion during the introduction session revealed the students’ motivations for attending the course, as shown in [Table 3](#). The medical students emphasized their demand for enhancing their knowledge in head and neck anatomy and improving their manual skills. Apart from that, they wanted to learn more about the techniques in oral and maxillofacial surgery. The dental students confirmed that they wanted to strengthen their knowledge and skills in oral and maxillofacial surgery techniques. In addition they wanted to refresh their anatomical knowledge.

All of the 16 students (100%) successfully participated in both tests. All students showed significantly better results in the post-test than in the pre-test, as shown in [Fig. 5](#). Using the *t*-test, the mean score for the anatomical questions was raised from 6.75 (SD:

**Table 3**  
Summary of the expectations and motivations for attending the course. Participants were allowed to name more than one.

	n
Medical students	
Practicing surgical skills	1
Refresh anatomical knowledge, especially the head & neck anatomy	3
General interest for oro- and maxillofacial surgery	1
Dental students	
Repetition of anatomical knowledge	5
Surgical techniques	2
Improve theoretical knowledge	9



**Fig. 5.** Results of the anatomical and the surgical test before and after the course. The mean score for the anatomical test was raised from 6.75 to 10.0 ( $p < 0.0001$ ). The mean score for the surgical test was raised from 5.88 to 10.5 ( $p < 0.0001$ ).

**Table 4**  
Results of the course evaluation. The questions 1–6 were answered on a six-point scale, 1 indicating ‘fully agree’ and 6 ‘totally disagree’. Question 7 and 8 were answered on a six-point scale, 1 indicating ‘very good’ and 6 ‘deficient’.

Evaluated aspects	Mean value	Standard deviation
1. The course was well structured.	1.06	0.25
2. The topics being covered were useful.	1.25	0.58
3. The study matter was very comprehensible.	1.06	0.25
4. The lectures and practical trainings were well coordinated.	1.06	0.25
5. The supervision was individual and helpful.	1.06	0.25
6. The chosen timeframe of the entire course was adequate.	1.88	0.72
7. I value the concept of the course as. . .	1.13	0.34
8. I value the entire course as. . .	1.06	0.25

24.6) to 10.0 (SD: 2.83;  $p < 0.0001$ ). The mean score for the clinical questions was raised from 5.88 (SD: 2.0) to 10.5 (SD: 1.79;  $p < 0.0001$ ).

The course evaluation showed a very high satisfaction of the students. All results are displayed in [Table 4](#).

#### 4. Discussion

Over the last couple of years, the role of anatomy in medical teaching has been changing. The trend is to teach anatomy in a more interdisciplinary way to better prepare students for their clinical work ([Drake and Pawlina, 2010](#)). This vertical integration, which combines anatomical basics and clinical background, seems to be very effective. It deepens the understanding of the basics science in the context of the clinical problem and stimulates intellectual interest. Overall, it makes learning holistic and more meaningful ([Rajan et al., 2016](#)). Interdisciplinary projects enable to focus on plausible priorities with clinical relevancies. This improves student motivation and learning outcomes ([Rafai et al., 2016](#)). A study by [Sheikh et al. \(2016\)](#) surveyed the opinions of surgeons regarding teaching anatomy. The results show that in the surgeons' view cadaveric dissection is the most beneficial method of teaching anatomy.

This study showed that vertical integration in an interdisciplinary course could significantly improve the anatomical and surgical knowledge of the students. Other studies on interdisciplinary courses using vertical integration have shown similar results. They proved that this procedure resulted in improvement in student's synthesis and application of knowledge and retention ([Abu-Hijleh et al., 2005](#); [Farah and Parvizi, 2013](#); [Rajan et al., 2016](#); [Wijnen-Meijer et al., 2009, 2010](#)). Especially the interdisciplinary aspects of the course were very much appreciated by the students. The link between anatomical knowledge and clinical context enables students to transfer knowledge more easily. Also a study by [D'Souza et al. \(2018\)](#) confirmed the student's high acceptability and satisfaction for vertical integrated courses.

