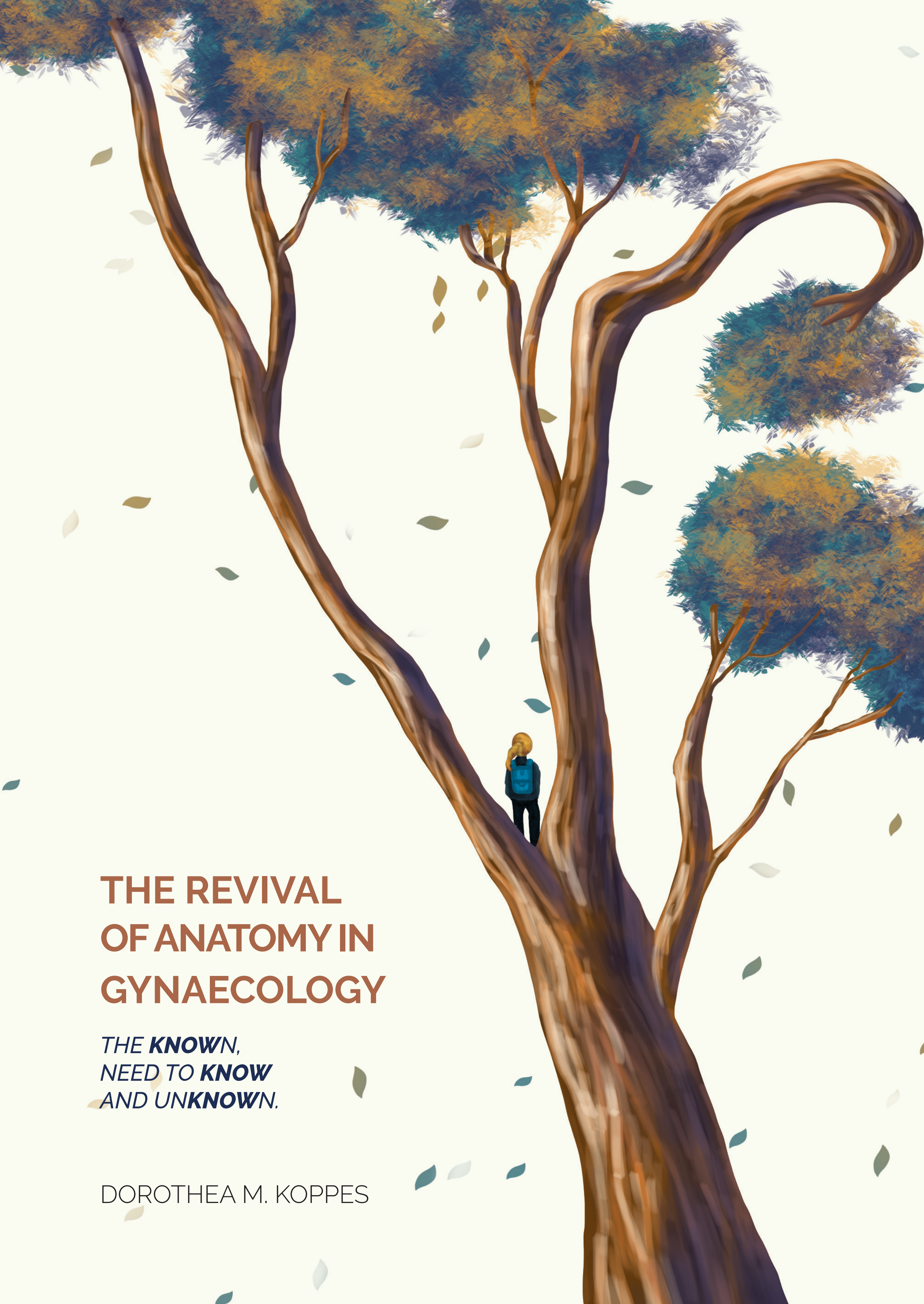
The revival of anatomy in gynaecology



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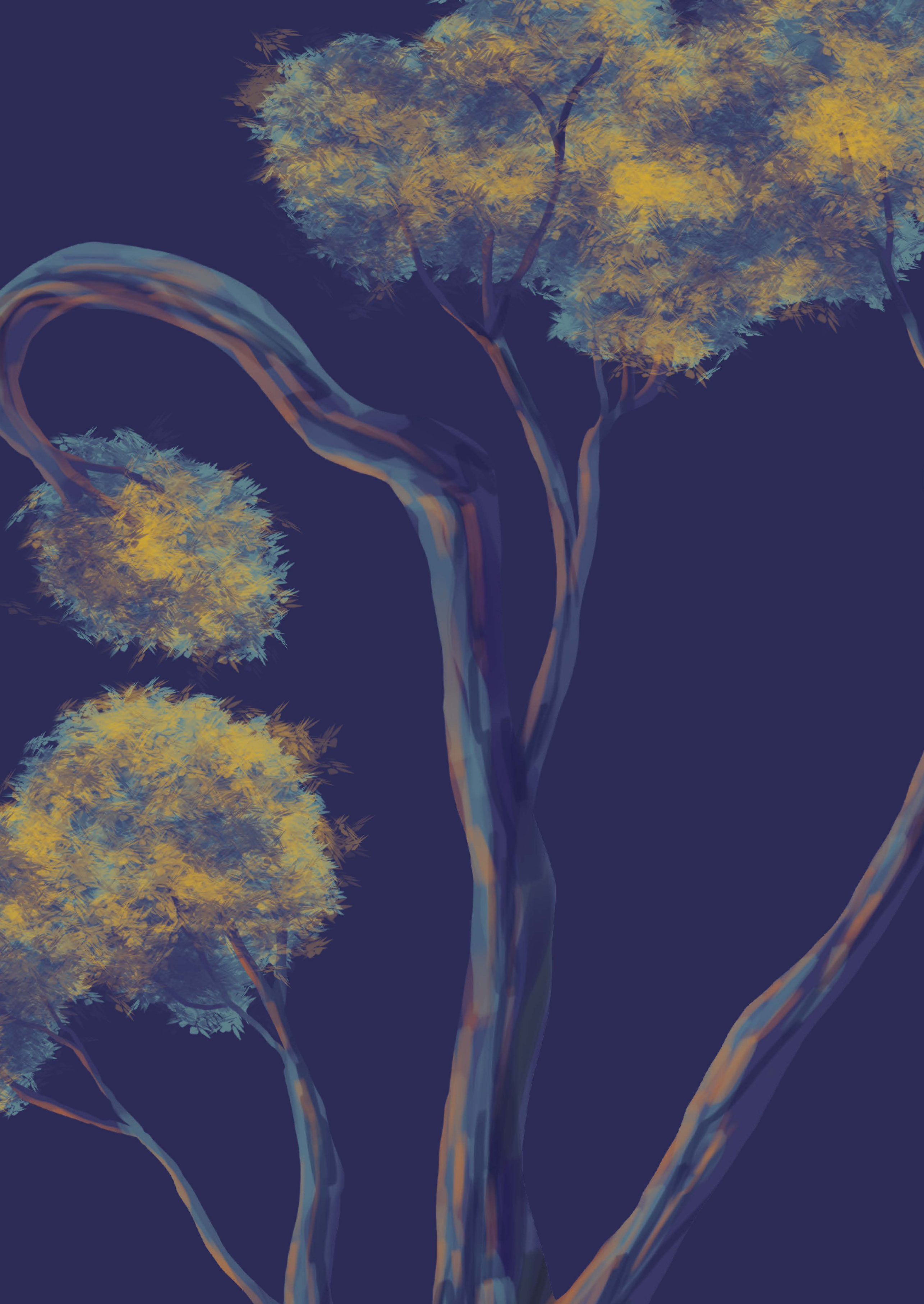
*AND UN**KNOW**N.*

DOROTHEA M. KOPPES



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THE REVIVAL OF ANATOMY IN GYNAECOLOGY

*THE **KNOW**N,*
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*AND UN**KNOW**N.*

Proefschrift

ter verkrijging van de graad van doctor aan de Universiteit Maastricht,
op gezag van de Rector Magnificus, Prof dr. Pamela Habibović ,
volgens het besluit van het College van Decanen,
in het openbaar te verdedigen op donderdag 10 november 2022 om 10 uur.

door

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1 General introduction

General introduction

"*Doctors without anatomy are like moles. They work in the dark and the work of their hands are mounds*". This dictum, from Friederich Tiedeman, a German anatomist (1781-1861), represents the general tone about anatomy and medicine from a deontological stance: a doctor is expected to have good anatomical knowledge. The deontological perspective is an ethical theory which places special emphasis on the relationship between duty and the morality of human actions. An action is considered morally good because of some characteristics of the action itself, not because the product of the action is good. In contrast, utilitarianism is a form of consequentialism that determines right from wrong by focusing on outcomes and usefulness. The utilitarian stance holds that the most ethical choice is the one that will produce the greatest good for the greatest number [1, 2]. From a utilitarian stance anatomy provides knowledge of normal structure and function. It provides understanding of the basis of abnormal structure and function, a context for clinical reasoning and is therefore required for safe practice.Both, the deontology and the utilitarian theory, play an important role in the development of the medical education curriculum and the role of anatomy in it.

Traditionally, anatomy served as a leading science in the founding of medical schools and was one of the basic pillars of medical training, mainly from a deontological stance [3]. Early in the twentieth century this traditional view was reinforced by the Flexner report. Flexner proposed to strengthen the academic and scientific components of medical education, including strengthening basic science departments [4]. However, the growth in medical science and in medical knowledge in general put pressure on the curriculum. In the same time, due to the power and independence of the basic science departments, fragmentation and duplication of teaching occurred. These developments, combined with the turbulent times of the 1960s, have led to a call for a more patient centred teaching and learning where basic science was no longer the dominating factor [5].A vision that was already propagated for decades by Osler. Flexner and Osler were of the same generation but were almost diametrically opposed. Osler stood for a practice-orientated teaching method, he emphasised that a diagnosis could be made by direct observation of the patient and not just from under the microscope [6, 7].

Osler's thought can be seen as the base for problem-based learning (PBL), which is formally introduced in the 1960s. PBL is a process that uses identified issues within a scenario to increase knowledge and understanding. It follows a constructivist approach to learning where students activate prior knowledge and build upon existing conceptual knowledge frameworks [8-10]. PBL assists to guide the student from theory to practice during their journey in solving the problem [11]. A consequence of the introduction of PBL is the virtually abolition of the separate teaching of basic science, such as anatomy [12-15]. The idea is that concepts or information from basic sciences are recognized by students and studied as learning objectives. In other words, in the PBL system learning can only occur after an objective has been defined. This is the point critics hit when it comes to basic science in PBL. They question the ability of students to ask the right questions to uncover the scientific basis of the problems. From studies in cognitive psychology, it is shown that just practice is not enough to develop expertise. A well-organized knowledge database is necessary for expert problem solving [16]. This can be explained from one of the utility aspects of basic science: understanding [5]. Understanding in this context is described as the possession of a theoretical framework into which new information can be inserted. Without this framework further growth, *i.e.,* learning, may be difficult. It will also affect the ability to explain actions and educate others.

Critics' concerns regarding PBL and basic sciences were supported by feedback from the field. Program directors, medical doctors and residents claim to be worried that medical students and residents are ill-prepared in anatomy when entering the clinical part of their education [17-19]. Also, both medical students and residents themselves feel insecure and concerned that their anatomical knowledge is not sufficient for clinical practice since PBL was introduced[17-22]. In addition, around the year 2000 a 7-fold increase is reported in claims related to anatomical errors submitted to the Medical Defence Union of the United Kingdom [23, 24] .

Those worries and insecurities can be understood from the standpoint of utilitarianism. Parties involved are concerned that their (lack of) anatomical knowledge will affect their actions. Raising the question if changes in medical education over the past century may have gone too far when it comes to basic sciences such as anatomy. Should we overthink our medical education to find the right balance between theory and practice?

However, before drawing conclusions on assumptions, it seems reasonable to monitor health professionals' anatomical knowledge and assess whether it meets standards set by a certain clinical discipline.

In 2016, a start has been made under the leadership of the anatomy association. Prepared by a panel of practising doctors, surgeons and anatomists, guidelines have been developed on an anatomy curriculum for independent medical practitioners to practice medicine safely [25]. This consensus should be welcomed as it allows a benchmark to be set for medical schools. Tailoring anatomy knowledge to a specific medical specialty may be a logical next step, since specialist trainees need more detailed knowledge of anatomy in their field and there is a difference in anatomy knowledge for a generalist and a surgical specialist.

Obstetrics and gynaecology is a broad and diverse specialty of medicine which also includes a surgical part. In a specialty like this, the need for knowledge is broad and the need to specify the required knowledge is important. However, we could not find any standards of anatomical knowledge for a gynaecologist in the literature. Curriculum plans mainly focus on the numbers of surgical procedures, CanMeds and Entrustable Professional Activities (EPA), without clear descriptions of expected knowledge [26, 27]. In the Netherlands, the attention paid to anatomy in the postgraduate training of O&G seems to be limited. The formal opportunities to learn anatomy consist of two 1-day courses of anatomy.The informal teaching opportunities are decreasing due to a shift in therapeutic approaches towards more conservative therapies resulting in less time in the operation theatre. These findings, together with the concerns about the effects of reformed undergraduate approaches to anatomy, underline the necessity to define the required knowledge of specialist trainees and assess whether it meets standard [17]. The literature showed us that it is also possible to formulate need to know knowledge. Emergency medicine, a specialty that has many similarities with obstetrics & gynaecology, determined the curricular content for anatomy through the modified Delphi technique [28].

Objectives of this thesis

The overall objective of this thesis is to provide insight in the different aspects of anatomy knowledge and acquisition of anatomy knowledge in order to answer if the general feeling that we fall short in anatomical knowledge is justified.

Part I of this thesis aimed to determine how medical students learn anatomy and what is known about the level of anatomy knowledge in general.

- In **chapter 2** we explored medical students' attitude with regard to studying anatomy and evaluate possibilities for improvement.
- In **chapter 3** we provide an overview of what is known about measured anatomical knowledge and discuss different aspects of sufficient anatomical knowledge.

Part II focusses on anatomy in the speciality obstetrics and gynaecology. We aimed to define what is need to know knowledge for a general gynaecologist, the level of anatomical knowledge and the use and acquisition of this knowledge in the daily practice.

- In **chapter 4** we determined which anatomical structures should be taught to ensure safe and competent practice among Dutch general gynaecologists.
- In **chapter 5** we internationally validate which anatomical structures should be taught to ensure safe and competent practice among general gynaecologists.
- In **chapter 6** we measured the anatomical knowledge level of postgraduate trainees' obstetrics and gynaecology in order to define if there is need for improvement.
- In **chapter 7** we determined the role and significance of anatomy in the practice of obstetrics and gynaecology and the relationship between the importance of anatomy and the acquisition of anatomical knowledge.

This thesis is a first step in the development of a comprehensive training program for the postgraduate training in obstetrics and gynaecology for the subject anatomy. Hereby we approach the role of anatomy from the principle of utility.

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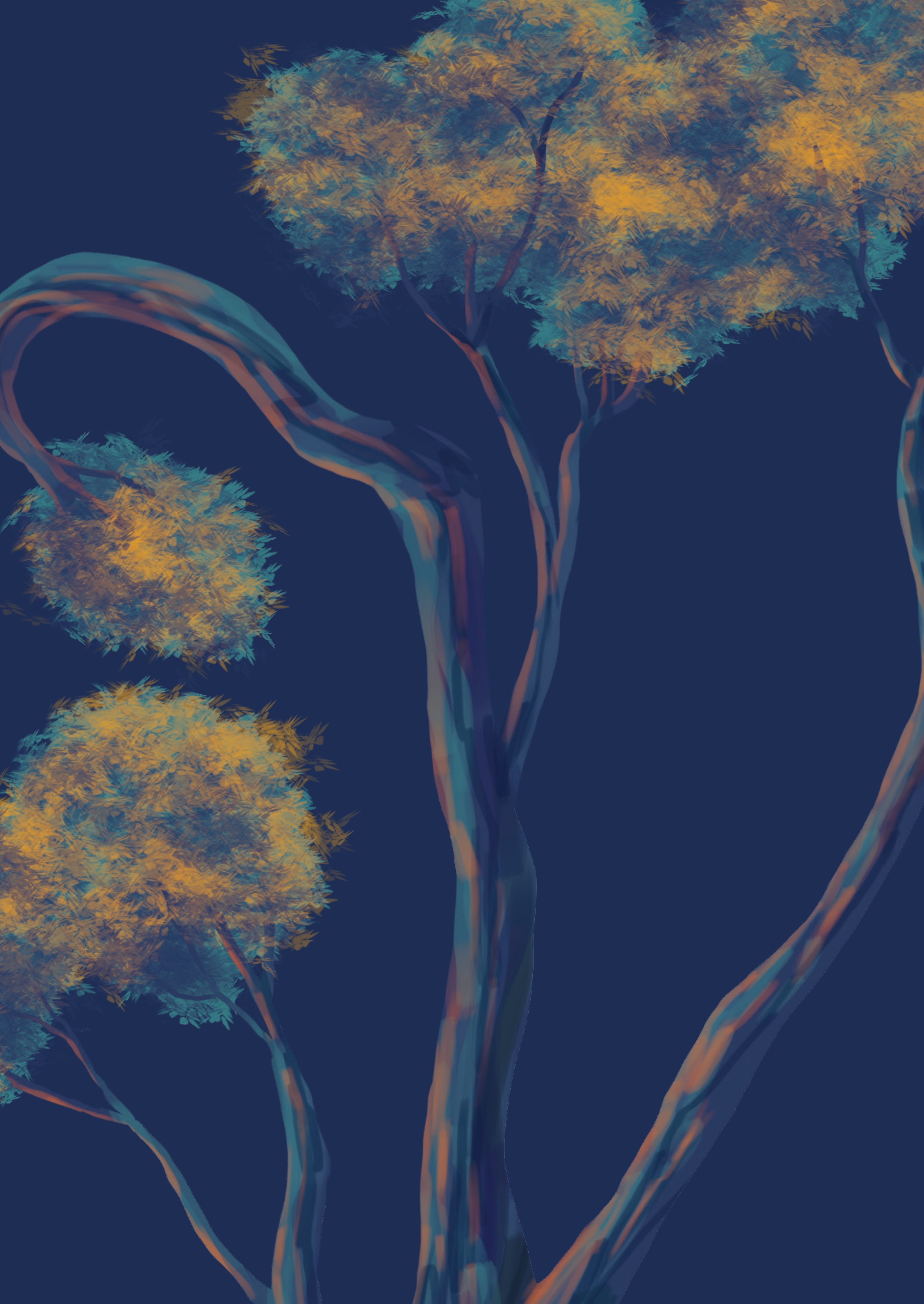

Part 1

How do medical students learn anatomy and what is known about the level of anatomy knowledge in general?

2

Medical students' perspective on training in anatomy.

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Abstract

Gaining sufficient knowledge of anatomy is an important part of medical education. Factors that influence how well students learn anatomical structures include available sources, learning time and study assistance. This study explores the attitude of medical students with regard to learning anatomy and evaluates possibilities for improvement of training in anatomy. Twenty medical students participated in a focus group meeting. Based on this focus group, an online survey consisting of 27 questions was developed and distributed amongst medical students of Maastricht University, the Netherlands. A total of 495 medical students (both Bachelor and Master level) participated in this survey. Master students found learning anatomy less attractive than Bachelor students (36.8% of the Master students vs. 47.9% of the Bachelor students ($p = 0.024$)).Although most students responded that they thought it is important to learn anatomy, 48% of all students studied anatomy less than 10 hours per study block of 8 weeks. Only 47.9% of the students rated their knowledge of anatomy as adequate. Students suggested that three-dimensional techniques would help improve their knowledge of anatomy. Therefore, investing in three-dimensional tools could prove beneficial in the future.

Keywords: Student, Anatomy, Attitude, Education, Learning, Improvement, Three-dimensional

Introduction

Knowledge of anatomy is essential to ensure safe clinical practice for many clinicians, especially in the fields of surgery and imaging. In addition to physiology, pathology and clinical reasoning, anatomy is one of the basic subjects taught in medical curricula [1, 2]. Anatomical knowledge facilitates the learning pathophysiology, supports the examination of a patient, and facilitates reaching a diagnosis and communicating these findings to the patient and other medical professionals [3].

Evidence suggests that students at all stages of their medical training find anatomy important [4-6]. Medical students nevertheless admit that they have, on average, insufficient anatomical knowledge [7]. To determine why there is a lack of anatomical knowledge, most studies evaluate the efficacy of the medical degree curriculum [3, 7-10], while other studies focus on medical students' perception ofthe anatomy curriculum [11]. Some studies compare traditional versus problem-based-learning curricula, but conclude that there is no difference between the two regarding the students' knowledge of anatomy [12, 13]. However, it is known that the learning approaches of teachers also affect students' learning methods and thereby their medical functioning in a clinical setting [14].

Possible explanations for the lack of sufficient anatomical knowledge include absence of or too few core courses in anatomy, decline of dissection as a teaching tool and failure to vertically integrate the teaching of anatomy [7, 15].

