European status on temporal bone training: a questionnaire study.

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Abstract

PURPOSE: In otorhinolaryngology training, introduction to temporal bone surgery through hands-on practice on cadaveric human temporal bones is the gold-standard training method before commencing supervised surgery. During the recent decades, the availability of such specimens and the necessary laboratory facilities for training seems to be decreasing. Alternatives to traditional training can consist of drilling artificial models made of plaster or plastic but also virtual reality (VR) simulation. Nevertheless, the integration and availability of these alternatives into specialist training programs remain unknown.

METHODS: We conducted a questionnaire study mapping current status on temporal bone training and included responses from 113 departments from 23 countries throughout Europe.

RESULTS: In general, temporal bone training during residency in ORL is organized as in-house training, or as participation in national or international temporal bone courses or some combination hereof. There are considerable differences in the availability of training facilities for temporal bone surgery and the number of drillings each ORL trainee can perform. Cadaveric dissection is still the most commonly used training modality.

CONCLUSIONS: VR simulation and artificial models are reported to be used at many leading training departments already. Decreasing availability of cadavers, lower costs of VR simulation and artificial models, in addition to established evidence for a positive effect on the trainees' competency, were reported as the main reasons. Most remaining departments expect to implement VR simulation and artificial models for temporal bone training into their residency programs in the near future.

Keywords: Temporal bone surgery; mastoidectomy; surgical education; cadaveric dissection; simulation-based training.

INTRODUCTION

Surgical skills in mastoidectomy is an important part of the training and education of future otorhinolaryngologists as this procedure represents fundamental competencies in the surgical management of diseases of the middle ear and temporal bone [1]. Traditionally, the training of novices through cadaveric temporal bone dissection has been considered the gold-standard training method [2]. However, during the recent decades, the number of temporal bones available for dissection has decreased due to stricter legislation as well as a reduced number of specimens donated for scientific use. High-quality training is important to ensure competency, a good surgical outcome, and patient safety.

The poor availability of temporal bones at many institutions has led to an increased interest in alternative training models such as artificial models made of plastic or plaster, and virtual reality (VR) simulation [3]. These training models can most likely not entirely substitute cadaveric dissection on human temporal bones but—in combination with a better understanding of the cognitive learning processes—may play an important role in the education and training of future otorhinolaryngologists. These new opportunities for temporal bone training make it possible to acquire surgical skills in a safe environment before performing supervised surgery in contrast to the traditional "see one, do one, teach one" paradigm in surgical education [2].

It is well established that VR simulation training before cadaveric dissection training in mastoidectomy can improve the performance of novices [4, 5], but there is still a gap in knowledge on how mastoidectomy skills training should be organized to facilitate repeated training to automaticity—the level where a specific activity or skill no longer requires cognitive effort [6]. According to Ericsson, years of experience and perceived mastery of knowledge and skills are not enough to exert the true expert level [7]. Deliberate practice to mastery is dependent on continued and cognitively engaged effort in improving performance and can be achieved by actively defining goals for further development, continually receiving feedback, and repeatedly practicing technically difficult parts of the surgical procedure. Furthermore, motivation is key to achieve this level of true expertise [7].

The new temporal bone training models provide opportunity for such repeated and deliberate practice. For example, VR simulation makes it convenient and feasible to practice repeatedly and provide real-time feedback by simulator-integrated tutoring, and 3D printing of plastic temporal bones can provide a variety of anatomical variants for training [8]. Although evidence is increasing for the benefit of supplementing dissection training with these alternative training models [4, 5], the availability and use of the models, as well as the integration into residency training programs remains unknown.

This study intends to investigate the current status of temporal bone training in Europe and through questionnaires sent to training institutions across Europe, map the availability of the different temporal bone training modalities provided in otorhinolaryngology training.

MATERIAL AND METHODS

An electronic questionnaire was designed in SurveyXact (Rambøll, Aarhus, Denmark) and distributed as a hyperlink by e-mail. The dynamic questionnaire could adapt in response to the previous answers.