Besides the vertical integration, the motivation of the students could have influenced the significant outcome of the tests. All participants voluntarily participated at this course in their free time and were particularly interested in deepening their understanding about head and neck anatomy and surgery.

The concept of the course, combining medical and dental students in one class, includes an immense advantage. By dissecting and preparing in mixed groups, dental and medical students can complement their knowledge and experience. This leads to an even higher learning effect. All participants confirmed this assumption during their feedback. Apart from that the students enjoyed the mix of dental and medical students. Some of the dental students who already had attended an intensive anatomical class, had the impression that the repetition of the anatomical dissection was too long. They proposed to use prepared heads for the purpose of demonstration. The medical students in contrast did not confirm this conception. They found the dissection very useful and the time appropriate. Also the small group size proportional to the present lecturers enabled a personal and intensive supervision during the entire week, which was appreciated by the students during the feedback round. In addition to that, the students pointed out the good coordination and the personal support of the lecturers during the entire course.

The participants did all anatomical preparations on formalin-fixed cadavers. All surgical procedures were practiced on fresh cadavers. According to the difference of the tissue, different preparation techniques had to be used by the students. The improvement of manual skills were verified by observation, but not systematically assessed by this course. Students were supposed to do the dissections and surgical procedures as a team and most likely they switched stepwise. Still, during the supervision of the lecturers gifted students could be discovered and encouraged for a surgical career.

The concept of the course with a continuous switch between theory and practice was very helpful to settle the recently gained knowledge. By participating on this hands-on course, the students did not only improve their manual skills by dissection, but they also got the unique chance to practice surgical procedures on fresh cadavers, which is exceptional for medical students. This simulates real operating situations and can motivate students to become a surgeon. [Krones et al. \(2010\)](#) showed that in addition to the manual improvement, students' interest for surgery can be enhanced and new talents can be acquired ([Bauer et al., 2016](#); [Krones et al., 2010](#)). As other studies proved, hands-on courses in general are superior to other teaching methods like only demonstrations or videos ([Buerkle et al., 2013](#); [Hilal et al., 2017](#)). Here, in addition to the practical course, videos of the surgical instructions were produced as e-learning tools and as supplementation for future courses. In a study by [Majerník and Szerdióvá \(2017\)](#), these multimedia education tools have been found to be useful as complementary material to traditional cadaver dissections. Similar results have been shown by [Estai and Bunt \(2016\)](#). In their opinion, multiple resources should be combined to teach modern anatomy, since learning seems to be

more effective when multimodal and system-based approaches are integrated. Nevertheless, cadaver dissection should not be replaced by multimedia resources or medical imaging, since it is the most favorable approach to learning anatomy (Chapman et al., 2013; Olowo-Ofayoku and Moxham, 2014).

Overall, the study objectively demonstrated that the interdisciplinary hands-on course is an effective teaching method. It is not possible to discern which educational intervention, vertical integration or the immediate practical application, had the most significant effect. Presumably the combination of both methods was most effective. At the end, all participants declared to recommend this course to other students.

As a limitation of our study, the assessment of knowledge gain was immediately after the course. Therefore, we cannot rule out that the knowledge gain may disappear over time. In a future study, it would be interesting to assess the long-term retention of the acquired knowledge. Apart from that, similar, but not identical questions could create biased results. On the other hand, in repetition tests, it is common practice not to use identical questions to avoid just memorizing the answers. Since the two corresponding questions of the pre- and post-tests were created to activate the same knowledge by querying an equal content, it is in our opinion justified to assess the gained knowledge in this way.

Another possible drawback of our study are the operating expenses for this course, which are relatively high using formalin-fixed and fresh cadavers for a small group of students.

In summary, the students significantly enhanced their knowledge as shown by the post-test, and the evaluation of the course was overwhelmingly positive. All participants confirmed that their prior expectations were completely fulfilled and they could greatly improve their manual skills.

## 5. Conclusion

The new interdisciplinary course is an effective method to consolidate anatomical knowledge and to link this awareness to a better understanding of head and neck surgery. The students improved their manual skills and got more interested in and more open-minded for oral and maxillofacial surgery. A constant offer of this training course to interested students could greatly enhance the number of students entering a surgical career.

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