Controversy exists regarding how students can best study anatomy [16, 17], but also regarding how anatomy can best be taught [16, 18, 19]. Some favour dissection of human cadavers in combination with studying with textbooks, whereas others support the use of newer technologies to learn anatomy (*e.g.*, computer-assisted learning and the use of three-dimensional images) [20]. A combination of using an anatomical book or dissection and newer technology is probably the best learning system [16]. Accordingly, anatomical learning methods are now supplemented or combined with e-learning [21, 22].

Medical students' perceptions of anatomy education and their opinion of the best methods to teach or learn anatomy may help shape future courses in anatomy and optimize student performance. The aim of our study was, therefore, to explore medical students' attitude toward and appreciation of learning anatomy at different phases of their studies and to evaluate possibilities for improving anatomy education.

Methods

Study Setting

The setting of this cross-sectional study was Maastricht University (MU), Maastricht, the Netherlands. MU divides its medical curriculum into three years of Bachelor and three years of Master education. The Bachelor program concentrates on basic sciences, while the Master program aims to apply the basic sciences to requirements of clinical practice. MU uses Problem-Based Learning (PBL) as its educational model. The anatomical curriculum is a 'block-centred curriculum', based on a specific organ, which covers both anatomical knowledge and physiological knowledge. Training in anatomy consists of macroscopy, histology, and (human) developmental biology with lectures, (pre-dissected) cadavers, and virtual microscopy as teaching tools. Furthermore, in accordance with PBL, anatomical topics are discussed in small groups of approximately 13 students, who are supervised and assisted by a tutor. During the PBL lesson, students determine for themselves how extensively all anatomical structures, in combination with physiological knowledge, will be discussed. The tutor checks if all topics of the study block are discussed. Therefore, the total anatomical education hours depend on the difficulty and final objectives of a study block. For this reason, it is difficult to indicate exactly how many hours are spent on anatomy. Approximately 10% of the final test after an 8-week study block consists of questions on the anatomy relevant for that block. In the Master phase, clinical knowledge is individually assessed during clinical practice. The medical curriculum at MU does not have separate anatomical tests. Ethical approval was not applicable to this study.

Development of the Survey

In order to develop a survey for medical students, a focus group discussion was conducted. Twenty medical students varying in gender, age, current study year, previous education and preference for future specialisation participated. Prior to the focus group, a script with relevant topics and questions about anatomy education and its appreciation was developed based on the experience and literature research of two researchers (CPRT and KJBN). This script was used to check if all topics were discussed. The group discussion was recorded and transcribed verbatim and then clustered into five principal themes. Based on this qualitative content analysis, we developed twenty-seven questions for the survey (Appendix 1). The survey was conducted in Dutch and contained closed questions that could be scored on binary scales (*e.g.*, yes/no), 4- 5- and 6-point Likert scales (ranging from totally disagree to totally agree) and 10-point Likert scales. In addition to the closed questions, it contained open-ended questions such as "Which other sources do you use for studying anatomy?". The survey was checked regarding quality and structure by an education expert (HEP). We performed a pilot test survey among 15 medical students (Bachelor and Master students). Informed consent for participation was provided by each medical student upon submission of the completed online survey.

Distribution of the Survey

The survey was distributed to Bachelor and Master medical students using SurveyMonkey (SurveyMonkey Inc, San Mateo, California, USA). This is a secured online website on which surveys can be developed and hosted. For privacy reasons, MU did not allow mass emailing to all medical students. Therefore, medical students were personally invited – face-to-face on campus, before the start of a lecture or classes, and during preparations for medical clerkships at the Maastricht University Medical Centre – to visit the website and complete the online survey. Medical students were asked to invite their classmates to do so as well.

Statistical Analysis

Characteristics of the participating medical students were described using means and standard deviations for continuous variables, and absolute values and percentages for categorical variables. To describe the completed surveys, we stratified the medical students into Bachelor and Master students. Differences between Bachelor and Master students were tested using Pearson's Chi-squared test and the non-parametric Mann-Whitney U test for dichotomous and ordinal scores. P-values smaller than or equal to .05 were considered to indicate statistical significance. Data from the focus group were analysed using qualitative content analysis [23]. All analyses were performed using IBM SPSS version 23.

Results

The following are the five principal themes that emerged from the survey: importance of learning anatomy, appreciation for learning anatomy, assessment of the student's own knowledge of anatomy and of learning tools that could be used to improve the anatomical knowledge of students in the future, and attitude about learning anatomy in the Bachelor phase compared to that in the Master phase (*e.g.*, study time and resources).

Characteristics of the Survey Respondents

In total, 497 medical students completed the survey.During the study period 1890 medical students were registered at the MU, but it was impossible to keep track of how many students were invited to participate either by the authors or by other students.

Table 1. Characteristics of 495 respondents who filed in the survey at Maastricht University in 2016

		Total Sample (N = 495)
Female		N = 351 (71.1%)
Male		N = 143 (28.9%)
Study year students		-
Mean age		21.5 year (range 18 - 30)
Previous education	Yes	N = 186 (37.7%)
	No	N = 308 (62.3%)
Preference for future specialisation	Yes	N = 244 (49.4%)
	No	N = 250 (50.6%)

Data are presented as N (%) or mean (range)

Therefore, it was impossible to compute a response rate. Of the completed surveys, two (0.4%) had to be excluded from the analysis because of an incomplete response. Table 1 shows some of the characteristics of the medical students who participated in the survey. The skewed sex distribution (29.1% male, 70.9% female) is representative for the actual sex distribution of medical students in the Netherlands. According to the *Dienst Uitvoering Onderwijs* (DUO), a Dutch institution that is responsible for educational laws and legislation for the Ministry of Education, Culture and Science, the percentage of female first-year students in the academic year 2015–2016 in Maastricht was 68.3%. The difference between our gender ratio and that reported by the DUO was not statistically significant ($p = .248$).

Students' Opinion Regarding the Importance of Anatomy

None of the medical students found anatomy to be a completely unimportant part of the medical curriculum. Regarding becoming a competent medical practitioner, respondents considered learning anatomy to be: not important (1.2%), moderately important (20%), very important (50%) or extremely important (28.7%). There was no significant difference between the answers of Bachelor- and Master students ($p = .596$). Nevertheless, most Master students (68.6%) found anatomy to be more important in their current phase compared to in their Bachelor phase of the curriculum. Respondent characteristics (*e.g.*, gender, age, previous education and preference for future specialisation) did not significantly affect the students' opinion of the importance of anatomy (data not shown).

Bachelor (N = 337)	**Master (N= 157)**
N = 246 (73.0%)	N = 105 (66.9%)
N = 91 (27.0%)	N = 52 (33.1%)
Year 1: N = 120 (24.3%) Year 2: N = 115 (23.3%) Year 3: N = 102 (20.6%)	Year 4: N = 47 (9.5%) Year 5: N = 56 (11.3%) Year 6: N = 54 (10.9%)
20.4 year (range 18 - 30)	23.9 year (range 21 - 30)
N = 119 (35.3%)	N = 67 (42.7%)
N = 218 (64.7%)	N = 90 (57.3%)
N = 128 (38.0%)	N = 116 (73.9%)
N = 209 (62.0%)	N = 41 (26.1%)

Appreciation for Learning Anatomy

Just over half of the medical students (55.6%) do not find anatomy to be an attractive subject (in the sense of arousing interest) and 44.4% of the students do find it to be an interesting subject. Bachelor students found learning anatomy significantly more attractive than Master students (47.9% and 36.8% respectively, p = .024). Medical students who had a preference for a surgical specialization in the future were significantly more likely to find learning anatomy attractive compared with students who had a preference for a non-surgical specialization (57.7% and 38.5% respectively, p = .007).

Students' Assessment of their Own Anatomical Knowledge

Almost half of all medical students (47.9%) rated their anatomical knowledge as sufficient, and slightly fewer (42.1%) rated it as insufficient. Only a few students (9.3%) rated their knowledge as good or excellent (0.6%). There was no difference in this respect between Master and Bachelor students (46.7% of the Master and 40.2% of the Bachelor students, p = .287). Respondent characteristics (*e.g.*, gender, age, previous education and preference for future specialisation) did not significantly affect the students' assessment of their own anatomical knowledge.

Attitude towards Learning Anatomy in the Bachelor Phase Compared to the Master Phase
1. Study Time
Table 2 shows the amount of time that the medical students spend studying anatomy. It is noteworthy that 89.0% of all the medical students who filled in the survey spent less than 20 hours per 8 weeks studying anatomy and that a significant percentage of these students (48.4%) spent less than 10 hours doing so. Of all the Bachelor students, 46.1% spent less than 10 hours per 8 weeks studying anatomy compared to 53.5% of all Master students ($p = .300$). Remarkably, 42.9% of the medical students who spent less than 20 hours per 8 weeks studying anatomy reported that they found doing so interesting.

Table 2. Study time of all respondents of the survey, Bachelor students and Master students

	Total sample (N = 495)	**Bachelor (N = 337)**	**Master (N = 157)**
0 – 10 hours	48.4%	46.1%	53.5%
10 – 20 hours	40.6%	43.9%	33.1%
30 – 40hours	9.5%	8.8%	11.3%
40 – 50 hours	0.9%	0.6%	1.4%
50 – 60 hours	0.2%	0.3%	0.0%
>60 hours	0.4%	0.3%	0.7%

N = number of students

2. Study Resources
Table 3 shows an overview of all study resources used by respondents of the survey, as well as a list stratified by Bachelor and Master students. Most of the students (92.7%) used at least one anatomy book (Prometheus or Sobotta) for learning anatomy.More than half of the students (59%) also used video clips about anatomical structures (*e.g.*, on YouTube) to study anatomy. Other study resources used by students to learn anatomy are notes from attended surgical operations (10.5%), notes from lessons in the dissection room (67.8%), internet sites (other than YouTube) (25.1%), and other sources (33.6%).

CHAPTER 2

Table 3. Overview of the used sources of all respondents of the survey, Bachelor students and Master students

	Total Sample (N = 495)	Bachelor (N = 337)	Master (N = 157)
Traditional anatomy book	92.7%	92.9%	92.4%
Movies on the internet (*i.e.*,YouTube)	59.1%	60.8%	55.4%
Notes from surgical operations	10.5%	2.1%	28.7%
Notes from dissection room	67.8%	72.7%	57.3%
Other internet sites (*E.g.*, Wikipedia, pictures from Google)	25.1%	22.0%	31.8%
Other sources (*E.g.*, lectures, notes from PBL cases, applications on phones)	33.6%	31.8%	37.6%

N = number of students

Students' Opinions Regarding Tools to Improve the Acquisition of Anatomical Knowledge
Figure 1 illustrates the medical students' perspective on digital feedback in an e-learning tool, the attractiveness of studying three-dimensional anatomical images compared to a traditional book, whether interactive media (*e.g.*, computers and using 3D) would help students learn anatomy, and whether having a case as a guide makes it easier to remember anatomy. Regarding the improvement of anatomical learning in the future, of the students who filled in the survey 15.6% totally agree and 52.6% agree with the following statement: 'It makes it more enjoyable to learn anatomy with a case as a guide'. Only 1.7% of the students totally disagree with the statement above and 7.9% of the students disagree. Some students (22.2%) had no opinion.

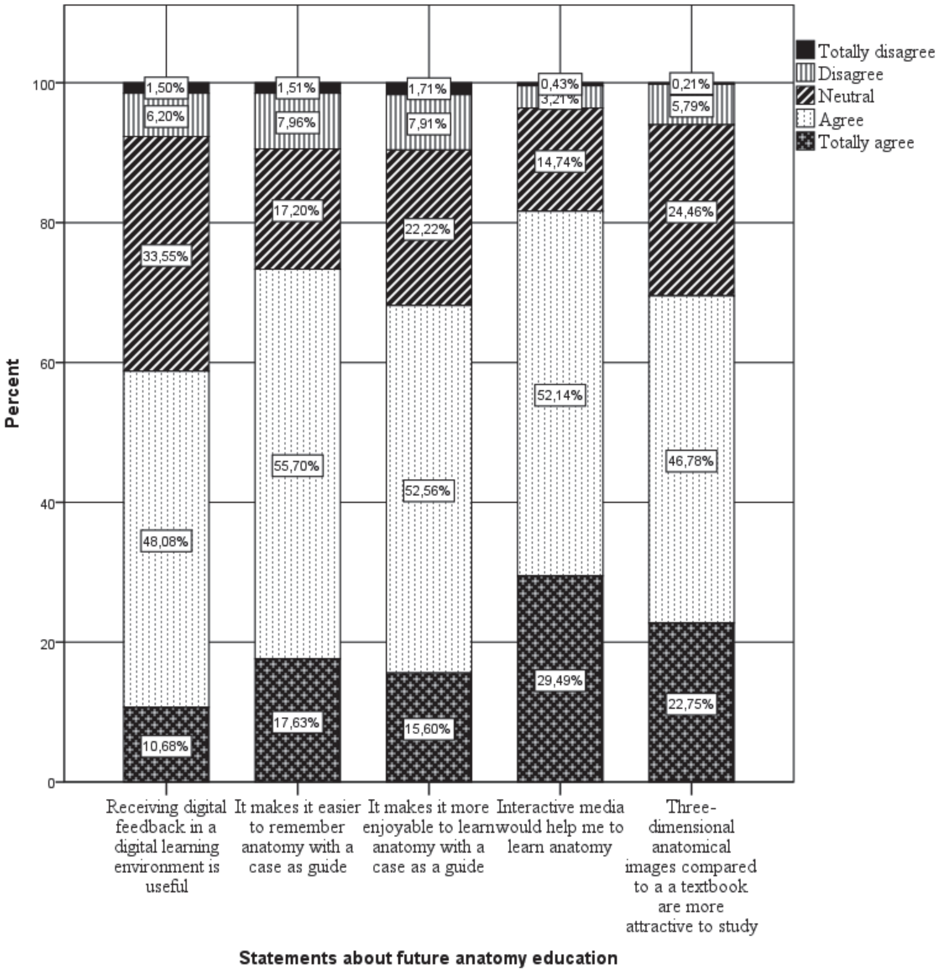

Figure 1. Statements about future anatomy education

Discussion

Half of all the medical students (50.0%), in both the Bachelor and Master phases, considered anatomy to be very important. Furthermore, 28.7% of all the medical students considered it to be extremely important to have sound knowledge of anatomy. This finding is in agreement with the literature [4, 24]. The majority of all Master students (68.6%) found learning anatomy to be more important during clerkships compared to the Bachelor phase. However, not all Master students found learning anatomy to be important. This may be due to the fact that these Master students, as mentioned before, are no longer confronted with anatomy lessons and anatomy tests. Furthermore, these Master students may have less time to study anatomy or they may already have sufficient anatomy knowledge.

It is remarkable that almost half of the respondents (47.9%) rated their knowledge of anatomy as sufficient. Several studies have found, however, that this is not the case [10]. Many surgeons, anatomists but also the general public share the view that medical students' anatomical knowledge is insufficient for today's clinical setting [3, 25]. A study showed that even laypersons have strong beliefs that gross anatomy is crucial for medical education, holding the view that the medical profession's esteem would be diminished if anatomy is not a significant part of the medical curriculum[26]. Despite this fact, our results show that the students spent a relatively small amount of time, 10 hours on average per study block of 8 weeks, studying anatomy. Our results, however, do not explain why, on average, students would only spend 10 hours per 8 weeks studying anatomy. It is unlikely that 10 hours per study block is a sufficient amount of time to fully learn the anatomy of that block; it is more likely that anatomy questions are underrepresented in the exams and therefore not worth the time investment. It is known that examinations are extrinsic motivators to learn [24]. In the current curriculum at MU, no separate anatomical tests are used to test the students' anatomy knowledge. Another reason that could possibly explain a deficiency in knowledge is a lack of time to teach anatomy [7, 27]. Anatomy is often difficult to learn and therefore investment in study time is necessary [7].

Regarding the amount of study time, a difference between Bachelor and Master students was expected. The results showed that 90.0% of all Bachelor students spent less than 20 hours per 8 weeks studying anatomy compared to 86.6% of all Master students. It can be assumed that Master students spend more time studying anatomy to gain enough anatomical knowledge for the clinical phase. This assumption was based on the fact that Master students start with clerkships in which they need to apply their anatomical knowledge in clinical settings. In contrast, for the Bachelor students, anatomy is still abstract and not linked to a patient. As expected, medical students who are interested in becoming surgeons found learning anatomy more attractive compared to medical students who prefer a non-surgical specialization. It is not clear whether the students who are interested in the surgical specialisation have more anatomical knowledge. Furthermore, learning strategy could play an important role especially because only 10% of the final medical test relates to anatomy. Students probably learn only information that they expect they should know for a test. For these reasons it is not surprising that students do not study diligently for anatomy.

In order to improve anatomical knowledge of medical students, it is important to understand how students study anatomy and which sources they use. Our results show that most of the medical students (92.7%) still use anatomical textbooks. Furthermore, movies on the internet about anatomical structures and notes from the dissection room are also used nowadays. Each student has his/her own preferences with regard to how anatomy is learned and teaching techniques vary between universities [28, 29]. It seems that the problem-based learning approach, which is used at MU, is not able to ensure an adequate acquisition of anatomy knowledge [28]. In contrast, in another study it was found that students at medical schools that used the problem-based-learning method reach the same perceived level of anatomy knowledge as students at medical schools that used other methods [30]. In accordance with the respondents of our survey, another study suggested that teaching in context improves anatomy education [28]. Other investigated learning methods, such as private study, formal lectures, practical work and informal discussions with peers are also shown to be effective [31].

The current medical students have grown up surrounded by digital applications on phones, tablets and computers and the pace of progress is very rapid. To increase their level of anatomical knowledge, three-dimensional tools for learning anatomy are nowadays available and under development [22]. The new teaching methods, like online dissection, interactive anatomical and surgical live-stream lectures, have proven to be beneficial for students' knowledge of clinical anatomy [32, 33]. Some medical students think that it is easier to learn using a three-dimensional tool than a book [29]. Furthermore, even social media could play an important role in the learning of anatomical structures [34]. However, one studies suggest that there is no difference between these two learning methods [22]. Despite the increase in the availability of electronic tools and resources for learning anatomy, it is still unclear whether these tools are more effective than other methods like dissection or anatomical textbooks and easy enough to use. Investing in 3-D techniques for teaching anatomy could prove beneficial in the long run, as such techniques may make studying anatomy more attractive than traditional resources do [29]. At this moment, our study shows that the majority of medical students (55.6% of all medical students) did not find studying anatomy in the current PBL curriculum attractive. Using three-dimensional tools may make studying anatomy more attractive. Some students prefer digital applications to learn anatomy while others prefer books [22, 29]. The respondents of our survey confirmed that medical students would prefer using three-dimensional tools in the future. Development and improvement of these tools can be important for anatomy education. For future improvements, the students suggested that anatomy tools related to a clinical scenario can make learning anatomy more attractive.

Strengths and Limitations

A major strength of this study is the large number of respondents (*N* = 495). Because we were not allowed to send a mass mail, it is unclear how many students we have actually reached. Therefore, it is impossible to calculate a response rate or to assess whether any selection bias could have occurred. The fact that more Bachelor students filled in the survey than Master students is an indication of the difficulty of reaching the latter group. Therefore, the analyses are stratified by Bachelor/Master. Another limitation of this study is the fact that it is unclear how representative our results are for other faculties in this country or for other countries. The curriculum regarding anatomy content, instruction and assessment is highly variable between universities. Nevertheless, it is shown that the medical curriculum in the Netherlands is based on CanMEDS and a framework for undergraduate medical education, which is equal for each medical university [35]. The framework defines the learning outcomes of university programmes in medicine in terms of competencies in those roles that must be mastered by physicians in order for them to function as medical doctor. All students who study medicine in the Netherlands are subject to the exact same 'test of progress', a test that is the same at each university. As a result, the emphasis that anatomy receives is unlikely to differ between universities. Naturally, attitudes of students could differ between schools due to, amongst other reasons like differences in teaching personnel.

Conclusion

This study showed that students found it important to have sufficient knowledge of anatomy. Almost half of the respondents rated their knowledge as insufficient, while the majority of the students (89.0%) studied less than 20 hours per study block of 8 weeks. Investing in three-dimensional techniques for teaching anatomy could help medical students study anatomy, but the educational effectiveness of three-dimensional tools compared to anatomical books should be further explored.

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3

The level of anatomical knowledge, hard to establish: A systematic narrative review.

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Abstract

Objective
This literature review aimed to gain more insight into the level of anatomical knowledge based on published measurements among medical students, residents, fellows and specialists.

Methods
We performed an extensive literature search in three online databases: Medline (using PubMed), Web of Science and Education Resources Information Centre (ERIC).

Results
A total of 30 relevant studies were found.In these studies participants took different anatomy tests and their mean/median scaled scores range from 22.5% to 82.4% on a 0 to 100% scale.

Conclusion
This review provides an overview of what is known about measured anatomical knowledge. After critically reviewing the literature we have to conclude that the existing literature confirms that anatomical knowledge is hard to establish, mainly due to the lack of standardization.

Further research should focus on ways to define and assess 'desired anatomical knowledge' in different contexts. In a next phase we can discuss if anatomical knowledge is lacking and interventions are needed.