Introductory questions intended to identify the position of the respondent, the geographic localization of the institution, the range of otosurgical procedures performed, the number of residents/trainees, the length of the residency program, and at which point in residency novices are offered temporal bone surgical training and whether this training is mandatory.

Next, we outlined three possible organization forms for temporal bone training: (1) in-house training facilities, which includes open laboratory training facilities both "wet" (dissection) and "dry" (VR and physical models) with *local training* at the department, and/or (2) temporal bone dissection courses, which can be (A) *nationally* or (B) *internationally* organized.

If trainees had access to in-house training facilities, additional questions explored whether this currently included training on human cadavers, artificial physical models, or VR simulation, reasons for this, and finally, if alternative models would be considered in the future and why/why not. If trainees were offered participation in temporal bone courses nationally or internationally, several additional questions aimed at further detailing this including the training methods being used at these courses, and reflections on future possibility of supplementing training at courses with in-house facilities.

For most questions, response options were categorical or numerical ranges, if relevant also with an "other" option, which opened a free text field for further elaboration. The rest of the questions were free text fields.

A complete list of e-mail addresses for all relevant training institutions in Europe does not exist. Therefore, the questionnaire was distributed by e-mail to the 38 board members of the European Academy of Otology and Neuro-Otology, the 36 European members of the International Federation of Oto-rhino-laryngological Societies, the 34 members of European Union of Medical

Specialists Otorhinolaryngological section and 17 contacts of the national courses. We encouraged the recipients to further distribute the questionnaire to all other national contacts they deemed relevant.

To achieve the best possible geographical coverage, follow-up e-mails were sent to countries with a low initial response rate. These follow-up e-mails were sent to persons who had already been contacted as well as national otorhinolaryngology organizations where possible.

RESULTS

During the period from 1/9/2016 to 19/3/2017, representatives from a total of 120 departments from 24 countries reacted to the questionnaire. 101 respondents completed the whole questionnaire and 12 respondents completed enough parts of the questionnaire to be included. Two responses were too incomplete to be included. Furthermore, five responses were from departments without residency training and were also excluded from further analysis. This resulted in responses from 113 departments from 23 countries being included in the subsequent analyses (Fig. 1). The number of responses to each question varies because some respondents did not answer all questions or were not presented with the question if they had answered "no" to a previous question.

The majority of responding departments had between 1 and 5 trainees (83%, 88 of 106 responses) and 67% (73 of 109 responses) of the departments identified temporal bone training as an obligatory part of their residency program (Table 1). Five departments did not offer trainees any training in temporal bone surgery. Most respondents were head of departments, faculty, or program directors.

In-house training

77 of 106 departments offered their trainees in-house training (Table 2). 72 of the 77 departments specified the training methods offered: training on human temporal bones was provided at 89% of the departments, primarily as the only training method (n = 49), but 15 departments supplemented training on human temporal bones with either VR simulation (n = 7), physical models (n = 2), or both (n = 6) (Fig. 2). 11% of the departments provided VR simulation or physical model training alone or in combination without supplemental in-house training on human temporal bones. 79% of departments having in-house access to cadaveric dissection training found the number of temporal bones available sufficient. 74% (n = 28) of these departments reported that each trainee could drill six temporal bones or more (Table 3).

A majority of departments providing only cadaveric training in-house (86%) considered using supplementing training with VR simulation or physical models in the near future. The remaining departments most often reported financial reasons for not considering alternative training methods. Surprisingly, some respondents reported not to know any alternatives to dissection on human cadavers. None reported concerns about insufficient learning outcome with VR simulation or physical models for temporal bone training.

Eight departments provided their trainees with VR simulation or physical model training exclusively, mainly because of the poor availability of human temporal bones. One respondent considered VR simulation and training on physical models "superior" to cadaveric dissection training. Departments offering VR simulation and/or physical models for temporal bone training reported varying degrees of use by the trainees (Table 4).

87% of the 23 departments who did not offer in-house training wanted to provide this in the future: 40% would prefer "wet" facilities for training on human cadavers; 35% "dry" facilities with VR simulation, physical models or a combination of these; and 25% a combination of "wet" and "dry" facilities mainly with VR simulation. Main indications for considering "dry" facilities only were the poor availability of human temporal bones and costs; main indications for considering "wet" facilities only were costs and not being aware of alternatives to cadaveric dissection.