Keywords: Anatomy, Knowledge, Test, Scientific Perspectives

Introduction

In 1975, Sinclair wrote an editorial in *The Lancet* expressing his concerns about medical students' low level of anatomical knowledge [1].Ever since, many other authors have reported similar concerns [2-8]. In the contemporary literature, clinicians as well as medical students report concerns about what they perceive as their own insufficient knowledge of anatomy [9-12]. Some authors even suggest that this lack of anatomical knowledge is the reason why the number of medico-legal claims in healthcare is rising [13, 14].Anatomical knowledge facilitates learning pathophysiology, supports the examination of a patient, and facilitates rendering a diagnosis [7].Hence, a good understanding of human anatomy is not only important for surgeons but for all medical specialists to ensure safe clinical practice [7]. Numerous studies describe interventions and education programs to improve anatomical knowledge, suggesting that there is a need for improvement [15, 16]. However, research on the actual level of anatomical knowledge and the impact of suggested shortage of anatomical knowledge is scarce. Of the few studies that aim to assess knowledge, many focus on individual opinions instead of on quantification of anatomical knowledge [17].

Methods

The aim of this review was to gain more insight into the level of anatomical knowledge among medical students, residents, fellows and specialists by performing a literature review of studies that quantify anatomical knowledge.

The meaning of those findings is discussed from two different scientific perspectives: the deontological one and the utilitarian stance [18].

The deontological perspective is an ethical theory which places special emphasis on the relationship between duty and the morality of human actions. In deontological ethics an action is considered morally good because of some characteristic of the action itself, not because the product of the action is good.The theory believes that the ethical actions follow universal moral laws, such as "Don't lie. Don't steal. Don't cheat." Unlike consequentialism, which judges' actions by their results, deontology doesn't require weighing the costs and benefits of a situation. This avoids subjectivity and uncertainty because you only have to follow set rules. So, following the rules makes deontology easy to apply. But it also means disregarding the possible consequences of our actions when determining what is right and what is wrong.

An example of deontological stance: suppose you're a software engineer and learn that a nuclear missile is about to launch that might start a war. You can hack the network and cancel the launch, but it's against your professional code of ethics to break into any software system without permission. And, it's a form of lying and cheating. Deontology advises not to violate this rule. However, in letting the missile launch, thousands of people will die.

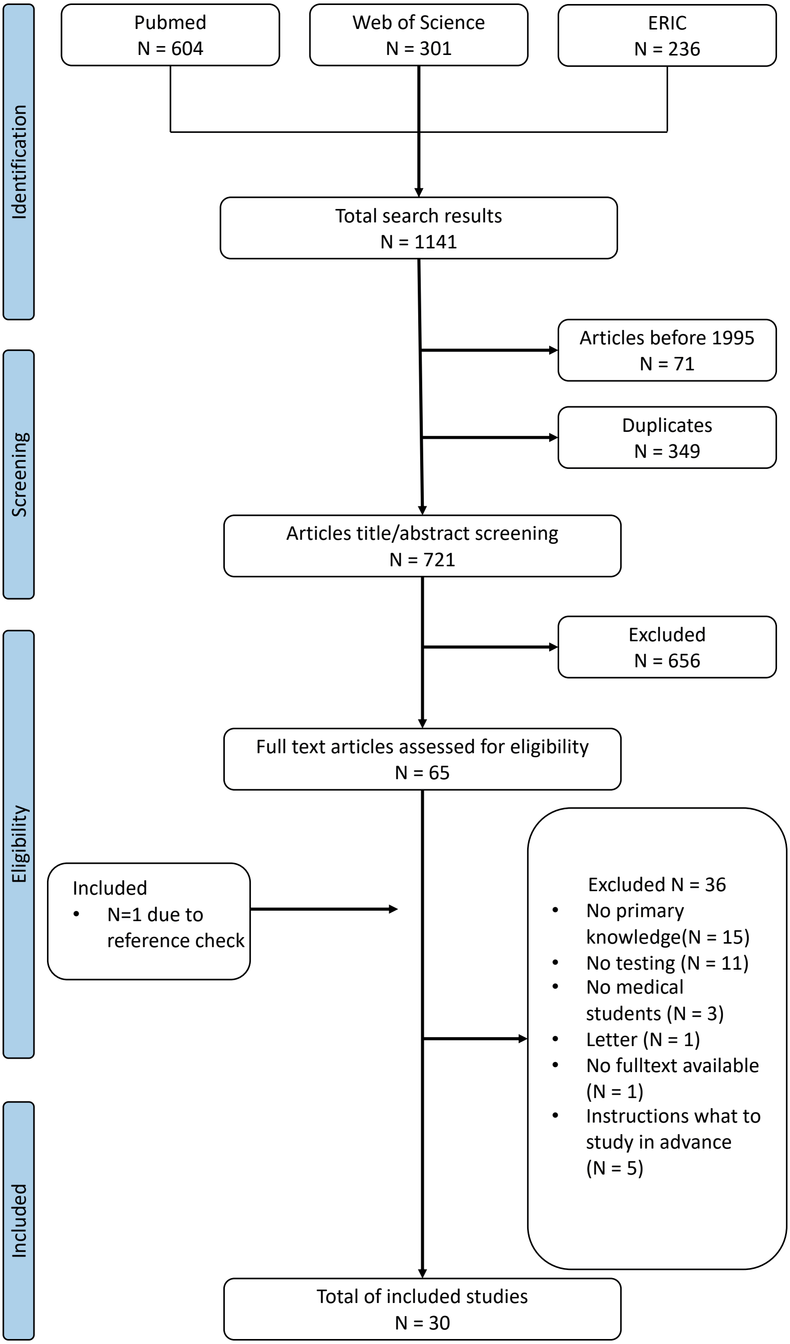
Utilitarianism, a form of consequentialism, is an ethical theory that determines right from wrong by focusing on outcomes.The utilitarian stance holds that the most ethical choice is the one that will produce the greatest good for the greatest number. However, because we cannot predict the future, it's difficult to know with certainty whether the consequences of our actions will be good or bad.

An example of utilitarianism: assume a hospital has four people whose lives depend upon receiving organ transplants: a heart, lungs, a kidney, and a liver. If a healthy person wanders into the hospital, his organs could be harvested to save four lives at the expense of one life. This would arguably produce the greatest good for the greatest number. But few would consider it an acceptable course of action, let alone the most ethical one.

This study was written in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) items that were relevant for this review [19].

Search

A comprehensive search was performed in the following online databases: Medline (using PubMed), Web of Science, and Education Resources Information Centre (ERIC). We used both medical subject headings (MeSH) and text terms from January 1st, 1995 to October 15th, 2018. The structured search can be reproduced using the following keywords and logical operators: ((("Students, Medical"[Mesh] OR "Medical students" OR "Medical student" OR "Resident" OR "Residents" OR "Fellow")) AND ("Anatomy/education"[Mesh] OR "Anatomy knowledge" OR "Anatomical knowledge" OR "Clinical anatomy" OR "Anatomy education" OR "Anatomical education")) AND ("Testing" OR "Test" OR "Examination" OR "Test result" OR "Achievement" OR "Cognitive load" OR "Skill" OR "Effectiveness" OR Outcome OR Measurement))).



From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA group (2009). *P*referred *R*eporting *I*tems for *S*ystematic *R*eviews and *M*eta-*A*nalyses: The PRISMA statement. PLoS Med 6(7): e100097.doi:10.1371/journal.pmed1000097

Figure 1. Flowchart of the literature

Study selection
Two researchers (D.K. and C.S.) selected the studies. First, manuscript titles and abstracts were screened for potential relevance. For all of the selected studies, the full text was reviewed to determine eligibility. In case of disagreement about a study, two other researchers (S.v.K and K.N.) decided whether the study was suitable for this literature review or not. We included all studies written in English in which anatomical knowledge was tested among medical students, residents, fellows or medical doctors.

Over the last decades, anatomy education changed in many universities. Therefore, we chose to exclude any studies conducted before 1995.

In the case of a mixed group of participants (*i.e.,* physician assistants and medical students), only those studies which described the results separately for the different participants were included. From these studies, we only included the participants who fulfilled the inclusion criteria.Flowchart of literature search is shown in figure I.

Scaled score
We anticipated heterogeneity with respect to the quantification of the test results between the different studies and within the studies by using different scales or scores. In order to aid interpretation, all the scales were recalculated to a scaled average test score with a range instead of the SD between 0 and 100%.

Results

Study selection
Flowchart of literature search is shown in figure I.
The electronic search strategy identified 1141 studies which were assessed for eligibility. After exclusion of duplicates and studies conducted before 1995, 721 studies remained eligible. Titles and abstracts were screened for eligibility and 65 articles were selected for further reading. After full text reading, 29 articles were selected for inclusion. A cross-reference search of the references of the included articles resulted in one additional relevant article.A total of 30 articles was included.

Study characteristics

Details of the included studies are summarized in tables 1 and 2.

Table 1 shows studies whose primary aim was quantifying current anatomical knowledge. Eleven studies primarily evaluated anatomical knowledge. There were six studies which primarily evaluated the anatomical knowledge of medical students, four which evaluated (young) medical doctors. One study assessed the anatomical knowledge of fellows and medical specialists.

The nineteen studies summarized in table 2 evaluated an intervention and tested anatomical knowledge before and after the intervention. For this review, we assumed that the pre-intervention tests reflected the participants' level of anatomical knowledge. Hence, we only extracted the pre-intervention results from these studies. Seven studies tested the knowledge of medical students before the intervention by the authors. A total of eight intervention studies involved a pre-test on residents. We identified two studies which performed an intervention study on fellows. Two intervention studies focused on the anatomical knowledge of a mixed group of students, residents and fellows.

Table 1. Anatomical knowledge [20, 21, 26, 27, 30, 33, 34, 38-41]
Primary aim of the included studies was quantifying current anatomical knowledge.

Author (Year)	**Participants (N)**	**Study design**	**Anatomical region**	**Measurement method**
Brunk et al. (2017)	5th and 6th year medical students (5383)	Cohort (multicentre)	All anatomy	Anatomical multiple-choice questions (Berlin progress test)
Holda et al. (2018)	Medical students (931) and medical graduates (interns, residents, specialists) (255)	Cross-sectional	All anatomy	Internet-based survey with 10 open and 10 multiple-choice questions of labelled structures on cadaveric specimens
Prince et al. (2005)	Fourth year medical students (348)	Cohort (multicentre)	Clinical anatomy	107 questions which were linked to 13 patient cases. Test consisted of open questions, multiple choice questions, and true/false questions.
Jurjus et al. (2014)	Third year medical students (189)	Cohort	General Surgery and Obstetrics and Gynaecology	20-question test one week prior to obstetrics/ gynaecology clerkship. 25-question test one week prior to general surgery clerkship. 75% multiple choice questions and 25% image labelling questions.
Doomernik et al. (2017)	Second year medical students (165)	Cross-sectional	Abdominal anatomy	53 items correlated to clinical cases and computed tomography images

Result of study	Scaled score 0-100*	Remarks of the authors
Factual knowledge score 40.8% Simple application 38.3% Clinical application 22.5%	Factual knowledge 40.8% (no SD known) Simple application 38.3% (no SD known) Clinical application 22.5 % (no SD known)	Five panels of experts set a standard score for fail/ pass for each of the three domains. Those scores were respectively 67.6%, 73.5% and 53.5%.
Mean score 65.6% Mean score students 67.3% Mean score graduates 59.5%	Mean score 65.6% Mean score students 67.3% Mean score graduates 59.5%	The cut-off for fail/pass was set at 60%. 27.9% did not pass the test. The overall mean score is moderate according to the authors.
Mean score 53.2% (range 32 - 80)	Mean score 53.2% (range 32 - 80)	Four different panels, consisting of fourth-year students, recent graduates, clinicians and anatomists, established what in their opinion was a standard score. Those standard scores were respectively 56.0%, 46.9%, 54.3% and 50.2%.
Surgery rotations 67.0% (range 62.1 - 70.6) O&G rotations 64.4% (range 63 - 69.7)	Surgery rotations overall 67.0% (range 62.1 - 70.6) O&G rotations overall 64.4% (range 63 - 69.7)	
Mean score 37.9 (SD 5.48) Relative score 71.5% (10.3%)	71.5% (range 61.2 - 81.8)	

Table 1. Continued.

Author (Year)	**Participants (N)**	**Study design**	**Anatomical region**	**Measurement method**
Grunfeld et al. (2012)	Graduating medical students (134)	Cohort (multicentre)	Musculo-skeletal	75 questions, consisting of 14 basic science and 61 clinical science. Question were selected from the National Board of Medical Examiners Board of Medical Examiners Musculoskeletal Subject Examination.
Diaz-Mancha et al. (2016)	Medical students (39)	Cross-sectional	Carpal and tarsal bones	Recognizing labelled bone structures, 15 in total.
Dickson et al. (2009)	Accident and Emergency senior house officers (26)	Cohort (multicentre)	Hand anatomy	11 questions; one question about hand bones, 5 questions about tendons, and 5 about nerves.
Gupta et al. (2008)	Preregistration house officers (29) Senior house officers (68) Specialist registrars (21)	Cohort	All anatomy	Multiple choice questions covering 15 areas of the body
Navarro-Zarza et al. (2014)	Rheumatology fellows (84) Rheumatologist (61) Non-Rheumatologists (25)	Cohort (multicentre)	Joints	20 questions selected from a pool of 40 anatomic items
Mizrahi et al. (2017)	Gynaecology residents (52)	Cross-sectional	Pelvic anatomy	Questions and image labelling questions, 20 questions in total

Result of study	Scaled score 0-100*	Remarks of the authors
Medical students 73.8% (SD 9.7)	73.8% (range 64.1 - 83.5)	
Medical 6.1/15 (SD 3.27)	40.9% (range 19.1 - 62.7)	
Overall score 26.9%	Overall score on all questions 26.9%	
PHO 72.1% (SD 3.29) SHO 77.1% (SD 2.16) Specialist registrars 82.4% (SD 2.17)	PHO 72.1% (range 68.8 - 75.4) SHO 77.1% (range 74.9 - 79.3) Specialist registrars 82.4% (range 80.2 - 84.6)	
Rheumatology fellows 50.8 (SD 17.6) Rheumatologists 44.3 (SD 17.9) Non-Rheumatologists 39.1 (SD 17.6)	Rheumatology fellows 53.5% (range 34.9 – 72.0) Rheumatologists 46.6% (range 27.8 - 65.5) Non-Rheumatologists 41.2% (range 22.6 - 59.7)	
Overall score 6.67 (SD 0.46) Global score youngest (yr 1-3) 5.53 (SD 0.46) Global score eldest (yr 4-5) 9.24 (SD 0.76)	Overall 33.4% (range 31.1 - 35.7) Youngest 27.7 % (range 25.4 - 30.0) Eldest 46.2% (range 42.4 - 50)	O&G resident's level in anatomy is poor and residents should be educated to a specific teaching in anatomy throughout their residency program

CHAPTER 3

Table 2. Intervention studies [23-25, 28, 29, 31, 32, 42-53]

Included studies evaluate an intervention and tested anatomical knowledge before and after the intervention. For this review, we assumed that the pre-intervention tests reflected the participants' level of anatomical knowledge. So only the pre-intervention score is included.

Author (Year)	**Participants (n)**	**Study design**	**Anatomical region**	**Measurement method**
Jurjus et al. (2016)	Third year medical students during clerkship O&G (143)	Cohort	Gynaecology	Test consisting of * 22 multiple choice questions in e-learnings * 25 multiple choice questions and matching questions in a laboratory session
Maresky et al. (2018)	First year medical students (59)	Cohort	Cardiac anatomy	5 conventional cardiac anatomy questions 5 visual-spatial questions
Luetmer et al. (2017)	First year medical students (53)	Cohort	Shoulder and elbow	Six clinical scenarios in the form of multiple-choice questions
Morgan et al. (2017)	Fourth year medical students Applied clinical anatomy (47) Surgery resident preparation course (40) Obstetrics and Gynaecology course (36)	Cohort	Musculo-skeletal system, emergency medical procedures, and radiology	Three Applied Clinical anatomy courses with a pre-test on physical examination, anatomical knowledge, and radiology.
Burgess et al. (2012)	Stage 3 senior medical students (42)	Cohort	All anatomy	Identify 20 labelled structures in four wet specimens of different anatomical regions.

Result of study	Scaled score 0-100*	Remarks of the authors
All questions pre-test mean 59.5% (SD 2.09)	All questions 59.5% (range 57.4 - 61.6)	
Overall score 50.9 % (SD 16.5) Conventional cardiac anatomy 62.9 % Visual-spatial cardiac anatomy 38.6%	Overall score 50.9 % (range 34.4 - 67.4) Conventional cardiac anatomy 62.9 % Visual-spatial cardiac anatomy 38.6%	
Median score 67%, mean 66.1 (SD 13.9)	Median score 67% (range 53.1 - 80.9)	
Emergency medical procedure 45.9% (SD 12.77) Musculoskeletal system 56.9% (SD 14.6) Obs and gyn 67.3% (SD 18.19)	Emergency medical procedure 45.9% (range 33.18 - 58.72) Musculoskeletal system 56.9% (range 42.33 - 71.53) Obs and Gyn 67.3% (range 49.14 - 85.52)	All of the intervention courses emphasized the correlations between anatomical concepts and clinical applications. Thus, the applied clinical anatomy course was divided into three separate courses: emergency medical procedures, anatomy meets radiology, and the musculoskeletal system. The knowledge of the participants was assessed through a test compromised of questions created by the American Association of Anatomists and a question bank created by one of the course directors.
Pre-test median is 9/20 (range 2-18)	45% (range 10 - 90)	

CHAPTER 3

Table 2. Continued.

Author (Year)	**Participants (n)**	**Study design**	**Anatomical region**	**Measurement method**
Sarkis et al. (2014)	Final year graduate medical students (24)	Cohort	All anatomy	Identify 20 labelled structures located over four wet specimens.
Stott et al. (2016)	Medical students years 3-5 (18)	Cohort	Heart	20 multiple choice questions, consisting of a mixture of basics and clinical science.
Mackenzie et al. (2017)	Surgical residents year 3-6 (40)	Cohort (multicentre)	Emergency medicine	Assessment done by 1 anatomist and 1 physician located in the same laboratory with a standardized script.
Jaswal et al. (2015)	Radiation oncology residents (29)	Cohort (multicentre)	All anatomy and radiology	30 item multiple choice question style test. Each question consisted of 1 or more images projected on a large screen along with the question. Each question was restricted to 15 seconds, with no opportunity to revisit previous questions.
Burgess et al. (2016)	Postgraduate surgical trainees (26)	Cohort	All anatomy	Standardized practical examination of 20 items
Ozcan et al. (2015)	Urology residents (25)	Cohort (multicentre)	Kidney, ureter, retroperitoneal region, prostate, bladder, urethra, pelvis, penis, and scrotum.	20 multiple choice questions with a maximum of five alternative answers. Questions were randomly selected form a bank of multiple-choice questions prepare by 37 scientists.

Result of study	Scaled score 0-100*	Remarks of the authors
Pre-median 8/20 (range 2-14)	40% (range 10 - 70)	
Pre-course score 59.6% (SD 13.8)	59.6% (range 45.8 - 73.4)	
Pre-test anatomy score 47% (SD 11)	47% (range 36 - 58)	
Pre-test median 18.2/30 (range 16-21)	60.6 % (range 53-70)	
Pre-test median 8/20 (range 5-14)	40% (range 20 - 75)	
Pre-test median 11.7/20	58.5%	

Table 2. Continued.

Author (Year)	Participants (n)	Study design	Anatomical region	Measurement method
Corton et al. (2003)	Residents (24)	Cohort	Pelvis	Practical exam consisted of identifying 20 tagged structures on prosected specimens. Written exam consisted of 20 multiple choice questions that assessed resident's knowledge of perineal, retropubic, presacral, retroperitoneal, pelvic support anatomy and clinical correlations.
Arrantes et al. (2017)	General practitioner trainees (20)	Cohort	Neuroanatomy	30 identification questions 30 multiple choice questions referring to clinical cases
Juo et al. (2018)	Surgical interns (14)	Cohort	All anatomy	30 multiple choice questions 20 structure identification questions
Chino et al. (2011)	Postgraduate Radiology oncology residents' years 2-5 (10)	Cohort (multicentre)	All anatomy and radiation oncology	10-15 question test consisting of boards-style multiple choice questions, segmentation of radiographic images of critical tissues, and radiation field design.
Saavedra et al. (2016)	Rheumatology fellows (17) Orthopaedic fellows (14)	Cohort (multicentre)	Joints and musculoskeletal	20 questions of identification or demonstration of relevant anatomical items (or their action), arranged by regions and asked in five dynamic stations.

Result of study	Scaled score 0-100*	Remarks of the authors
Practical exam overall correct score 72% Written exam overall correct score 58.5%	Practical exam overall correct score 72% Written exam overall correct score 58.5%	No standard deviation or range was given
Overall mean identification score 26.8% Overall mean multiple choice score 56.7%	Overall mean identification score 26.8% Overall mean multiple choice score 56.7%	
Average multiple-choice score 15.9 (SD 5.1) 53% Average identifications score 10.1 (SD 3.0) 50.5%	Average multiple-choice score 53% (range 36% - 70%) Average identifications score 50.5% (range 35.5% - 65.5%)	
Median pre-test score 66% (range 53-82) board test MCQ pre-test median 71% (range 41-100)	Median pre-test score 66% (range 53-82) board test MCQ pre-test median 71% (range 41-100)	
Median correct answers pre-test Orthopaedic 7/20 (range 2-12) Rheumatology 5/20 (range 1-10)	Orthopaedic 35% (range 10 - 60) Rheumatology 25% (range 5 - 50)	

Table 2. Continued.

Author (Year)	Participants (n)	Study design	Anatomical region	Measurement method
Barton et al. (2009)	10 gynaecological oncologist fellows	Cohort (multicentre)	Vulva, Vagina, perineum, anterior and posterior abdominal wall, retroperitoneum, groin, pelvis, abdomen and, radiological anatomy.	Multiple choice questionnaire on abdominal and pelvic anatomy.
Corton et al. (2006)	Medical students and postgraduate year 1-4 (36) Female Pelvic Medicine and Reconstructive Surgery fellows (3)	Randomized longitudinal cohort	Pelvis	20 questions about anatomy pelvic support and 36 multiple choice questions about vulva and perineal anatomy.
Labranche et al. (2015)	Medical physicists (3) Fellow (1) Radiation oncology residents (13)	Cohort	Thorax, abdomen, male pelvis, and female pelvis.	10 multiple choice questions and identification questions

Result of study	Scaled score 0-100*	Remarks of the authors
Mean 57/100 (range 32-71)	57% (range 32 - 71)	
Pre-test pelvic support - interactive 56.0 (SD16.9) - conventional 53.4 (SD 13.4) Vulvar and perineal - interactive 63.2 (SD 9.1) - conventional 61.8 (SD 17.7)	Pre-test pelvic support - interactive 56.0% (range 39.1 - 72.9) - conventional 53.4% (range 40 - 66.8) Vulvar and perineal - interactive 63.2% (range 54.1% - 72.3%) - conventional 61.8% (44.1% - 79.5%)	
Thorax 4.5/10 (SD 2.6) Abdomen 5.1/10 (SD 2.1) Male pelvis 6.1/10 (SD 1.4)	Thorax 45% (range 19 - 71) Abdomen 51% (range 30 - 72) Male pelvis 61% (range 47 - 75)	

Discussion

Main findings

The actual measured knowledge of anatomy of medical students, residents, fellows and specialist differed substantially between studies. Scores were reported as median or mean and after scaling ranged from 22.5%-82.4% correct answers. Scores per group were 22.5-73.8% for medical students, 26.9-82.4% for residents and 25.0-63.2% for medical doctors/fellows.Almost two-thirds of the total given mean/median scores were below 60%.

In six of the thirty studies, the authors expressed their interpretation of the measured level of anatomical knowledge. Based on the measurement results of their research, they conclude that the level of knowledge is deficient and moderate to worryingly low.

Interpretation of the findings

The question whether knowledge of anatomy is sufficient or too low may be approached from different perspectives. One of those perspectives is the deontological one. As a physician, one has to have good knowledge of anatomy. It is an obligation or duty towards the patient and is a generally accepted rule we should conform to. The current literature seems to lean on deontological ethics. The opinion provided by five of the studies that knowledge is moderate to worrying low is an example of deontology. However, there is no research on what the level of knowledge should be. The utilitarian stance is another perspective we can approach. Utilitarianism states that the best action is the one that maximizes utility, which is usually defined as that which produces the greatest well-being of the greatest number of people.

When is anatomical knowledge worryingly low so that it will cause danger to a patient? Or opposite, that it leads to higher appreciation of the patient? We could not find any evidence showing that a low level of anatomical knowledge is the reason for medical errors or unsatisfied patients. This might suggest that the way most medical professionals deal with anatomy is pragmatic and a fair choice in the abundance of demanded competencies. However, we must also acknowledge that the absence of proof is not always the proof of absence.

The quest for a gold standard for how much anatomy

So far, the literature does not provide a convincing gold standard for how much anatomy is required for safe clinical practice. Following the deontological stance, an international consensus could set the standard. However, with more than 100 curricula all over the world this sounds like an impossible job. Two studies, Brunk *et* *al*. and Prince *et al*., tried to set a gold standard through the use of expert panels. In the study of Brunk *et al*. the pass rate was set at 60.4% for a 5th and 6th year medical students. The actual score was 29.9%. Prince *et al*. used different expert panels to set the standard. Showing that fourth-year students set the highest pass rate at 56.0%, where recent graduates set the lowest pass rate at 46.9%. The mean overall score was 53.2%. The conclusion of the authors of both studies was that the results are way below the expected standard [20, 21]. However, given the known retention levels of basic science, it is questionable whether this conclusion is correct. In an extensive study by Custers *et al*. it is shown that participants still in medical school and those not too long out of it achieved scores of approximately 40% correct answers on basic science. Specifically looking at anatomical knowledge for 5th and 6th year students this percentage lies between 45-50% [22].

Strengths and limitations

Our review holds some limitations that need to be addressed. We included 30 studies in which 30 different tests were used. There was much heterogeneity in the number and type of questions, as well as in the region of interest which was tested. Based on the different characteristics of the tests some can be regarded as more reliable than others. One of the most frequent manner of testing was identification of labelled structures with a maximum of 20 items [23-33]. But Brunk *et al*. used the Berlin Progress Test Medicine (PTM), a test of 200 items chosen from an item pool containing 5000 items. All items are administered in single-best answer multiple-choice format and typically make use of clinical vignettes [20]. In contrast, Dickson *et al*. derived their conclusion on a 11-question test [34]. Besides, the sort of test, the context in which it was taken, the time between the test and the period in which the anatomy was learned, and if there has been repeated learning are important variables. In our selection we only included studies that did not test anatomical knowledge after an intervention or repeated learning. The time-interval between the moment the material was studied and when it was tested, was hard to assess since there are many different curricula. However, in most curricula anatomy is taught in the preclinical years.

This diversity of tests and moment of testing creates two difficulties. First, although pooling the results using meta-analysis techniques is statistically not impossible, we felt it would not yield a useful summary of test results for the purpose of our study. Second, it makes it hard to interpret the reliability of the scores. For example, an average score of 50% on a difficult exam with questions of function and applied clinical anatomy might be the same as a 90% score on an easy exam with only identification of structures.

Another point to mention is the diversity of participants. In the included study this ranged from medical students up to medical doctors. This can be seen as a limitation if comparisons between studies are made, but it is also a strength in providing some insight of anatomical knowledge over time and making the results of our review generalizable to a broader group.

The strength of our study can be found from a more philosophical point of view. Our review has shown that anatomical knowledge is hard to establish and a gold standard cannot be found. The questions around anatomy education should be rephrased using different paradigms from philosophy. The main question will be 'when to give students the right level and amount of which anatomy in order to feel safe and competent to do their clinical work'. Which means that we should also focus on ways to define and assess this level.

Suggestions and challenges for the future

In our search for the level of anatomical knowledge the result is the absence of standardization. Not only in ways of testing but also in need to know knowledge.Without agreements about the need for knowledge, which will differ at different stages of the medical and postgraduate education, it is difficult to judge about the level of anatomical knowledge. There are universities with an extensive curricular plan including a good description of what anatomy knowledge is expected [35]. This is a good start, although it can vary from university to university and from country to country. While in general the human being and her anatomy and illness does not vary. A suggestion to remedy this absence is to conduct a Delphi study to determine what knowledge is required to know. In a Delphi study, experts will discuss a topic and reach a consensus. An example is being carried out in the Netherlands for the gynaecology specialty [36]. After focus groups, in depth interview and two Delphi rounds a core list of anatomical structures that are relevant to the safe and competent practice of general gynaecologists was identified. Such a list can be used to guide gynaecology postgraduate education and assessment.

The second challenge is the wide variety of specialties and subspecialties. A gastro-intestinal surgeon does not need to have the same knowledge as a cardiac surgeon or a gynaecologist. Determine what the knowledge need is for each stage of education, specialty and subspecialty what the need to know knowledge is will be an extensive job. However, in our opinion, this is an indispensable step in the process of assessing and determining anatomical knowledge.

A third challenge is the way of testing. Our results already show different ways in which anatomical knowledge can be assessed.In general, anatomical knowledge can be tested using a variety of assessment tools, such as multiple-choice exams, oral exams, or structured practical examinations. These tools reflect the three domains of anatomy training: theoretical knowledge, practical 3D application of this knowledge, and clinical or bedside application of knowledge [37]. So, after determining which knowledge is essential, this anatomical knowledge should be tested in various ways within the different domains.

Conclusion

This review provides an overview of what is known about measured anatomical knowledge. After critically reviewing the literature we have to conclude that the existing literature confirms that anatomical knowledge is hard to establish, mainly due to the lack of standardization.

Further research should focus on ways to define and assess 'desired anatomical knowledge' in different contexts. Suggestions are to conduct a Delphi study among experts from the field to define essential anatomical structures. After that, it is important to asses anatomy knowledge through various assessment to test different domains of anatomical knowledge. In a next phase we can discuss if anatomical knowledge is lacking. And if so, what the impact of this shortage is and whether interventions are needed.

Abbreviations
D.K: Dorothea Maria Koppes
C.S: Carlijn Franscisca Anna Smeets
S.v.K: Sander Martijn Job van Kuijk
K.N: Kim Josephina Bernadette Notten
ERIC: Education Resources Information Centre

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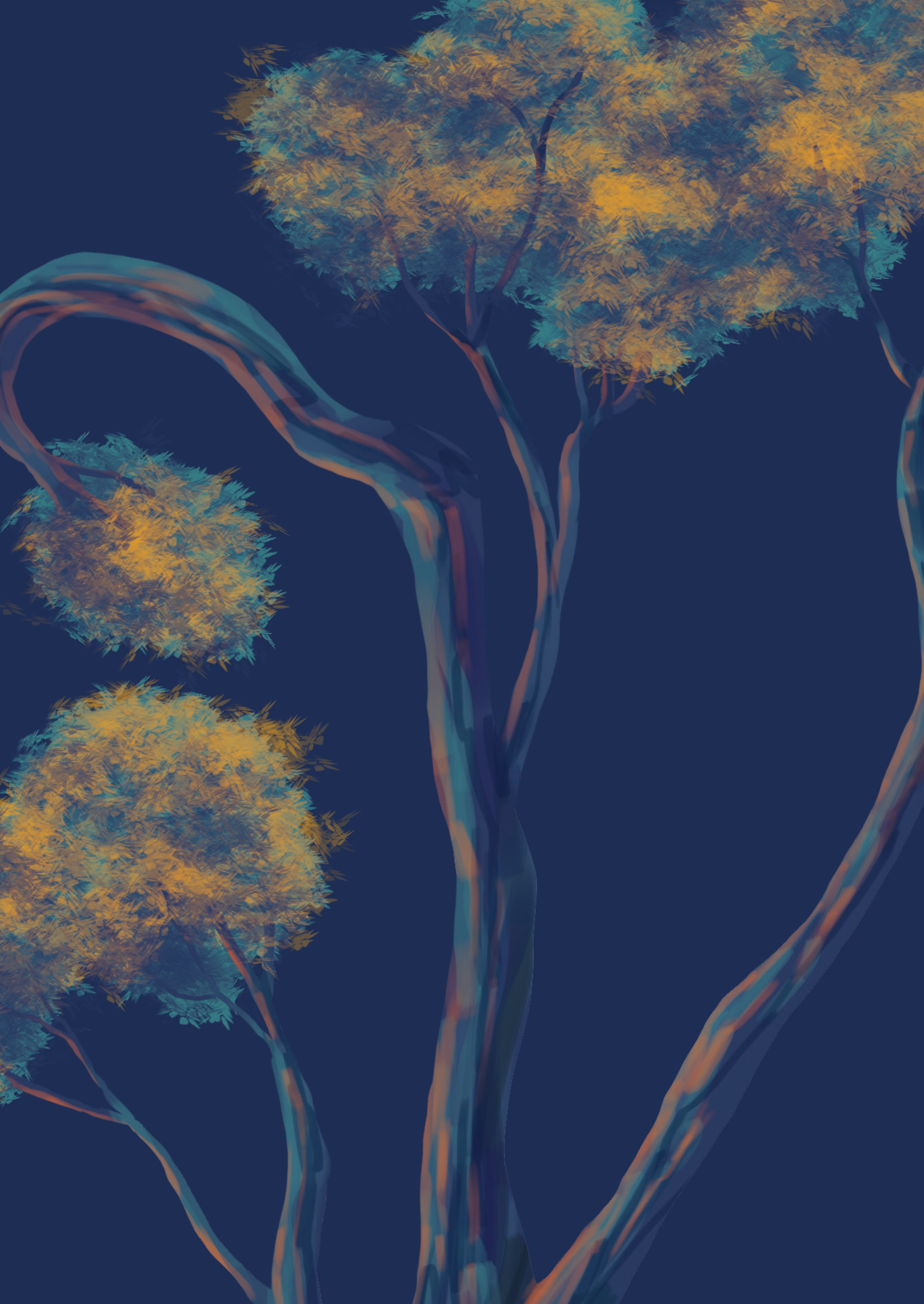

Part 2

Anatomical knowledge
in the speciality obstetrics
and gynaecology

4

What do we need to know about anatomy in gynaecology:

a Delphi consensus study.

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Abstract

Objective

Determination of the anatomical structures that should be taught to ensure safe and competent practice among general gynaecologists.

Study Design

A two-round Delphi survey, face-to-face meeting in focus groups and an individual interview. Participants were medical doctors and trainees from gynaecology, surgery, urology and radiology from academic, non-academic teaching and non-academic, non-teaching hospitals in the Netherlands. Relevant structures were collected from gynaecology surgery atlas based on most common gynaecological surgeries and diseases. These structures were supplemented and critically viewed in focus groups followed by a Delphi survey. In the Delphi survey gynaecologist and trainees' gynaecology from all over the Netherlands scored the items on a Likert scale between 1 (not relevant) and 5 (highly relevant). Consensus was defined when≥ 70% of the panellist scored the item as relevant or very relevant and the average rating was ≥ 4. Main outcome was clinically relevant anatomical structures.

Results

Consensus on 86 clinically relevant anatomical structures divided by nine categories.

Conclusions

This study identified a core list of anatomical structures that are relevant to the safe and competent practice of general gynaecologists and that can be used to guide gynaecology postgraduate education. This is the first step in a much wider and complex process of becoming a competent gynaecologist.

Keywords: Anatomy, Gynaecology, Clinically Relevant, Delphi Study, Medical Education

Introduction

From a historical perspective, anatomy can be considered as one of the basic pillars of medical training [1]. It is one of the oldest branches of medicine and has allowed medical knowledge to develop. However, in the past two decades radical changes have been made to the teaching of anatomy [2, 3]. This has resulted in a reduction in teaching hours and a possible decline in anatomy knowledge among medical professionals [4, 5]. Whether this reduction in anatomy teaching also leads to a decrease in knowledge, as some studies suggest, remains the subject of debate. Regardless of whether or not the anatomy knowledge of doctors is declining and the debate about how much anatomy should be taught, the relevant question is what constitutes a sufficient amount of anatomical knowledge to ensure safe and competent clinical practice.

In the UK for medical education, the Council and the Education Committee of the Anatomical Society have compiled guidelines on anatomy curriculums with individual structures mentioned. These emphasise the importance of a structure and describe a curriculum 'roadmap', which has the flexibility to accommodate local requirements [6]. In gynaecology, the MRCOG provides a description of anatomy requirements but does not describes individual structures[7] . Making it still subject of debate what is mentioned with for example 'surgical anatomy of the abdomen and pelvis'. In the Netherlands this road map is completely absent when it comes to the teaching of anatomy in gynaecology. For example, on completion of the Dutch Society of Obstetrics and Gynaecology (NVOG) training, NVOG expects a gynaecologist to have attained a level of competence in surgery and be able to independently manage a range of common gynaecological conditions and emergencies. However, the training and assessment of anatomy and its application to surgical obstetrics and gynaecology are not defined in the current training programme [8]. In the Standards of care for women's health in Europe, which were recently launched by the European Board and College of Obstetrics and Gynaecology, there is no chapter describing what level of knowledge should be expected of our trainees [9].

Obstetrics and gynaecology is, a broad and diverse branch of medicine, including surgery. Therefore, an adequate understanding of anatomy can be considered to be particularly important in the field of obstetrics and gynaecology. The performed surgical procedures are in anatomically difficult areas (*i.e.*, the pelvis and the retroperitoneal space). An adequate understanding of anatomy is therefore important to limit associated risks of these surgical procedures. Thereby, due to the shift in therapeutic approaches toward more conservative therapy, trainees get less anatomy exposure. Furthermore, in the past most gynaecologists were educated to become generalists. Nowadays a shift is seen into earlier focusing on subspecialties within gynaecology. All of these factors support the need to define the level of anatomical knowledge expected of a general gynaecologist.

Here, we aim to define the anatomical structures that should be taught to ensure safe and competent practice among general gynaecologists.

Material and Methods

The Delphi method was used to determine the most valuable anatomical structures for gynaecological practice. Focus group meetings were therefore conducted to obtain relevant input for the Delphi study. The study was conducted in the Netherlands.

Focus groups

The focus group procedure is a research technique that utilises group interviews, during which participants are encouraged to talk to each other, ask questions and comment on each other's experiences and opinions [10]. To guide discussion, a script was developed prior to the meeting comprising 98 essential abdominal and pelvic structures divided into eight categories (table 1). This script was developed on the basis of gynaecology surgery atlas combined with the most common gynaecological surgeries and diseases. An expert panel comprising three gynaecologists, one radiologist and one anatomist has checked the script and supplemented it when necessary. The focus group was facilitated by two trainees and field notes were taken by a medical student; this group is referred to here as the research team. All participants were encouraged to comment on and complete the list of important anatomical structures.

Two focus groups and one individual interview were conducted. The first focus group involved five trainees (years 4–6) from four specialties: surgery, urology, obstetrics and gynaecology and radiology. The choice for these specialties was based on the similarities in anatomical context with gynaecology. The second focus group consisted of six medical specialist consultants (a radiologist with special interest in gynaecological anatomy and radiology and five gynaecologists with different subspecialties covering urogynaecology, benign gynaecology, fertility, obstetrics and oncology). The individual interview was conducted with the programme director of surgery and performed by two members of the expert team. All sessions were recorded and analyses were independently performed by two members of the research team using NVivo 11 [11].

The Delphi procedure

This procedure is a research technique designed to reach consensus on a specific topic among a panel of experts through a process of information feedback and iteration. The Delphi process is complete when consensus is reached [12-15].

Selection of the Delphi panel

For the Delphi procedure, forty gynaecologists and twenty trainees were both, randomly chosen from the Dutch national register of gynaecology and approached from our own network. To create an appropriate and heterogenous sample of panellists, participants were recruited from either 1. gynaecologists of all subspecialties (oncology, benign gynaecology, urogynaecology, fertility and obstetrics) as well as general gynaecologists; or 2. all types of hospitals/workplaces (academic and non-academic teaching hospitals, non-academic non-teaching hospitals). Trainees from years 2–6 were asked to participate.

Consensus and feedback

Each panellist received an invitation to participate in an online survey (Survey MonkeyÒ; San mateo, USA). Panellists were asked to rank all items on a 1–5 Likert Scale, with 1 being not relevant and 5 being highly relevant. A free text box was included at the end of each category to capture qualitative comments or to add items. Two reminders were sent to participants who did not respond to the first request.

Consensus on item level was achieved when ≥ 70% of the panellists scored the item as relevant or very relevant and the average rating was ≥ 4. When only one of these criteria was met, or the item was found to be relevant or very relevant by between 50–70% of the panellists, the item was selected for the second round. In this second round, only the responders from the first round received an invitation to participate. If an item scored < 50% and ≤ 4, it was deemed to be non-relevant for the general gynaecologist.

Results

Focus groups

The original script developed by the expert panel consisted of a list of 98 items classified into eight categories: bones, ligaments, organs, anatomical spaces and structures, general muscles, pelvic floor muscles, arteries and veins, and nerves. After the two focus groups and the individual interview had been completed, the total number of items had increased to 123 and one category (imaging) was added. The results are discussed below by category and an overview is shown in table 1.