National and international temporal bone courses

75% of the respondents sent their trainees on national temporal bone courses, 40% on international courses, and 8% on both (Table 2). Most respondents indicated that course participation was offered as a supplement to in-house training.

Most national training courses use human cadaveric temporal bone specimens, either alone (76%) or in combination with mainly VR simulation (20%). Only three national courses were reported to use VR simulation training in combination with artificial physical models or training on physical models alone. A similar pattern was reported for the international courses: 30 of 41 respondents indicated that training on human cadavers was the only method used, two courses used training with VR simulation or training on physical models alone, whereas the remaining respondents indicated a combination of cadaveric dissection and alternative methods.

Most national and international courses allowed participants to drill only one or two cadaveric temporal bones (Table 5). In addition, most courses were reported to be relatively short (between 1 and 3 days).

DISCUSSION

In this questionnaire study, we have mapped the current state of temporal bone training in Europe with responses from the head of department, faculty or program directors at academic institutions. Dissection-based training on human cadavers is still the most frequently used training modality. In-house training including the use of VR simulation is widespread and often provided as a supplement to participation in national and/or international courses, where "wet" dissection training remains predominant.

In a 2002 study from England and Scotland, it was reported by trainees that 53 of all the 57 training departments had in-house (dissection) training facilities [9]. However, only in three of the 53 departments, the training facilities were used by the trainees due to poor availability of human temporal bones. As a result, most of the trainees were sent to training on a national course [9]. In contrast to this, we found that 64 of the 113 (senior) present respondents (57%) provided in-house training on human cadavers and most reported a sufficient number of temporal bones for training. This could indicate a recent improvement in the availability of temporal bones or suggest a different point of view for seniors and trainees—but more likely it reflects a bias of our study towards the largest and most active departments in Europe. This is further corroborated by the fact that we only received responses from six institutions in the UK compared with the 57 institutions identified in the 2002 study. Therefore, our study most likely overestimates the temporal bone training currently offered. As there exists no prior study regarding temporal bone training in multiple European countries it seems acceptable to compare our results with a study from the UK, as there in the UK exists one of the most comprehensive training programs in otorhinolaryngology in Europe [10].

In our questionnaire, many respondents considered two temporal bone drillings to be sufficient for development of the necessary competencies. This could reflect differences in the curriculum tradition or in the desired competency level of trainees. However, such a level might raise concern about the readiness for supervised surgery considering the long learning curve of the mastoidectomy procedure [11], the documented effect of VR simulation training [4, 5] and the fact that training to automaticity would require even further repeated practice [7]. With all the available training modalities in temporal bone surgery and the evidence for their efficacy in training, trainees should not practice on patients to acquire the initial and most basic competencies.

A majority of responding departments sent their trainees on national and international courses. These were most often reported to be 1–3 days and such short and intensive training courses result in massed practice, which for mastoidectomy has been demonstrated to result in poorer performance than distributed practice [11]. In addition, the principles of deliberate practice include continuing practice of technical difficult passages of the surgical procedure, cognitive engagement in improving performance, and well-defined goals for further skill development and refinement and feedback [12, 13]. This can be difficult to achieve within the limited time frame of most temporal bone courses, but more easily pursued during repeated and distributed training, which is easier to achieve by in-house "wet" dissection, VR simulation, or artificial models.

Dissection training on human temporal bones has a long-standing history as the gold standard of mastoidectomy training [2] and our study suggests that most respondents still consider this to be true. However, it seems that VR simulation and artificial temporal bone models have an increasing role in the training of the future otorhinolaryngologists and is integrated into many training programs either as a part of in-house facilities or as a part of national/international courses. Nevertheless, the implementation in residency programs remains an issue and our data suggest that VR simulations and physical models are used variably and inconsistently.