Table 1.Results of the Delphi study per category

Category	Startlist/Focus group script	
Bones	N = 9 Symphysis pubica Os pubis Spina ischiadica Os ilium Os coccygis Os sacrum Promontorium Foramum obturatum **Femur**	SI joint SIAS Foramen ischiadicum SIPS RSOP RIOP
Ligaments	N = 10 Lig. falciforme Lig. infundibulopelvicum Lig. latum uteri Lig. ovarii proprium Lig. sacro-uterinum Lig. inguinale Lig. sacrospinale Lig. rotundum **Lig. cardinale** **Lig. pubovesicale**	

Results focus group/ Delphi study script	Results Delphi study/ Final list
N = 14	N = 9
Symphysis pubica	Symphysis pubica
Os pubis	Os pubis
Spina ischiadica	Spina ischiadica
Os ilium	Os sacrum
Os coccygis	Promontorium
Os sacrum	Foramum obturatum
Promontorium	Foramen ischiadicum
Foramum obturatum	SIAS
SI joint	SIPS
Foramen ischiadicum	
SIAS	
SIPS	
RSOP	
RIOP	
N = 8	N = 6
Lig. falciforme	Lig. infundibulopelvicum
Lig. infundibulopelvicum	Lig. latum uteri
Lig. latum uteri	Lig. ovarii proprium
Lig. ovarii proprium	Lig. sacro-uterinum
Lig. sacro-uterinum	Lig. sacrospinale
Lig. inguinale	Lig. rotundum
Lig. sacrospinale	
Lig. rotundum	

Table 1.Continued.

Category	Startlist/Focus group script	
Organs	N = 21 Uterus Adnexa uteri Bladder Liver Gallbladder Stomach Spleen Pancreas Colon transversus Colon descendens Colon ascendens Caecum Sigmoid Rectum Appendix Small intestine Kidney Ureter Peritoneum Omentum **Adrenal glands**	
Anatomical spaces and structures	N = 12 Cavum Douglasi Fascia superficialis Bursa omentalis Excavatio vesico-uterina Linea alba Linae semilunaris Linea arcuata Plica umbilicalis mediana Plica umbilicalis medialis Plica umbilicalis lateralis **Pararectal space** **Paravesical space**	Retropubic space (cave of Retzius) Fascia transversalis

Results focus group/ Delphi study script	Results Delphi study/ Final list
N = 20	N = 16
Uterus	Uterus
Adnexa uteri	Adnexa uteri
Bladder	Bladder
Liver	Liver
Gallbladder	Colon transversus
Stomach	Colon descendens
Spleen	Colon ascendens
Pancreas	Caecum
Colon transversus	Sigmoid
Colon descendens	Rectum
Colon ascendens	Appendix
Caecum	Small intestine
Sigmoid	Kidney
Rectum	Ureter
Appendix	Peritoneum
Small intestine	Omentum
Kidney	
Ureter	
Peritoneum	
Omentum	
N = 12	N = 6
Cavum Douglasi	Cavum Douglasi
Fascia superficialis	Fascia superficialis
Bursa omentalis	Retropubic space (cave of Retzius)
Excavatio vesico-uterina	Excavatio vesico-uterina
Linea alba	Linea alba
Linae semilunaris	Fascia transversalis
Linea arcuata	
Plica umbilicalis mediana	
Plica umbilicalis medialis	
Plica umbilicalis lateralis	
Retropubic space	
Fascia transversalis	

Table 1.Continued.

Category	Startlist/Focus group script
General muscles	N = 10 m. rectus abdominis m. pyramidalis m. psoas m. obliquus internus abdomins m. obliquus externus abdominis m. transversus abdominis m. piriformis **m. iliacus** **m. obturatorius externus** **m. obturatorius internus**
Pelvic floor muscles	N = 10 m. bulbospongiosus m. sphincter ani internus m. sphincter ani externus m. sphincter urethra m. puborectalis m. pubococcygeus m. iliococcygeus m. transversus perinei profundus m. transversus perinei superficialis m. ischiocavernosus
Arteries and veins	N = 19 aorta v. cava **truncus coeliacus** a. epigastrica superficialis a. epigastrica inferior a. mesenterica inferior **a. mesenterica superior** a./v. iliaca communis a./v. iliaca interna a./v. iliaca externa a./v. renalis **a./v. pudenda interna** **a./v. pudenda externa** **a./v. circumflexa iliaca superficialis** **a./v. circumflexa iliaca profundal**

Results focus group/ Delphi study script	Results Delphi study/ Final list
N = 7 m. rectus abdominis m. pyramidalis m. psoas m. obliquus internus abdomins m. obliquus externus abdominis m. transversus abdominis m. piriformis	N = 7 m. rectus abdominis m. pyramidalis m. psoas m. obliquus internus abdomins m. obliquus externus abdominis m. transversus abdominis m. piriformis
N = 10 m. bulbospongiosus m. sphincter ani internus m. sphincter ani externus m. sphincter urethra m. puborectalis m. pubococcygeus m. iliococcygeus m. transversus perinei superficialis m. ischiocavernosus	N = 10 m. bulbospongiosus m. sphincter ani internus m. sphincter ani externus m. sphincter urethra m. puborectalis m. pubococcygeus m. iliococcygeus m. transversus perinei superficialis m. ischiocavernosus
N = 13 aorta v. cava a. epigastrica superficialis a. epigastrica inferior a. mesenterica inferior a./v. iliaca communis a./v. iliaca interna a./v. iliaca externa a./v. uterine a./v. obturatoria a./v. umbilicalis a./v. femoralis a./v. renalis	N = 13 aorta v. cava a. epigastrica superficialis a. epigastrica inferior a. mesenterica inferior a./v. iliaca communis a./v. iliaca interna a./v. iliaca externa a./v. uterine a./v. obturatoria a./v. umbilicalis a./v. femoralis a./v. renalis

Table 1.Continued.

Category	Startlist/Focus group script	
Nerves	N = 7 plexus hypogastricus n. pudendus n. ischiadicus n. genitofemoralis n. femoralis **n. levator ani** n. obturatorius	n. cutaneus femoris n. peroneus/fibularis
Imaging	N = 0	aorta a. iliaca communis a. iliaca interna/externa adnexa uteri uterus / bladder ureter / kidneys rectum / sigmoid **v. ovarica** **os ilium** **RIOP / RSOP** **os pubis / os sacrum** **galbladder/liver/spleen** **pancreas/stomach** **promontorium** **tuber ischiadicum** **small intestine** **colon ascendens** **colon descendens** **colon transversum** **m. psoas** **lig. rotundum** lig. sacro-uterinum

SI joint = sacroiliac joint
SIAS = spina iliaca anterior superior
SIPS = spina iliaca posterior superior
RSOP = ramus superior os pubis
RIOP = ramus inferior os pubis
Bold = not important by focus group or Delphi study

Results focus group/ Delphi study script	Results Delphi study/ Final list
N = 8	N = 8
plexus hypogastricus	plexus hypogastricus
n. pudendus	n. pudendus
n. ischiadicus	n. ischiadicus
n. genitofemoralis	n. genitofemoralis
n. femoralis	n. femoralis
n. obturatorius	n. obturatorius
n. cutaneus femoris	n. cutaneus femoris
n. peroneus/fibularis	n. peroneus/fibularis
N = 31	N = 11
aorta	aorta
a. iliaca communis	a. iliaca communis
a. iliaca interna/externa	a. iliaca interna
bladder	a. iliaca externa
uterus	bladder
adnexa uteri	uterus
kidneys	adnexa uteri
ureter	kidneys
sigmoid	ureter
rectum	sigmoid
v. ovarica	rectum
os ilium	
RIOP	
RSOP	
os pubis	
tuber ischiadicum	
os sacrum	
promontorium	
gallbladder	
liver	
spleen	
pancreas	
stomach	
small intestine colon ascendens	
colon descendens	
colon transversum	
m. psoas	
lig. rotundum	
lig. sacro-uterinum	

CHAPTER 4

Bones
Six new bones were added. The femur was listed by the expert panel but was not deemed to be relevant by the members of the focus groups.

> ***Interviewer:*** *"What are important bones to recognise?"*
>
> ***Gynaecologist 1****:" You must know the sacral promontory, ramus superior/inferior os pubis, spina ischiadicum, sacroiliac joint, spina iliaca anterior superior, spina iliaca posterior superior; and also, the foramen ischiadicum because of the nervus pudenda in this area".*

Ligaments
A total of ten ligaments were listed by the expert panel. Eight ligaments were considered useful for a general gynaecologist by the members of the focus group. The median umbilical ligament was mentioned by the members of the focus groups in this section. However, the expert panel considered it more as a structure and listed this ligament in the section structures and spaces.

Organs
The original list included 21 organs and 20 organs were mentioned by the members of the focus group. The adrenal glands were listed by the expert panel but were not considered to be relevant by the members of the focus groups.

Anatomical spaces and structures
Although 12 structures/spaces were listed and 12 structures were mentioned by the focus groups, there were two discrepancies. The members of both focus groups did not find the paravesical and pararectal space to be clinically relevant for a general gynaecologist as most gynaecologist do not perform surgery in this area. They pointed out that this is important for gynaecologists specialising in oncology. The retropubic space, also known as cave of Retzius, and the fascia transversalis were found to be relevant by the focus groups but had not been listed by the expert panel.

General muscles
Ten general muscles were listed in advance, seven of which were considered to be relevant by the members of the focus groups. The m. iliacus, m. obturatorius externus and m. obturatorius internus were deemed to be irrelevant by the members of the focus groups as they are outside the field of gynaecological surgery.

Pelvic floor muscles

In the category of pelvic floor muscles, there was no discrepancy between the items listed by the expert panel and the items considered to be relevant by the members of the focus groups.

Arteries and veins

Nineteen arteries and veins were listed in this category. Thirteen of them were graded as relevant by the members of the focus groups. In both focus groups, the members agreed that the posterior division of the internal iliac artery was too specific for a general gynaecologist.

Nerves

Seven nerves were listed. Eight were considered relevant by the members of the focus groups. The nervus levator ani was included by the expert panel but was not considered relevant by the members of the focus group. Two nerves that were not included by the expert panel were added and considered relevant by the members of the focus groups, namely, the nervus cutaneus femoris and the n. peroneus, also known as the nervus fibularis.

> ***Gynaecologist 1***: *"The nervus cutaneus femoris is also important. We do see patients with compression of the nervus cutaneus femoris. They complain of a dead spot in the skin. It happens mainly when they lay in bed for a long time. If you do not know it is the innervation area of the nervus cutaneus femoris you might miss the right diagnosis."*
>
> ***Gynaecologist 1: "****Also, the nervus peroneus!"*
>
> ***Gynaecologist 2: "****Yes, very good you are mentioning that one. It is important when you do a laparoscopy. You must know how to position a patient to prevent damage to the nervus peroneus.****"***

Imaging

This subdivision had not been included by the expert panel and was added by the focus groups.

Delphi study results

Across the nine categories, the 123 items identified as relevant by the focus groups were subsequently evaluated in a National Delphi study. The demographic characteristics of participants in both rounds are shown in table 2.

In the first round, 60 panellists were invited to participate. Over a period of 3 months (April–June 2018), 46 people responded (76.7%). Of the 123 items, 74 were accepted (60.2%), 24 were denied (19.5%) and 25 were selected for a second round (20.3%). Comments on why each panellist found a structure relevant were captured as part of the process. No new structures were added (table 1).

In the second round, 35 of the 46 panellists responded (78.3%) during a period of 3 months (October–December 2018). Of the 25 structures that were disputed in the first round, ten were accepted (40.0%). Thirteen structures were denied based on our criteria of a mean score of ≥ 4 and ≥ 70%. Two structures, the spina iliaca posterior superior (77.2%, 3.8) and the foramen ischiadicum (86.6%, 3.9) reached ≥ 70% but scored ≤ 4. As it was not considered appropriate to set up a third Delphi round, the two structures were accepted. Therefore, a total of twelve structures were added (table 1).

After completing the two Delphi rounds, a list of 86 clinically relevant structures was compiled (table 1).

Table 2. Demographic composition

		Round 1 N (%)	Round 2 N (%)
Gender	Female	33 (71.7)	25 (67.6)
	Male	13 (28.3)	12 (32.4)
Medical Doctor	Residents	19 (41.3)	13 (35.1)
	Specialists	27 (58.7)	24 (64.9)
Workplace	Academic hospital	22 (48.9)	14 (37.8)
	Non-academic teaching hospital	20 (44.4)	23 (62.2)
	Non-academic, non-teaching hospital	3 (6.7)	0 (0.0)
Specialty	Obstetrics	12 (29.1)	7 (18.9)
	Fertility	7 (15.2)	8 (21.6)
	Oncology	6 (13.0)	8 (21.6)
	Urogynaecology	5 (10.9)	2 (5.4)
	No subspecialty / resident	16 (34.8)	12 (32.4)

Comment

Main findings

The aim of this study was to determine the anatomical structures that are relevant to the safe and competent practice of a general gynaecologist. Two focus groups, an individual interview and two Delphi rounds were performed, resulting in consensus on 86 clinically relevant anatomical structures.

Interpretation

Bergman *et al*. (2011) described eight factors that are considered to have a negative influence on anatomical knowledge, one of which is the absence of a core anatomy curriculum [16]. The curriculum time devoted to teaching anatomy has decreased over the years and the significant increase in scientific knowledge means that the amount of basic scientific information is too large to accommodate. In addition, technological advancements and social and health policy developments are influencing anatomy education. Therefore, it is important that informed decisions are made about which subjects are taught. The lack of a core curriculum may also contribute to confusion about whether too much or too little is taught for certain disciplines. In this study, we utilised the focus group and Delphi approaches to obtain a collective opinion on core content that would help to improve clinically relevant teaching. Previous literature has emphasised the importance of such a core curriculum to ensure topics of real clinical relevance are covered and to equip students with a good grasp of the relationship between structure and function [5, 17]. The importance was also emphasised by Friedman *et al*. (2006), who recommended that the basic science component of medical education should move away from the acquisition of large amounts of detailed information. Instead it should focus on mastering more general concepts relevant to the practice of medicine and the process through which this conceptual material is used to solve medical problems [18]. The clinical relevance has also been emphasised by Smith *et al.* (2011), who described an exploratory case study demonstrating that students and alumni exhibited a positive change in motivation when anatomy was linked to the clinical context. Around half of the alumni reported that they used > 70% of the anatomy they had been taught during the anatomy courses in an average year of practice. This supports not only the importance and relevance of anatomy in clinical practice, but also the positive effects on learning anatomy when it is in a clinically relevant context [5]. In addition to professional anatomists and medical students, laypersons (*i.e.,* patients and potential patients) also report a very positive attitude towards the clinical importance of anatomy. As we now live in a consumer society, we cannot ignore the opinion of this group. Moxham *et al.*(2016) performed a survey of laypersons to find out their opinion on the relevance of anatomy in medicine, demonstrating that they strongly believe that gross anatomy is crucial for medical education and that the esteem in which medical professionals are held would be diminished if anatomy were not a significant part of the medical curriculum [19].

Strengths and limitations

The main strength of our study is the design, which first involved the development of a list of essential structures from textbooks related to gynaecology examination and surgery. This list was checked by an anatomist and gynaecologists from all subspecialties. Secondly, gynaecology trainees from years 4–6, as well as surgeons, urologists and radiologists, discussed this list in two focus groups. Thirdly, consensus on the structures agreed as relevant during the focus groups was reached using the Delphi method, involving gynaecologists and trainees from years 2–6. This has resulted in a widely supported and clinically relevant list of anatomical structures that can be used to guide the teaching of anatomy during gynaecology postgraduate education. Through this list, we not only make anatomy teaching clinically relevant, but also effective in a time of increasing demands by providing a structure that programme directors can follow.

Related to the design is the diversity within the focus groups, which included different subspecialists from gynaecology as well as other specialties, *i.e.,* surgery, urology and radiology. Diversity also comes from the involvement of trainees and medical doctors with differing levels of experience and education. The large number of trainees participating in this study could be seen as a limitation of this study. However, in our opinion, it is a fare reflection of the medical doctors employed in gynaecology nowadays in the Netherlands. Overall, we have almost 1000 gynaecologist and approximately 400 trainees. This means that trainees compromise 40% of the doctors working in the modern field of gynaecology as in our Delphi survey. In our opinion we believe this diversity is a key strength since it demonstrates the engagement of all parties involved in the development process, which makes uptake more likely [20]. Several reports have evaluated the role of gross human anatomy in the medical curriculum, illustrating differing perspectives held by students [21-24], anatomists [25], postgraduate doctors [26] and clinicians [27, 28]. Therefore, to establish a realistic and widely supported list it is important to reflect the perspectives of them all.

We believe that the response rate seen in this study represents another strength, being higher than the previously-reported range for questionnaire-based surveys. Baruch and Holtom (2008) analysed 490 studies that involved the use of surveys and demonstrated the average response rate to be approximately 50%, with a standard deviation of approximately 20% [29]. In addition, the fact that panellists from academic, non-academic teaching and non-academic non-teaching hospitals responded ensures that our results are comprehensive and representative, and that panellists from all subspecialties within gynaecology were represented.

A limitation of this study is that although the Delphi approach is highly effective to generate consensus between individuals, it does not provide guidance on the pedagogic approach required to deliver these components. It is known that the relationship between knowledge and its application in clinical practice is not a straightforward one. Individual experience can vary and personal perceptions of anatomy, the context of learning and emotions all play a role in this process [5, 30]. Future studies may be required to provide additional guidance for teaching programmes.

Another limitation is that the final process of the Delphi approach included only clinicians and no anatomists. This carries the risk that what is not known is not found important, although Koens *et al*. (2006) have shown that basic scientists and physicians do not diverge at the clinical level of biomedical science [31].

Conclusions

This study identified a core list of anatomical structures that are relevant to the safe and competent practice of general gynaecologists and that can be used to guide gynaecology postgraduate education. This is the first step in a much wider and complex process of becoming a competent gynaecologist. The next step could be to investigate suitable teaching methods for work-related learning.

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5

What do we need to know about anatomy in gynaecology? An international validation study.

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Abstract

Objective: international validation of the Dutch Delphi study about which anatomical structures should be taught to ensure safe and competent practice among general gynaecologists.

Study design: validation study with gynaecologists and trainees in gynaecology from academic, non-academic teaching and non-academic, non-teaching hospitals worldwide.

The relevance of 123 items included in the Dutch Delphi study was scored on a Likert scale between 1 (not relevant) and 5 (highly relevant). Consensus was defined when≥ 70% of the panellist scored the item as relevant or very relevant and the average rating was ≥ 4.

Results: A total of 192 gynaecologists and trainees from seven countries (Belgium, Germany, Norway, Oceania, Sweden, United Kingdom and United States) completed the questionnaire. Of the 123 structures, 72 (58.5%) were internationally relevant. When the 72 relevant structures from the international Delphi study were compared with the 86 relevant structures from the Dutch Delphi study, 70 (81.4%) structures matched.

Conclusions: This study identified 70 anatomical structures that should be taught for safe and competent practice of general gynaecologists based on national and international validation. The results of our study identify the learning needs (*i.e.*, the content) for an international anatomy curriculum. The development of the curriculum (*i.e.*, the form) can be determined by each country and used to standardize and guide postgraduate training in gynaecology. This is an important step in the era of international teaching and training.

Keywords: Anatomy, Clinical Competence, Graduate Medical Education, Gynaecology, Internationality

Introduction

Trainees across the world are educated to become skilled and competent gynaecologists. Each country has its own curriculum, which not only differ in terms of length of education, but also in terms of structure and content [1]. For surgical curricula, the length of education does not influence surgical skills or cognitive knowledge when surgeons begin to practice [2]. However, the difference in content might influence the quality of care and therefore patient safety. A study in the United States assessed 107 obstetrics and gynaecology (O&G) residency programs in terms of patient outcomes. Substantial variation in maternal complications was found. These findings are the first empirical support of the clinical implications of variation in medical education [3]. Therefore, it seems reasonable to strive for an international speciality-specific standard to guarantee a high quality of care and patient safety worldwide. Several specialties have attempted to establish such international standards for specific procedures. Examples are global curricula for robotic surgery and urolithiasis in urology, an international curriculum for headache in neurology and the global curriculum in surgical oncology [4-7]. The European Board and College of Obstetrics and Gynaecology is committed to the harmonization of European postgraduate training in O&G. An example of their activities is the Project of Achieving Consensus in Training (PACT) [8]. The PACT training curriculum sets out defined goals for training all gynaecologists in Europe and provides a structure to design training programmes on a local basis. However, anatomy training and assessment and their application to surgical O&G are not defined in this training program or in other national curricula [8-10]. Anatomy can be considered one of the basic pillars of medical training and therefore a good level of anatomical knowledge is mandatory to become a skilled and competent gynaecologist [11]. During development of a curriculum, a systematic approach is required, starting with the identification of learning needs. A core curriculum, including what knowledge trainees are expected to acquire, contributes positively to adequate anatomical knowledge [12]. In a previous national Delphi study conducted in the Netherlands, we identified a list of anatomical structures relevant for safe and competent practice of general gynaecologists. The aim of this study was to internationally validate this list.

Methods

Survey list

In a previous national Delphi study performed in the Netherlands, we assembled a survey list of 123 anatomical structures, divided into nine categories, of which 86 were identified as clinically relevant for safe and competent practice of general gynaecologists [13]. In this international study, the survey list of 123 anatomical structures was used for validation (table 2).

Selection of the validation panel

For the validation procedure, gynaecologists and trainees in gynaecology were approached. To acquire an appropriate and heterogenous sample of panellists, panellists from all subspecialties, general gynaecologists and trainees from all years of training programs and from all types of hospitals (academic teaching hospitals, non-academic teaching hospitals and non-academic non-teaching hospitals) were recruited. We used our network to conduct the survey in as many countries as possible. We employed the 'oil slick' principle. Specifically, we asked our contacts to complete the survey and forward it to people in their networks, who could be in their hospital or in neighbouring hospitals, specialist colleagues or students, and subsequently ask the next panellist to do the same.

A country was included when at least ten surveys were completed. After 3 months, the number of completed surveys in each country was counted. If there were fewer than ten completed surveys, our contacts were recontacted and asked to forward the survey again. After another 3 months, the survey was closed.

The results for Great Britain and Ireland as well as New Zealand and Australia were combined and reported as the results for the United Kingdom and Oceania, respectively.

Validation procedure

Each panellist received an invitation to participate in an online survey (SurveyMonkey1; San Mateo, USA). Panellists were asked to rank all items on a Likert Scale from 1 (not relevant) to 5 (highly relevant). The survey list was divided into nine categories: bones, ligaments, organs, anatomical spaces and structures, general muscles, pelvic floor muscles, arteries and veins, nerves and imaging. An empty text box was included at the end of each category to capture qualitative comments or to add items. The order in which the categories and anatomical structures were listed was the same for each panellist. The survey was returned anonymously and therefore no reminders could be sent.

Consensus about the relevance of an item was achieved when ≥70% of panellists scored the item as relevant or very relevant and the average rating was ≥4. If an item was scored as relevant or very relevant by <50% of panellists and the average rating was <4, it was deemed to be non-relevant for general gynaecologists. When only one of these criteria was met or the item was scored to be relevant or very relevant by 50–70% of panellists, the item was deemed to be possibly relevant, but there was no consensus [14, 15].

Ethics approval
The medical ethics committee of Maastricht University Medical Centre / University Maastricht confirmed that the Medical Research Involving Human Subjects Act (WMO) did not apply to the primary Dutch Delphi study or therefore to this validation study. Date of approval April 29, 2019. Reference number was 2019-1119.

Results

Validation panel
Initially, panellists from 20 countries (Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Israel, Italy, Norway, Oceania, Poland, Portugal, Slovenia, Spain, Sweden, United Kingdom and United States) were asked to participate. A total of 202 panellists from ten countries responded. Ten or more surveys were (partially) completed in seven countries, with 192 surveys completed in total. The baseline characteristics of the included panellists are presented in table 1.

Validation procedure
Of the 123 structures, 72 (58.54%) were internationally relevant. Ten (8.13%) structures were non-relevant and 41 (33.33%) were possibly relevant, but there was no consensus. When the 86 relevant structures from the Dutch Delphi study were compared with the 72 relevant structures from the international Delphi study, 70 (81.4%) structures matched. The two additional relevant structures in the international validation were the ovarian vein and uterosacral ligament from the imaging category.

Of the 16 additional relevant structures in the Dutch Delphi study, only one (the posterior superior iliac spine) was non-relevant in the international validation, while the other 15 structures were possibly relevant, but there was no consensus. No new structures were mentioned to add. All the results are presented in table 2 and table 3.

Table 1. Baseline characteristics

	Norway N = 24	Sweden N = 42	United Kingdom N = 30
Gender			
Woman	20 (83.3)	34 (81)	19 (63.3)
Man	4 (16.7)	8 (19)	11 (36.7)
Current position			
Resident	11 (45.8)	30 (71.4)	13 (43.3)
Medical doctor	9 (37.5)	9 (21.4)	12 (40.0)
Other	4 (16.7)[1]	3 (7.2)[2]	5 (16.7)[3]
Workplace			
Academic teaching	20 (83.3)	36 (85.7)	18 (60)
Non-academic	4 (16.7)	6 (14.3)	8 (26.7)
Non-academic non-teaching	0 (0)	0 (0)	4 (13.3)
Subspecialty			
Obstetrics	6 (25)	4 (9.5)	5 (16.7)
Fertility	2 (8.3)	2 (4.8)	0 (0)
Oncology	3 (12.5)	1 (2.4)	2 (6.7)
Urogynaecology	1 (4.2)	3 (7.1)	6 (20.0)
Benign gynaecology	3 (12.5)	4 (9.5)	4 (13.3)
No subspeciality	9 (37.5)	28 (66.7)	13 (43.3)
Rating of anatomical knowledge			
Inadequate	3 (12.5)	6 (14.3)	2 (6.7)
Adequate	14 (58.3)	25 (59.5)	19 (63.3)
Good	7 (29.2)	10 (23.8)	8 (26.7)
Excellent	0 (0)	1 (2.4)	1 (33.3)

Numbers in brackets are percentages.

1. PhD candidate and teacher of medical students in obstetrics/gynaecology, gynaecologist, Professor Emerita and fellow.
2. Specialist physician, intern and postgraduate, not yet a resident.
3. Specialist registrar, O&G ST2, registrar, registrar ST6 and specialty O&G trainee.

	Belgium N = 54	Germany N = 18	Oceania N = 14	United States N = 10	Overall N = 192
	40 (74.1)	12 (66.7)	8 (57.1)	9 (90)	142 (74.0)
	14 (25.9)	6 (33.3)	6 (42.9)	1 (10)	50 (26.0)
	44 (81.5)	8 (44.4)	0 (0)	0 (0)	106 (55.2)
	8 (14.8)	7 (38.9)	10 (71.4)	10 (100)	65 (33.8)
	2 (3.7)[4]	3 (16.7)[5]	4 (28.6)[6]	0 (0)	21 (11.0)
	19 (35.2)	5 (27.8)	9 (64.3)	10 (100)	117 (61.0)
	34 (63.0)	11 (61.1)	5 (35.7)	0 (0)	68 (35.4)
	1 (1.8)	2 (11.1)	0 (0)	0 (0)	7 (3.6)
	14 (25.9)	6 (33.3)	0 (0)	0 (0)	35 (18.2)
	2 (3.7)	0 (0)	0 (0)	0 (0)	6 (3.1)
	5 (9.3)	3 (16.7)	5 (35.7)	1 (10)	20 (10.4)
	7 (13.0)	4 (22.2)	3 (21.4)	4 (40)	28 (14.6)
	0 (0)	0 (0)	3 (21.4)	5 (50)	19 (10.0)
	26 (48.1)	5 (27.8)	3 (21.4)	0 (0)	84 (43.8)
	9 (16.7)	4 (22.2)	2 (14.3)	0 (0)	26 (13.5)
	29 (53.7)	8 (44.4)	9 (64.3)	0 (0)	104 (54.2)
	14 (25.9)	5 (27.8)	2 (14.3)	5 (50)	51 (26.6)
	2 (3.7)	1 (5.6)	1 (7.1)	5 (50)	11 (5.7)

4. Consultant.
5. Consultant.
6. Fellow in gynaecological oncology, registrar, fellow and consultant gynaecologist.

CHAPTER 5

Table 2. Results of the Dutch and International Delphi per category

Category	Start list	Results of Dutch Delphi study
Bones	N = 14	N = 9
	Pubic symphysis	Pubic symphysis
	Pubic bone	Pubic bone
	Ischial spine	Ischial spine
	Os sacrum	Os sacrum
	Sacral promontory	Sacral promontory
	Obturator foramen	Obturator foramen
	Sciatic foramen	Sciatic foramen
	Anterior superior iliac spine	Anterior superior iliac spine
	Posterior superior iliac spine	Posterior superior iliac spine (PSIS)
	Sacroiliac joint	
	Os ilium	
	Os coccyx	
	Superior pubic rami	
	Inferior pubic rami	
Ligaments	N = 8	N = 6
	Infundibulopelvic ligament	Infundibulopelvic ligament
	Broad ligament of the uterus	Broad ligament of the uterus
	Ovarian ligament	Ovarian ligament
	Uterosacral ligament	Uterosacral ligament
	Sacrospinous ligament	Sacrospinous ligament
	Round ligament	Round ligament
	Falciform ligament	
	Inguinal ligament	

Difference	Results of international Delphi study
N = 2 PSIS Sciatic foramen	N = 7 Pubic symphysis Pubic bone Ischial spine Os sacrum Sacral promontory Obturator foramen Anterior superior iliac spine
	N = 6 Infundibulopelvic ligament Broad ligament of the uterus Ovarian ligament Uterosacral ligament Sacrospinous ligament Round ligament

Table 2. Continued.

Category	**Start list**	**Results of Dutch Delphi study**
Organs	N = 20	N = 16
	Uterus	Uterus
	Adnexa uteri	Adnexae
	Bladder	Bladder
	Liver	Liver
	Colon transversus	Transverse colon
	Colon descendens	Descending colon
	Colon ascendens	Ascending colon
	Caecum	Caecum
	Sigmoid	Sigmoid
	Rectum	Rectum
	Appendix	Appendix
	Small intestine	Small intestine
	Kidney	Kidney
	Ureter	Ureter
	Peritoneum	Peritoneum
	Omentum	Omentum
	Gallbladder	
	Stomach	
	Spleen	
	Pancreas	
Anatomical space and structures	N = 12	N = 6
	Rectouterine pouch	Rectouterine pouch
	Vesicouterine pouch	Vesicouterine pouch
	Retropubic space	Retropubic space
	Linea alba	Linea alba
	Transversalis fascia	Transversalis fascia
	Superficial fascia	Superficial fascia
	Omental bursa	
	Semilunar line	
	Arcuate line	
	Median umbilical ligament	
	Medial umbilical ligament	
	Lateral umbilical ligament	

Difference	Results of international Delphi study
N = 4	N = 12
Liver Transverse colon Small intestine Kidney	Uterus Adnexae Bladder Descending colon Ascending colon Caecum Sigmoid Rectum Appendix Ureter Peritoneum Omentum
N = 3	N = 3
Linea alba Transversalis fascia Superficial fascia	Rectouterine pouch Vesicouterine pouch Retropubic space

Table 2. Continued.

Category	Start list	Results of Dutch Delphi study
General muscles	N = 7 m. Rectus abdominis m. Pyramidalis m. Psoas Internal oblique muscle External oblique muscle Transverse abdominal muscle m. Piriformis	N = 7 m. Rectus abdominis m. Pyramidalis m. Psoas Internal oblique muscle External oblique muscle Transverse abdominal muscle m. Piriformis muscle
Pelvic floor muscles	N = 10 m. Bulbospongiosus Internal anal sphincter External anal sphincter Urethral sphincter(s) m. Puborectalis m. Pubococcygeus m. Iliococcygeus Deep transverse perineal muscle Superficial transverse perineal muscle m. Ischiocavernosus	N = 10 m. Bulbospongiosus Internal anal sphincter External anal sphincter Urethral sphincter(s) m. Puborectalis m. Pubococcygeus m. Iliococcygeus Deep transverse perineal muscle Superficial transverse perineal muscle m. Ischiocavernosus
Arteries and veins	N = 13 Aorta Vena cava Superficial epigastric artery Inferior epigastric artery Inferior mesenteric artery Common iliac a/v Iinternal iliac a/v External iliac a/v Uterine a/v Obturator a/v Umbilical a/v Femoral a/v Renal a/v	N = 13 Aorta Vena cava Superficial epigastric artery Inferior epigastric artery Inferior mesenteric artery Common iliac a/v Internal iliac a/v External iliac a/v Uterine a/v Obturator a/v Umbilical a/v Femoral a/v Renal a/v
Nerves	N = 8 Hypogastric plexus Pudendal nerve Sciatic nerve Genitofemoral nerve Femoral nerve Obturator nerve Lateral cutaneous nerve Peroneal/fibular nerve	N = 8 Hypogastric plexus Pudendal nerve Sciatic nerve Genitofemoral nerve Femoral nerve Obturator nerve Lateral cutaneous nerve Peroneal/fibular nerve

Difference	Results of international Delphi study
N = 5 m. Pyramidalis m. Internal& external oblique Transverse abdominal muscle m. Piriformis	N = 2 m. Rectus abdominis m. Psoas
	N = 10 m. Bulbospongiosus Internal anal sphincter External anal sphincter Urethral sphincter(s) m. Puborectalis m. Pubococcygeus m. Iliococcygeus Deep transverse perineal muscle Superficial transverse perineal muscle m. Ischiocavernosus
N = 1 Renal artery/vein	N = 12 Aorta Vena cava Superficial epigastric artery Inferior epigastric artery Inferior mesenteric artery Common iliac a/v Internal iliac a/v External iliac a/v Uterine a/v Obturator a/v Umbilical a/v Femoral a/v
N = 1 Peroneal/ fibular nerve	N = 7 Hypogastric plexus Pudendal nerve Sciatic nerve Genitofemoral nerve Femoral nerve Obturator nerve Lateral cutaneous nerve

Table 2. Continued.

Category	Start list	Results of Dutch Delphi study
Imaging	N = 31	N = 11
	Aorta	Aorta
	Common iliac a/v	Common iliac a/v
	Internal iliac a/v	Internal iliac a/v
	External iliac a/v	External iliac a/v
	Bladder	Bladder
	Uterus	Uterus
	Adnexae	Adnexae
	Kidneys	Kidneys
	Ureter	Ureter
	Sigmoid	Sigmoid
	Rectum	Rectum
	Ovarian vein	
	Liver	
	Gallbladder	
	Spleen	
	Pancreas	
	Stomach	
	Small intestine	
	Ascending colon	
	Descending colon	
	Transverse colon	
	Psoas muscle	
	Broad ligament of the uterus	
	Uterosacral ligament	
	Os ilium	
	Inferior pubic rami	
	Superior pubic rami	
	Pubic bone	
	Ischial tuberosity	
	Sacrum	
	Sacral promontory	

Italics = structure not important in the national Delphi study

Difference	Results of international Delphi study
N = 2	N = 13
Ovarian vein Uterosacral ligament	Aorta Common iliac a/v Internal iliac a/v External iliac a/v Ovarian vein Bladder Uterus Adnexae Kidneys Ureter Sigmoid Rectum Uterosacral ligament

Table 3. Results of the Dutch and international Delphi study
Presented as percentage (SD) and mean rating (min-max)

Structures	National (The Netherlands)		International (*)	
	Percentage (SD) of panellists that scored the item as relevant or very relevant	Mean (min–max) rating	Percentage (SD) of panellists that scored the item as relevant or very relevant	Mean (min–max) rating
BONES				
Pubic symphysis	87.5 (1.03)	4.43 (1.5)	89.91 (0.68)	4.49 (2–5)
Pubic bone	85.0 (1.15)	4.33 (1–5)	79.97 (0.84)	4.26 (1–5)
Ischial spine	92.5 (1.11)	4.48 (1–5)	92.37 (0.68)	4.59 (2–5)
Os ilium	65.8 (0.73)	3.57 (2–5)	57.34 (1.03)	3.65 (1–5)
Os coccyx	62.9 (0.79)	3.62 (2–5)	59.66 (0.99)	3.78 (1–5)
Os sacrum	82.5 (1.03)	4.13 (1–5)	76.01 (0.88)	4.00 (1–5)
Sacral promontory	85.0 (1.10)	4.18 (1–5)	87.74 (0.81)	4.32 (1–5)
Obturator foramen	87.5 (0.99)	4.25 (1–5)	82.67 (0.89)	4.21 (1–5)
Sacroiliac joint	60.0 (0.69)	3.57 (2–5)	66.36 (0.98)	3.85 (1–5)
Sciatic foramen	86.6 (0.61)	3.90 (2–5)	61.49 (0.96)	3.75 (1–5)
Anterior superior iliac spine	70.0 (1.26)	3.98 (1–5)	73.20 (1.00)	4.06 (1–5)
Posterior superior iliac spine	77.2 (0.62)	3.81 (2–5)	45.20 (1.01)	3.40 (1–5)
Superior pubic rami	65.7 (0.74)	3.9 (2–5)	59.79 (0.92)	3.77 (1–5)
Inferior pubic rami	65.7 (0.65)	3.72 (2–5)	58.20 (0.95)	3.75 (1–5)
LIGAMENTS				
Falciform ligament	45.0 (1.27)	3.4 (1–5)	50.59 (1.03)	3.51 (1–5)
Infundibulopelvic ligament	92.5 (1.16)	4.65 (1–5)	90.40 (0.77)	4.60 (1–5)
Broad ligament of the uterus	97.5 (1.12)	4.75 (1–5)	92.04 (0.66)	4.62 (2–5)
Ovarian ligament	97.5 (1.12)	4.7 (1–5)	92.06 (0.72)	4.68 (1–5)
Uterosacral ligament	97.5 (1.12)	4.75 (1–5)	95.21 (0.56)	4.74 (2–5)
Inguinal ligament	51.4 (0.79)	3.75 (2–5)	65.31 (0.94)	3.82 (1–5)
Sacrospinous ligament	92.5 (1.16)	4.53 (1–5)	79.53 (0.93)	4.22 (1–5)
Round ligament	97.5 (1.12)	4.75 (1–5)	88.39 (0.69)	4.62 (2–5)
ORGANS				
Uterus	100.0 (0.8)	4.95 (1–5)	100 (0.16)	4.97 (4–5)
Adnexa	100.0 (0.79)	4.98 (1–5)	100 (0.38)	4.94 (1–5)
Bladder	97.5 (0.85)	4.90 (1–5)	100 (0.20)	4.96 (4–5)

Table 3. Continued.

Structures	National (The Netherlands) Percentage (SD) of panellists that scored the item as relevant or very relevant	National (The Netherlands) Mean (min–max) rating	International (*) Percentage (SD) of panellists that scored the item as relevant or very relevant	International (*) Mean (min–max) rating
Liver	80.0 (1.03)	4.17 (1–5)	67.97 (0.88)	3.94 (1–5)
Gallbladder	57.2 (1.01)	3.75 (1–5)	49.71 (1.00)	3.52 (1–5)
Stomach	62.9 (0.98)	3.88 (1–5)	53.23 (1.00)	3.58 (1–5)
Spleen	57.1 (0.99)	3.80 (1–5)	46.16 (0.99)	3.44 (1–5)
Pancreas	48.5 (1.01)	3.68 (1–5)	38.91 (1.1)	3.26 (1–5)
Transverse colon	75.0 (1.17)	4.08 (1–5)	64.34 (0.92)	3.84 (1–5)
Descending colon	82.5 (1.05)	4.27 (1–5)	80.27 (0.73)	4.16 (2–5)
Ascending colon	82.5 (1.07)	4.20 (1–5)	73.97 (0.87)	3.99 (1–5)
Caecum	82.5 (1.08)	4.25 (1–5)	84.20 (0.70)	4.23 (2–5)
Sigmoid	90.0 (1.02)	4.53 (1–5)	91.44 (0.63)	4.44 (3–5)
Rectum	97.5 (0.90)	4.65 (1–5)	96.00 (0.55)	4.63 (3–5)
Appendix	90.0 (0.96)	4.45 (1–5)	80.43 (0.89)	4.17 (1–5)
Small intestine	90.0 (0.91)	4.25 (1–5)	62.90 (0.93)	3.75 (1–5)
Kidney	82.5 (1.03)	4.23 (1–5)	65.81 (1.00)	3.81 (1–5)
Ureter	100.0 (0.82)	4.90 (1–5)	98.57 (0.33)	4.90 (3–5)
Peritoneum	100.0 (0.84)	4.85 (1–5)	98.16 (0.47)	4.76 (3–5)
Omentum	95.0 (1.05)	4.60 (1–5)	89.00 (0.75)	4.49 (2–5)
ANATOMICAL SPACES AND STRUCTURES				
Rectouterine pouch	100.0 (0.82)	4.90 (1–5)	99.46 (0.36)	4.87 (3–5)
Vesicouterine pouch	90.0 (1.01)	4.45 (1–5)	96.77 (0.52)	4.72 (3–5)
Retropubic space (space of Retzius)	82.5 (1.28)	4.18 (1–5)	85.50 (0.85)	4.20 (1–5)
Omental bursa	48.6 (1.01)	3.75 (2–5)	52.11 (1.00)	3.52 (1–5)
Linea alba	72.5 (1.18)	3.95 (1–5)	70.09 (0.97)	3.94 (1–5)
Semilunar line (Spigelian line)	22.8 (0.84)	3.45 (1–5)	38.37 (0.95)	3.22 (1–5)
Arcuate line (of the rectus sheath)	48.6 (0.86)	3.62 (2–5)	49.07 (0.94)	3.51 (1–5)
Median umbilical ligament	45.0 (1.43)	3.40 (1–5)	53.24 (0.99)	3.51 (1–5)

CHAPTER 5

Table 3. Continued.