The 113 departments completing our questionnaire varied in size, the number of residents, and geographic distribution. Unfortunately, a complete contact list to all relevant training departments in Europe does not exist. This challenged the distribution of the questionnaire and made it impossible to calculate the response rate because the extent of redistribution is unknown. A limitation of our study is that it represents only few training institutions in Europe, despite our best effort to distribute the questionnaire. Next, there is an imbalance in the representation from different countries: smaller countries such as Norway and Denmark a disproportionately represented (n = 20) whereas a large country such as Germany has few respondents (n = 3).

Almost half of the respondents were heads of department and, therefore, expected to have knowledge of local facilities, curriculum, and trainees' participation in national or international temporal bone courses. However, compared with trainees themselves, the heads of departments might be less familiar with the day-to-day use of in-house facilities and might also present a more positive picture (reporting bias).

Regardless, we consider our study to add valuable knowledge as it is the most comprehensive and systematic attempt at a European status on temporal bone training and most likely represents the leading 2–5% training institutions and includes responses from most European countries (and Israel due to the membership of EAONO). Conceivably, practices from these leading institutions will inspire remaining departments.

CONCLUSIONS

Temporal bone training in Europe remains largely based on traditional dissection of human cadaveric temporal bones by in-house training or participation in national or international temporal bone courses. VR simulation and artificial temporal bone models seem established as a training supplement to dissection in many leading institutions, with the majority of remaining departments expecting to offer this in the near future as the technology improves and costs decreases. The amount of temporal bone training provided varies greatly between institutions but many programs offer training only on a low number of temporal bones. Systematic integration of training using VR simulation or artificial models in otorhinolaryngology residency can potentially alleviate the limitations of cadaveric dissection training in addition to providing an opportunity for deliberate and repeated practice to automaticity.

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COMPLIANCE WITH ETHICAL STANDARDS

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Research involving human participants and/or animals: None.

Informed consent: Informed consent was obtained from all individual participants included in the study.

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Fig. 1 Geographic distribution of respondents (one respondent from Israel is not shown on the map).