Structures	National (The Netherlands) Percentage (SD) of panellists that scored the item as relevant or very relevant	National (The Netherlands) Mean (min–max) rating	International (*) Percentage (SD) of panellists that scored the item as relevant or very relevant	International (*) Mean (min–max) rating
Medial umbilical ligament	45.0 (1.44)	3.38 (1–5)	53.57 (0.98)	3.56 (1–5)
Lateral umbilical ligament	45.0 (1.44)	3.38 (1–5)	55.37 (0.95)	3.56 (1–5)
Transversalis fascia	77.5 (1.00)	4.05 (1–5)	68.13 (0.90)	3.91 (1–5)
Superficial fascia	75.0 (0.96)	4.03 (1–5)	65.70 (0.94)	3.84 (1–5)
GENERAL MUSCLES				
Rectus abdominis muscle	97.5 (0.90)	4.68 (1–5)	90.84 (0.66)	4.49 (2–5)
Pyramidalis muscle	92.5 (1.07)	4.47 (1–5)	70.14 (0.97)	3.93 (1–5)
Psoas muscle	87.5 (1.08)	4.32 (1–5)	71.31 (0.86)	4.01 (2–5)
Internal oblique muscle	85.0 (1.07)	4.20 (1–5)	66.37 (0.87)	3.91 (1–5)
External oblique muscle	82.5 (1.08)	4.18 (1–5)	67.81 (0.85)	3.90 (1–5)
Transverse abdominal muscle	77.5 (1.11)	4.13 (1–5)	66.36 (0.83)	3.92 (1–5)
Piriformis muscle	75.0 (1.11)	4.00 (1–5)	50.83 (1.00)	3.55 (1–5)
PELVIC FLOOR MUSCLES				
Bulbospongiosus muscle	92.5 (0.95)	4.55 (1–5)	83.36 (0.80)	4.42 (2–5)
Internal anal sphincter	100 (0.84)	4.83 (1–5)	98.33 (0.48)	4.76 (3–5)
External anal sphincter	97.5 (0.88)	4.80 (1–5)	98.31 (0.45)	4.80 (3–5)
Urethral sphincter(s)	70.0 (1.23)	4.10 (1–5)	87.64 (0.75)	4.44 (2–5)
Puborectalis muscle	85.0 (0.97)	4.27 (1–5)	91.60 (0.69)	4.55 (2–5)
Pubococcygeus muscle	97.5 (0.98)	4.65 (1–5)	89.04 (0.69)	4.53 (2–5)
Iliococcygeus muscle	97.5 (0.98)	4.65 (1–5)	88.49 (0.71)	4.50 (2–5)
Deep transverse perineal muscle	92.5 (0.94)	4.25 (1–5)	92.19 (0.64)	4.53 (3–5)
Superficial transverse perineal muscle	87.5 (0.94)	4.40 (1–5)	92.19 (0.64)	4.53 (3–5)
Ischiocavernosus muscle	92.5 (0.94)	4.25 (1–5)	82.16 (0.87)	4.25 (1–5)
ARTERIES AND VEINS				
Aorta	100.0 (0.85)	4.78 (1–5)	92.36 (0.63)	4.71 (1–5)
Vena cava	97.5 (0.90)	4.68 (1–5)	94.13 (0.63)	4.69 (1–5)

Table 3. Continued.

Structures	National (The Netherlands) Percentage (SD) of panellists that scored the item as relevant or very relevant	National (The Netherlands) Mean (min–max) rating	International (*) Percentage (SD) of panellists that scored the item as relevant or very relevant	International (*) Mean (min–max) rating
Superficial epigastric artery	92.5 (0.95)	4.52 (1–5)	92.23 (0.67)	4.46 (2–5)
Inferior epigastric artery	90.0 (1.08)	4.40 (1–5)	87.61 (0.79)	4.42 (1–5)
Inferior mesenteric artery	75.0 (1.09)	4.05 (1–5)	74.21 (0.94)	4.01 (1–5)
Common iliac artery/vein	97.5 (1.03)	4.58 (1–5)	92.39 (0.67)	4.64 (1–5)
Internal iliac artery/vein	97.5 (1.03)	4.60 (1–5)	97.60 (0.50)	4.75 (3–5)
External iliac artery/vein	95.0 (1.05)	4.55 (1–5)	92.07 (0.63)	4.64 (3–5)
Uterine artery/vein	100.0 (0.84)	4.85 (1–5)	99.24 (0.33)	4.90 (3–5)
Obturator artery/vein	82.5 (1.11)	4.13 (1–5)	85.16 (0.84)	4.28 (1–5)
Umbilical artery/vein	82.5 (1.07)	4.10 (1–5)	79.07 (0.82)	4.25 (1–5)
Femoral artery/vein	77.5 (1.20)	4.15 (1–5)	77.19 (0.92)	4.08 (1–5)
Renal artery/vein	77.5 (1.08)	4.13 (1–5)	66.84 (1.02)	3.87 (1–5)
NERVES				
Hypogastric plexus	75.0 (1.31)	4.00 (1–5)	75.89 (0.92)	4.02 (1–5)
Pudendal nerve	100.0 (0.85)	4.45 (1–5)	97.31 (0.50)	4.74 (3–5)
Sciatic nerve	87.5 (1.13)	4.23 (1–5)	80.99 (0.86)	4.22 (1–5)
Genitofemoral nerve	90.0 (1.15)	4.35 (1–5)	85.13 (0.79)	4.46 (1–5)
Femoral nerve	82.5 (1.30)	4.10 (1–5)	76.21 (0.87)	4.10 (1–5)
Obturator nerve	92.5 (1.14)	4.37 (1–5)	88.19 (0.82)	4.41 (1–5)
Lateral cutaneous nerve	80.0 (1.19)	4.00 (1–5)	74.41 (0.96)	4.03 (1–5)
Peroneal/fibular nerve	70.0 (1.30)	3.99 (1–5)	65.43 (1.15)	3.80 (1–5)
IMAGING				
Aorta	94.3 (0.69)	4.5 (2–5)	74.31 (0.99)	4.21 (1–5)
Common iliac artery/vein	88.6 (0.69)	4.5 (3–5)	77.11 (0.94)	4.19 (1–5)
Internal iliac artery/vein	88.5 (0.69)	4.5 (3–5)	82.11 (0.85)	4.28 (1–5)
External iliac artery/vein	82.9 (0.79)	4.4 (3–5)	75.80 (0.93)	4.16 (1–5)
Ovarian vein	40.0 (0.91)	3.13 (2–5)	78.11 (0.92)	4.10 (1–5)
Bladder	94.3 (0.60)	4.6 (3–5)	96.69 (0.57)	4.67 (2–5)

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Table 3. Continued.

Structures	National (The Netherlands) Percentage (SD) of panellists that scored the item as relevant or very relevant	National (The Netherlands) Mean (min–max) rating	International (*) Percentage (SD) of panellists that scored the item as relevant or very relevant	International (*) Mean (min–max) rating
Uterus	77.5 (0.72)	3.78 (1–5)	98.01 (0.45)	4.80 (3–5)
Adnexae	100 (0.45)	4.7 (4–5)	96.37 (0.50)	4.77 (3–5)
Kidneys	97.1 (0.60)	4.5 (3–5)	78.27 (0.85)	4.19 (1–5)
Ureter	89.6 (0.69)	4.5 (3–5)	93.74 (0.68)	4.59 (2–5)
Liver	45.0 (0.95)	3.25 (1–5)	59.86 (1.03)	3.80 (1–5)
Gallbladder	35.0 (1.15)	2.92 (1–5)	38.43 (1.10)	3.37 (1–5)
Spleen	30.0 (1.01)	2.85 (1–5)	40.24 (1.10)	3.32 (1–5)
Pancreas	25.0 (1.02)	2.72 (1–5)	39.31 (1.11)	3.30 (1–5)
Stomach	32.5 (1.08)	2.85 (1–5)	41.93 (1.08)	3.36 (1–5)
Small intestine	32.5 (1.05)	2.90 (1–5)	54.30 (1.00)	3.62 (1–5)
Ascending colon	40.0 (1.05)	3.08 (1–5)	61.11 (1.00)	3.75 (1–5)
Descending colon	40.0 (1.04)	3.10 (1–5)	66.36 (0.92)	3.86 (1–5)
Transverse colon	40.0 (1.06)	3.05 (1–5)	63.97 (1.00)	3.76 (1–5)
Sigmoid	91.4 (0.63)	4.4 (3–5)	79.13 (0.80)	4.11 (1–5)
Rectum	94.3 (0.60)	4.5 (3–5)	89.99 (0.77)	4.35 (1–5)
Psoas	32.5 (1.12)	2.92	56.14 (0.92)	3.71 (1–5)
Broad ligament of the uterus	35.0 (1.12)	2.90	67.07 (0.95)	3.83 (1–5)
Uterosacral ligament	35.0 (1.08)	2.93	73.06 (0.93)	4.00 (1–5)
Os ilium	12.5 (0.92)	2.53	52.54 (0.97)	3.61 (1–5)
Inferior pubic rami	15.0 (0.89)	2.70	56.37 (0.90)	3.60 (1–5)
Superior pubic rami	12.5 (0.92)	2.60	54.27 (0.90)	3.60 (1–5)
Pubic bone	27.5 (0.91)	3.00	66.29 (0.94)	3.83 (1–5)
Ischial tuberosity	17.5 (0.97)	2.68	51.70 (0.98)	3.60 (1–5)
Sacrum	30.0 (0.88)	3.10	60.33 (0.93)	3.82 (1–5)
Sacral promontory	37.5 (0.90)	3.20	59.99 (1.00)	3.82 (1–5)

* Belgium, Germany, Norway, Oceania, Sweden, United Kingdom and United States
Green: relevant, Red: not relevant, Yellow: possible relevant

Discussion

Main findings

This study reported an internationally validated list of 70 structures that are relevant for safe and competent practice of general gynaecologists. Based on the opinions of 192 panellists from seven international countries, 72 structures were validated and therefore found to be clinically relevant for general gynaecologists on an international scale. Of the 86 relevant structures in the Dutch Delphi study, 16 were possible relevant or non-relevant internationally. Conversely, only two internationally relevant structures, both of which were in the imaging category, were not relevant nationally, meaning that 70 relevant structures matched.

Interpretation

Anatomy is the cornerstone of good clinical practice. As less time and fewer resources are devoted to anatomical education, defining what is essential knowledge helps to provide a sufficient knowledge base [16]. The importance of a so-called core anatomy curriculum is well-described in the literature. A core curriculum ensures that topics of real clinical relevance are covered and that students gain an understanding of the relationship between structure and function [17, 18]. Consequently, the lack of a core anatomy curriculum negatively influences knowledge of anatomy [12].

With this internationally validated list of anatomical structures that are relevant for safe and competent practice of gynaecologists, we have defined essential anatomical knowledge for a general gynaecologist. This can therefore be seen as a first step in the development of an international anatomy curriculum. Effective curriculum development requires a systematic approach, starting with identification of the learning needs, followed by curriculum development, during which the training structure and environment can be defined, and subsequently validation, implementation and assessment of patient outcomes (figure 1) [5].

The results of our study identify the learning needs (*i.e.,* the content). The development of the curriculum (*i.e.*, the form) can be determined by each country.

It requires much more than anatomical knowledge to become a skilled and competent gynaecologist. Assembly of this international list is valuable at several levels. First, standardization of curricula content will enhance the quality of training programs and subsequently patient care [19]. Second, identification of learning needs is time-consuming and requires considerable resources. This core list means countries do not have to face these challenges, avoids repeating work and circumvents pitfalls already encountered [20].

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From a broader perspective, this international list is a first step for free movement of specialists [21]. If gynaecologists all achieve the expected competencies, which are internationally agreed, regulatory bodies can develop consistent approaches across countries. Subsequently, easier movement of gynaecologists between countries will facilitate exchange of knowledge and skills, which will help to improve the quality of patient care and training.

As mentioned in the Results section, there were a few differences between the national and international results. One structure, the posterior superior iliac spine, was relevant in the Dutch Delphi study, but not in the international validation. In the Dutch Delphi study, this structure was labelled as possibly relevant and thus considered for a second round. It remained possibly relevant, with 77.2% of panellists scoring it as relevant or very relevant and an average rating of 3.8. Only one other structure, the sciatic foramen, was considered for a third round. It was not considered appropriate to perform a third Delphi round for these two structures and therefore they were both accepted as relevant. The finding that the posterior superior iliac spine was not an important anatomical structure in the international study makes the decision to accept this structure as relevant in the national study questionable.

Differences between findings of the national and international Delphi studies were striking for items in the general muscle category. In the international Delphi study, only two of the seven muscles were relevant. Four of the five muscles that were not relevant, all abdominal wall muscles, had mean ratings of 3.9 and 66–70% of panellists scored them as relevant or very relevant. Similar results were seen in other categories. Structures such as the liver, transverse colon, kidney, transversalis fascia and renal artery/vein were not relevant in the international Delphi study, with mean ratings of 3.8–3.9. This might be due to interpretation of the instructions sent with the survey. We asked panellists to assess to what extent the named structure is relevant on a scale from 1 to 5 (1=not relevant, 3=neutral and 5=highly relevant). Whereby, it is important for the structures to be assessed on the level of a general gynaecologists who have just finished their training. A gynaecologist will not operate on the pyramidalis muscle or liver, but may encounter these structures during gynaecological surgery. Therefore, it is debatable whether it is not necessary to know about these structures. Another potential explanation is that a doctor may be expected to know about these structures from their medical education because they are so general.

Another discrepancy was seen in the imaging category. In this category, two structures, the ovarian vein and uterosacral ligament, were internationally accepted immediately. Furthermore, 14 structures were labelled as possibly relevant but were not relevant in the Dutch Delphi study in the first round. We cannot fully explain this difference in importance of these structures in the imaging category. Undergraduate radiology education, radiology curricula and radiology pedagogy vary widely between disciplines and between colleges within disciplines [22]. In the Netherlands, radiology is taught in medical school, usually in combination with anatomy, and radiology examinations are readily available and widely performed in daily clinical practice. However, there is no formal radiology course or teaching in postgraduate gynaecology. To our knowledge, this is not the case in other countries.

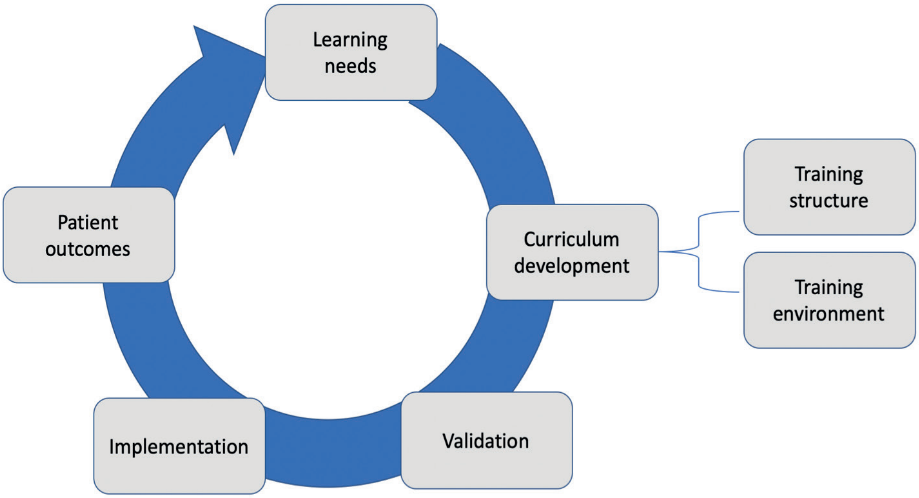

Figure 1. Development of a curriculum

Strengths and limitations

The main strength of the study is diversity. There was broad international engagement in the development process, ensuring that our results are comprehensive and representative. There was diversity in the included countries, with 192 responses from panellists in seven countries across the world. In addition, there was diversity in workplace (academic teaching hospitals, non-academic teaching hospitals and non-academic non-teaching hospitals) and subspecialty. Finally, there was diversity due to the involvement of trainees and medical doctors with different levels of experience and education. This diversity makes it more likely that the list will be included in national training programmes [23].

The design of the entire process, from the primary list to the international validation, is also a strength. We first developed a list of essential structures using textbooks related to gynaecological examination and surgery. Through focus groups and structured interviews, a survey list of 123 items was developed. This list was nationally and internationally validated, yielding 70 validated structures.

A limitation of this study is that the results were all from Western countries. Although we invited panellists from both Western and non-Western countries to participate in our study, the survey was not completed or was completed by fewer than ten panellists in non-Western countries. Therefore, we could not ascertain the degree to which these results address non-Western or local needs in anatomy. However, the anatomy of the female body is universal and therefore we expect that our results will also be applicable in non-Western countries.

To obtain as many responses as possible, we used the oil slick principle. However, this meant it was impossible to perform a second round for structures labelled as possibly relevant. In the first round of the Dutch Delphi study, 74 structures were relevant, 24 were non-relevant and 25 were possibly relevant, while 12 more structures were relevant after the second round. The numbers were similar in the international validation, meaning that more structures would have been labelled as relevant if a second round had been possible.

Conclusion

This study identified 70 anatomical structures that are relevant for safe and competent practice of general gynaecologists based on a national and international validation. The results of our study identify the learning needs (*i.e.*, the content) for an international anatomy curriculum. The development of the curriculum (*i.e.*, the form) can be determined by each country and used to standardize and guide postgraduate training in gynaecology. This is an important step in the era of international teaching and training.

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6

Anatomy (knowledge) in postgraduate obstetrics and gynaecology training: is it sufficient enough?

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Abstract

Background
Due to the importance, anatomy training is worldwide recognizable in virtually all undergraduate curricula and many postgraduate surgical curricula [1, 2].

The postgraduate curriculum of obstetrics and gynaecology (O&G) is such a surgical curriculum. It is a diverse branch of medicine and the role of anatomy in O&G is versatile. In the Netherlands nor in Europe the expectations of knowledge on anatomy are specified in the current training program, making trainees insecure about their performance in anatomy knowledge [3]. Therefore, we recently performed a Delphi study to determine which anatomical structures should be taught to ensure safe and competent practice among general gynaecologists [4]. The aim of this study is the determination of the anatomical knowledge level in postgraduate training for O&G. Our hypothesis is that the trainees possess a good knowlegde of anatomy and on average at least 80% of correct answers on core knowledge is shown.

Methods
A longitudinal knowledge analysis was performed under Dutch trainees' obstetrics and gynaecology. The anatomy questions of the annual progress tests from 2010-2019 were analysed. Anatomy questions were selected and assessed on relevance based on the previous performed Delphi study which identified 86 structures which are essential to perform safe and competent practice as a general gynaecologist. Scores on relevant anatomy questions were calculated.

Results
In 10-year 3136 trainees performed the annual progress test. 54 Anatomy related questions were asked on a total of 1637 questions (3.3%). Of these 54 questions, 38 (70%) were concerned as relevant questions. Overall 10-year score was 64.5%.

Conclusions
The anatomy knowledge of trainees' obstetrics and gynaecology is insufficient. Our results are a step in the awareness of testing and improving anatomy knowledge of postgraduate O&G training.

Keywords: Anatomy Knowledge, Progress Testing, Obstetrics and Gynaecology, Postgraduate Training

Introduction

Anatomy is considered a traditional memory-based discipline [5]. Whilst the importance of anatomy knowledge is obvious when considering surgery, it is also vital for performing physical examinations, examining radiological imaging findings, and explaining diagnoses and treatment procedures to patients and colleagues [6]. In theory, these tasks can be performed without an underlying knowledge of anatomy by solely following protocols and guidelines and using pattern recognition. However, knowledge without understanding does not provide a solid basis for medical work in terms of the variations seen in nature, or for future development [5]. Therefore, anatomy training is included in virtually all undergraduate medical curricula and many postgraduate surgical curricula worldwide [1, 2].

Postgraduate training in obstetrics and gynaecology (O&G) includes a surgical curriculum. In the Netherlands postgraduate training in O&G is a 6-year training program. Of those six years, the first four years are equal to all the trainees and contain the basics. The last two years contain a part subspecialisation and differ per trainee. All the years consist of clinical rotations complemented by formal teaching of various subjects.

O&G is a diverse branch of medicine with a versatile reference to anatomy. Indeed, a complete knowledge of anatomy is needed for many tasks. For example, gynaecologists perform diagnostic imaging using ultrasound; perform surgery in a difficult area (*i.e.,* the pelvis); and an understanding of the birth canal and acute medicine is required in obstetric care.

In the Netherlands, the obligatory formal anatomy training of obstetrician-gynaecologists consists of two 1-day courses supplemented with opportunities for informal learning during the 6-year postgraduate training. Expectations of anatomy knowledge are not specified in the current training program, but as part of the integrated training program, trainees are expected to gain a working knowledge of anatomy.Therefore, we recently performed a Delphi study to determine which anatomical structures should be taught to general gynaecologists to ensure safe and competent practice [4]. In that study, we reached a consensus on 86 clinically essential anatomical structures, which were divided into nine categories. This list can be used to guide postgraduate education and knowledge testing in anatomy [4].

Anatomy knowledge can be tested using a variety of assessment tools, such as multiple-choice exams, oral exams, or structured practical examinations. These tools reflect the three domains of anatomy training: theoretical knowledge, practical 3D application of this knowledge, and clinical or bedside application of knowledge [7]. In Dutch O&G postgraduate training, the annual progress test is used to assess theoretical knowledge of anatomy.

After the post training period every gynaecologist is expected to be an independent professional having an adequate knowledge of anatomy. By analysing the only theoretical knowledge test, *i.e.,* the annual progress test, we want to evaluate this knowledge level. We hypothesised that trainees of the Dutch postgraduate training for O&G possess a good knowledge of anatomy and would correctly answer at least 80% of questions on the previously defined essential structures in an annual progress test in order to represent safe practice [8-10].

Methods

Progress test

The annual mandatory progress test consists of approximately 150–170 multiple-choice questions. The questions are divided into the five O&G domains: obstetrics perinatology, benign gynaecology, reproduction and endocrinology, oncology, and general health. Anatomy questions were limited to the first four test domains, namely obstetrics perinatology, benign gynaecology, and reproduction and endocrinology, and oncology [11].