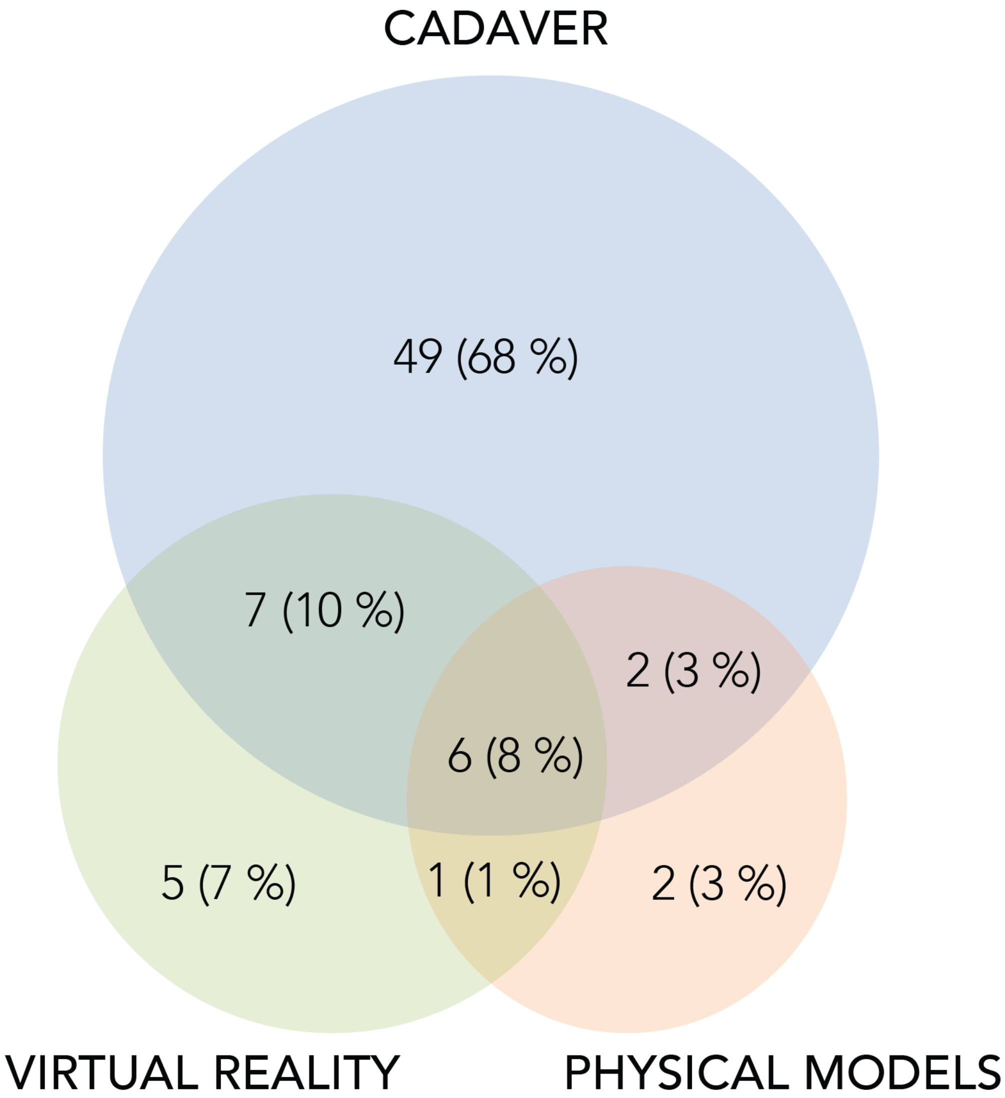

Fig. 2 Distribution of training methodology.

Table 1 General data on responding departments.

	n (%)
How many ORL trainees currently start in the residency program within the department pr. year?	
1 to 5	88 (83 %)
6 to 10	12 (11 %)
11 to 15	5 (5 %)
>15	1 (1 %)
What is your position at the department?	
Head of department	45 (40 %)
Program director	17 (15 %)
Faculty	28 (25 %)
Trainee	15 (13 %)
Other	7 (6 %)
N/A	1 (1 %)
What is the length of the ORL residency program (minimum length of postgraduate training)?	
3 years	8 (7 %)
4 years	8 (7 %)
5 years	80 (73 %)
6 years	13 (12 %)
>6 years	0 (0 %)
What year in the residency program is training in temporal bone surgery available?	
1. year	33 (30 %)
2. year	15 (14 %)
3. year	22 (20 %)
4. year	9 (8 %)
5. year	3 (3 %)
6. year	0 (0 %)
> 6. year	1 (1 %)
N/A	26 (24 %)

Table 2 Distribution of temporal bone training organization.

	n (%)
How are the ORL trainees offered practice in temporal bone surgery?	
In-house	17 (16 %)
National courses	13 (12 %)
International courses	3 (3 %)
In-house & national courses	29 (27 %)
In-house & international courses	1 (1 %)
In-house, national- & international courses	30 (28 %)
National- & international courses	8 (8 %)
Not offered any training	5 (5 %)

Table 3 Amount of human temporal bones available in-house.

Number of human temporal bones available pr. trainee	Departments reporting a sufficient number of temporal bones available	Departments reporting an insufficient number of temporal bones available
1	1 (3 %)	0 (0 %)
2	5 (13 %)	3 (27 %)
3 to 5	4 (11 %)	6 (55 %)
6 to 10	6 (16 %)	1 (9 %)
> 10	8 (21 %)	0 (0 %)
No limitations	14 (37 %)	1 (9 %)

Table 4 The trainees' use of VR simulation or artificial physical models.

	VR simulation	Physical models
Used by none	2 (11 %)	1 (10 %)
Used by some	7 (39 %)	3 (27 %)
Used by most	3 (17 %)	3 (27 %)
Used by everyone	6 (33 %)	4 (36 %)

Table 5 Amount of human temporal bones available at courses.

Number of drillings	Number of respondents **National courses**	Number of respondents **International courses**
1	27 (36 %)	14 (36 %)
2	32 (43 %)	11 (33 %)
3 to 5	7 (10 %)	9 (23 %)
6 to 10	3 (4 %)	0 (0 %)
More than 10	2 (3 %)	0 (0 %)
No limitations	3 (4 %)	3 (8 %)