For each question, trainees had the option to answer the question or to respond using a question mark to indicate that they did not know the answer. One point was assigned for each correct answer, and one point was deducted for each incorrect answer. Inserting a question mark results in neither earning nor losing a point. Results were calculated as a correct-minus-incorrect score. Final scores were expressed as percentages with a corresponding grade.

Every year, the progress test exam committee constructs a new set of exam questions based on recently released practice guidelines, recent relevant research findings, and knowledge that is essential for daily clinical practice. The exam committee consists of 8–10 practising gynaecologists, each of which is a specialist in one or more of the test subdomains. In addition to the practising gynaecologists, each year, four trainees are invited to participate in the test construction.

Participants
We analysed the results of year 1–6 postgraduate O&G trainees from all seven regional training networks in the Netherlands who participated in the obligatory annual progress test from 2010 up to and including 2019.A regional training network consisted of partner hospitals from one region working together for optimal implementation of postgraduate training.

The results of the year 4, 5, and 6 trainees were considered to represent the baseline for knowledge in anatomy. This subgroup was chosen in accordance with the intent of the Dutch postgraduate training programme, whereby a trainee should possess basic anatomy knowledge after 4 years. The last 2 years of training focus on maintaining and consolidating knowledge, supplemented with the choice of one or two subspecialisations.

Anatomy questions
Anatomy questions were divided into the two following categories: gross anatomy (GA) and applied anatomy (AA). This categorisation was performed by an anatomist, a gynaecologist, and an O&G trainee. Gross anatomy is a branch of anatomy that deals with the macroscopic structure of tissues and organs. Questions requiring trainees to label structures and determine the course of an anatomical structure were categorised as gross anatomy questions. Applied anatomy refers to the practical application of anatomy knowledge to diagnosis and treatment. (Examples of anatomy questions see appendix 1)

Statistical evaluation
The difficulty index was calculated for every anatomy question in the progress tests from 2010 to 2019. The difficulty index is a descriptive value representing the number of trainees that correctly answered the question divided by the total number of trainees and can range between 0-1 [12, 13]. Multivariate analysis of variance (ANOVA) was performed to assess the difference in the difficulty index between trainees in the different year groups. Additionally, post hoc analyses were performed to determine between which year groups there was a significant difference. A Kruskall–Wallis test was used to identify differences in dispersion between test years and regional training networks for the number of trainees. Analyses were performed using SPSS 26. A p-value < 0.05 was considered statistically significant.

Results

From 2010 until 2019, a total of 3136 trainees from seven regional training networks participated in the annual progress test. No further baseline characteristics are specified since the analysed information was completely anonymous. All ten tests had a Cronbach's alpha > 0.8 (0.815–0.869), which indicates that the annual progress test was reliable. There was no significant difference in dispersion between the test years 2010 and 2019, or between the seven training networks.

Relevance of the progress test anatomy questions

Over the 10-year study period, there were 54 anatomy-related questions out of a total of 1637 questions (3.3%). Of these 54 questions, 38 (70%) were concerned with essential structures that are included in the Delphi list.

The gross anatomy and applied anatomy categories included 23 and 15 questions, respectively. The remaining 16 questions were concerned with foetal or male anatomy, or female gynaecologic anatomy which were not considered essential according to the Delphi list. All subsequent results presented pertain to the 38 questions that were concerned with essential anatomical structures that should be known by general gynaecologists, according to the Delphi list. The number of relevant anatomy questions ranged from zero to four questions per year, per test domain. There were no relevant anatomy questions in the reproduction and endocrinology domain. The total number of relevant questions varied between one and six questions per year.

Performance on the relevant anatomy questions

Table 1 shows the performance on relevant anatomy questions by each cohort (years 1, 2, 3, 4, 5, and 6) for each year that the progress tests were analysed. Values are displayed as difficulty index results representing the amount of good answers. These results show that there is an increase in anatomy knowledge except for the year 2016 where first year trainees scored better than the sixth-year trainees.

Figure 1 shows the mean results of years 4 to 6 on the relevant anatomy questions. The red line at 80% represents the hypothesised minimum % of correct answers. Over 10 years, the average score was 64.5% for the year 4, 5, and 6 trainees.

Table 1. Performance by each cohort for each year

Year (Number of questions)	Year 1 (N)	Year 2 (N)	Year 3 (N)	Year 4 (N)	Year 5 (N)	Year 6 (N)
2010 (1)	0,140 (50)	0,267 (45)	0,186 (43)	0,360 (50)	0,417 (24)	0,373 (51)
2011 (6)	0,522 (46)	0,596 (59)	0,698 (48)	0,691 (38)	0,673 (50)	0,730 (42)
2012 (4)	0,343 (56)	0,440 (55)	0,500 (54)	0,565 (42)	0,553 (42)	0, 583(39)
2013 (3)	0,439 (60)	0,588 (55)	0,700 (50)	0,697 (44)	0,775 (46)	0,667 (35)
2014 (1)	0,250 (64)	0,417 (60)	0,417 (40)	0,425 (40)	0,404(52)	0,409 (44)
2015 (5)	0,387 (63)	0,391 (69)	0,519 (64)	0,562 (53)	0,630 (40)	0,671 (45)
2016 (3)	0,824 (53)	0,813 (59)	0,830 (51)	0,862 (58)	0,780 (44)	0,629 (35)
2017 (5)	0,537 (66)	0,523 (65)	0,590 (61)	0,623 (60)	0,666 (31)	0,658 (31)
2018 (5)	0,522 (59)	0,593 (61)	0,603 (66)	0,687 (60)	0,698 (59)	0,683 (53)
2019 (5)	0,493 (54)	0,550 (60)	0,609 (63)	0,638 (69)	0,669 (52)	0,665 (49)

N = total amount of students participating per year

CHAPTER 6

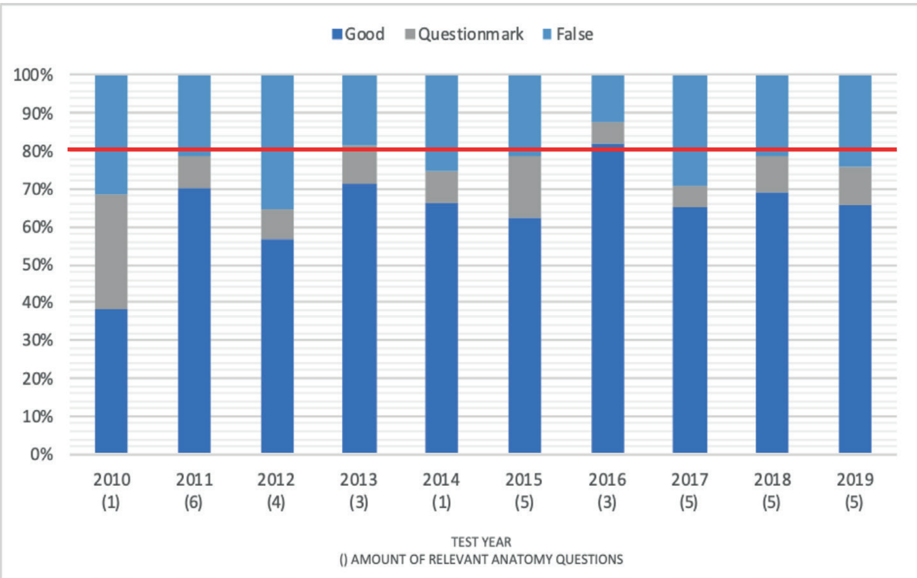

Figure 1. Mean results of years 4 to 6 on the relevant anatomy questions

Analysis of the data per year-group are shown in figure 2. They revealed a gradual significant increase in knowledge (p = 0.001) between year 1 trainees and year 4, 5, and 6 trainees. This was accompanied by a significant decrease in the use of question mark responses (p =< 0.001) of the year 1 trainees, year 2 trainees, and year 3–6 trainees compared with the year 4–6 trainees.

For the two categories of questions, *i.e.,* applied anatomy and gross anatomy, a significant difference in performance was seen for all answer options (p = 0.001). In the applied anatomy category, fewer questions were answered correctly, more question marks were used, and more questions were answered incorrectly than in the gross anatomy category (see figure 3).

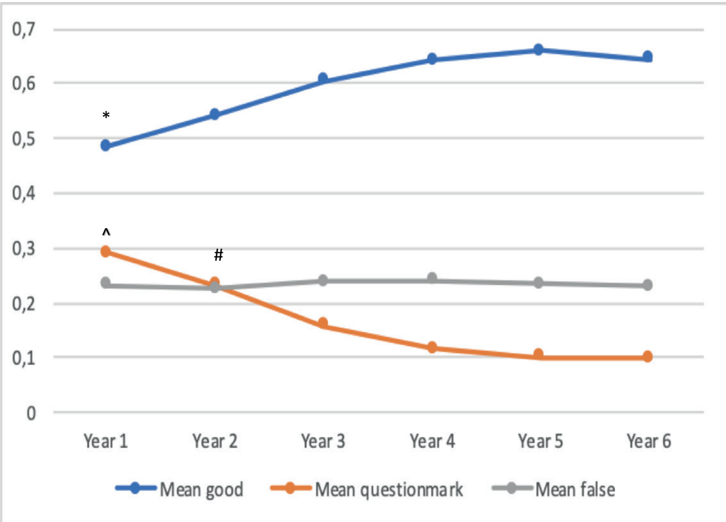

Figure 2. Mean results per year group for each of the three answer options

* statistically significant difference with year 4-5-6
^ statistically significant difference with year 3-4-5-6
\# statistically significant with year 4-5-6

Figure 3. Overview of the percentage of questions of the categories gross anatomy (blue) and applied anatomy (orange) per trainee year that were answered correctly (A), false (B) and with a question mark (C).

Discussion

Main findings

We hypothesised that O&G postgraduate trainees in the Netherlands have a good knowledge of anatomy and would correctly answer at least 80% of questions about anatomical structures. However, our analysis of results of the annual progress test over 10 years (2010–2019) revealed that year 4–6 trainees performed worse than expected, with an average correct response rate of 64.5%.

There was a remarkably low number of anatomy-related questions in the annual progress test (54 questions over 10 years of testing, which was 3.3% of all questions). Furthermore, an analysis of the relevance of anatomy questions according to the previous Delphi study showed that, of these questions, only 70% were concerned with the anatomical structures that trainees are expected to know [4].

The lower correct response rate on applied anatomy compared with gross anatomy questions suggest that trainees found it difficult to translate their theoretical knowledge into clinical situations.

Interpretation

In a previous study, we determined which anatomical structures general gynaecologists should have knowledge of for safe and competent practice [4]. Subsequently, in the present study, we analysed the actual anatomy knowledge of O&G trainees in their final years of training.

The postgraduate education of O&G is designed in a way that ideally one would expect that 4th year trainees would answer all relevant anatomical questions in the progress test correctly. Since this is not realistic, we expected that trainees with sufficient anatomical knowledge would score 80% or higher of course this cut off value is debatable.Only in 2016 this 'cut-off' of 80% is reached, for the whole group as well as for year 4. In this year only three anatomy questions were asked.A progress test is designed for assesing the individual progress as well as for cohort evaluations. The individual results are compared to the group average and based on this group average, which sets the standard, you pass or fail the test. Due to privacy regulations it is not possible to evaluate the progress test for individuals.

We found that trainees did not meet the set standards. Did we put the bar too high? Looking from trainee's perspective at anatomy, Sgroi *et al.* stated that 77% of the trainees in their 6th year perceived their anatomical knowledge sufficient. One of their conclusions is that 71% of the trainees thought anatomy was not assessed adequately. Although another conclusion in their study is that 71% of the trainees thought anatomy was not assessed adequately[14]. In a questionnaire study among radiologists it is shown that radiologists are not satisfied with the level of anatomy knowledge at the start of their training, while all agree that anatomy is central to radiology. They are also concerned about the level of anatomy knowledge of junior doctors [15].

To our knowledge, three other previous studies have set a cut-off for anatomy knowledge [16-18]. In one of these studies, the Berlin Progress Test Medicine was used to analyse the anatomy knowledge of students from ten German university medical schools [16]. The cut-off was established independently by five panels of anatomists at different universities across Germany. On average, only 29.9% of the year 5–6 medical students scored above the average cut-off score of 60.4% in that study.

Prince *et al.* (2005) used different expert panels to set the standard for anatomy knowledge and compared this with the results obtained from a computerised, case-based clinical anatomy test. This test was completed by a sample of students from eight medical schools in the Netherlands, and pass rates were set between 56.0% and 46.9%, depending on the type of expert panel. Students' mean overall correct response rate was 53.2% [17]. The third study set the cut-off at a correct response rate of 60% without any further explanation [18].

Looking more generally at cut-off scores, a correct response rate of 70% is universally acceptable for many tests [19]. The correct response rates in our study did not meet this cut-off score.

Despite these previously defined cut-off scores, we chose a correct response rate cut-off of 80% because our study was conducted with a selected group of participants, *i.e.*, O&G trainees, who were tested on well described, predefined, essential anatomy knowledge [4]. This is in contrast to the afore-mentioned studies, in which participants were medical students and thus the tested essential knowledge was much broader. Setting the bar at 80% may appear trivial but setting it at 100% is unrealistic, and it may correct for trainees' misinterpretation of questions, for example. Lowering the bar further, however, could endanger the quality of medical care.

The purpose of the progress test is to test long-term knowledge. It is therefore a method to identify knowledge gaps for both trainees and curriculum developers, with the hope that trainees subsequently focus their efforts on studying in areas identified as their weak spots [20]. This makes progress testing an excellent method by which to test anatomy knowledge. However, only 2.3% of questions were relevant to anatomy; thus, it seems clear that increasing the number of anatomy-related questions and ensuring that knowledge of the essential structures is tested could help to increase the correct response rates. Studies in medical students revealed that the perceived importance of the subject of anatomy is strongly associated with how thoroughly it is assessed and to what extent this contributes to the final test results [21, 22].

Strength and limitations

The main strength of our study lies in the longitudinal setting of random knowledge testing. As noted above, the progress test is well suited for testing anatomy knowledge. Anatomy knowledge is general knowledge that is required for everyday clinical practice. Thereby, questions about this subject contain only one correct answer. Analysing data obtained over 10 years offered a realistic representation of the anatomy knowledge of O&G trainees in their final years of training.

As is the case with all tests of knowledge, assessments of anatomy knowledge can be divided into four components, as follows: knowledge (knows), competence (knows how), performance (shows how), and action (does) [23]. Multiple-choice questions can effectively assess knowledge and competence but not performance and action. Therefore, the use of multiple-choice questions in the present study might be seen as a limitation; however, without the components of knowledge and competence, trainees will be unable to fulfil the performance and action aspects. This could explain why several previous studies have shown that student performance was better when anatomy knowledge was tested using multiple-choice questions than using other assessment tools [16, 24, 25].

A point to address is the question mark as an answer option. Using the question mark could lead to a strategic choice. Though, when it comes to anatomy you want people to be sure and not guessing. Thereby, we showed in figure 3 that the use of the question mark option is minimal for the final year trainees. Therefore, we think the results represent the real knowledge level.

A limitation is that we sampled trainees in just one discipline and in one country. To increase the generalisability of the present results, future work could investigate this topic in other disciplines and countries.

We are aware of the low number of anatomy questions in the test. Unfortunately, this is in reality the way we test our trainees for anatomy knowledge.

Conclusion

Based on our expectations of trainees' anatomy knowledge, results from the annual progress test revealed that the anatomy knowledge of O&G trainees after basic training is less than expected. Our results increase awareness of the importance of testing and improving the anatomy knowledge of postgraduate O&G trainees. Anatomy knowledge could be improved by optimising the progress test, which should include a representative number of questions about anatomical structures. This could also help trainees to understand what is expected of them and motivate them to study. This is not only important for patient safety but also for efficient work progress and trainees' confidence. Furthermore, there should be a greater focus on the translation of anatomy knowledge to everyday practice.

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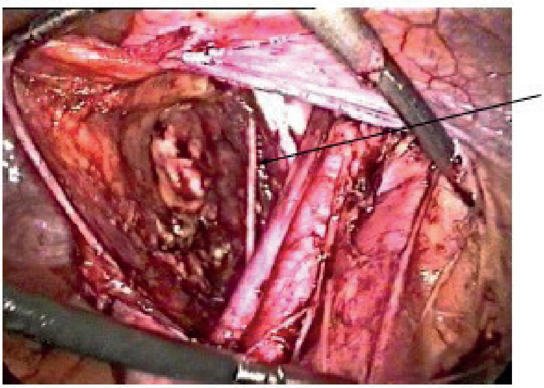
Appendix
Examples of gross anatomy questions:

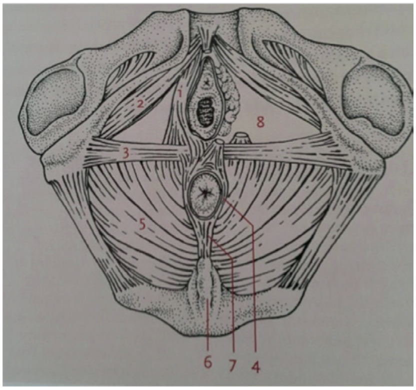
Question:
Which vessel crosses over the ureter?
Answer options:
a. A. Iliaca communis
b. A. Iliaca externa
c. A. Iliaca interna
d. A. uterina

Question:
The a. epigastria inferior orginates from:
Answer options:
a. A. iliaca interna
b. A. iliaca externa
c. A. thoracalis interna
d. A. epigastrica superior

Question:
Which structure is indicated with the arrow?
Answer options:
a. Lig. umbilicalis
b. Ureter
c. N. Pudendus
d. N. Obturatorius



Question:
Which muscle is indicated with number 2?



Answer options:

a. M. bulbospongiosis
b. M. transversus perinei superficialis
c. M. ischiocavernosus
d. M. levator ani

Examples of applied anatomy questions:

Question:
After a uterus extirpation with bilateral adnex extirpation and pelvic and para-oartal lymfe node dissection the patient complains of numbness in the inside of the thigh.
Which nerve is damaged?
Answer options:

a. N obturatorius
b. N. genitofemoralis
c. N. ischiadicus
d. N. femoralis

Question:
When a nerve sparing radical hysterectomy is performed in case of cervical cancer a nerve (bundle) is saved to prevent functional problems of the bladder. Which nerve or nerve bundle is this?

Answer options:

a. Plexus hypogastricus inferior
b. Plexus cervicalis
c. N. obturatorius
d. N. genitofemoralis

Question
The purpose of the deep perineal stitch after an episiotomy is repair of:
Answer options:

a. Urogenital diaphragm
b. M. levator ani
c. M. bulbospongiosus
d. M. ischiocavernosus

Question:
Which part of the ureter is most likely to get injured during gynaecological surgery?
Answer options:

a. Proximal 1/3
b. Middle 1/3
c. Distal 1/3

7

Anatomy in the daily practice of the gynaecologist, essential or just window dressing?

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Abstract

Anatomy is a basic pillar of medical training, with every medical school curriculum worldwide including instruction in human anatomy. The roles of anatomy and anatomy education in postgraduate training, are less well defined. Specific for the postgraduate training of obstetrics and gynaecology several signs suggest that anatomy education draws the short straw. The objective of this study was to determine the role and significance of anatomy in the practice of obstetrics and gynaecology (O&G) and the relationship between the importance of anatomy and the acquisition of anatomical knowledge.

Semi-structured interviews with gynaecologists and obstetrics and gynaecology trainees from Belgium and the Netherlands were used to answer the research question of the study.

The role of anatomy in the practice of O&G lies in three areas:

1. daily activities
2. for the feeling of self-efficacy;
3. to gain a respected name as a doctor.

Motivation plays a central role to which extent anatomy knowledge is actually obtained and seems to come quite late during postgraduate training or even while being already a gynaecologist. Stimulating factors for obtaining knowledge are *responsibility, patient problems*, *new techniques* and *supervisors* who pay attention to anatomy. Barriers are found in *the feeling of insecurity* and *the lack of a reference*.

Although anatomical knowledge plays an important role in gynaecology practice, this importance is frequently not recognized until late in postgraduate training. This may have a negative impact on patient safety, as this late realization can negatively affect knowledge acquisition.

Keywords: Anatomical Knowledge, Anatomical Knowledge Acquisition, Obstetrics and Gynaecology, Postgraduate Training

Introduction

Anatomy is one of the basic sciences taught to a greater or lesser extent in every undergraduate medical school curriculum worldwide [1, 2]. Although there are disagreements about the form of anatomy education, its value to teaching and learning medicine is clear, with basic science and its associated anatomical knowledge representing a tool that facilitates memorization and leads to more coherent understanding of clinical conditions [3-8].

In contrast with its role in undergraduate medical education, the role of anatomy and anatomical knowledge in postgraduate training is less well defined. Specific for the postgraduate training of obstetrics and gynaecology (O&G) several signs suggest that anatomy education draws the short straw. References to anatomy in O&G are based on the activities of a practicing gynaecologist and are much broader than in undergraduate training. Gynaecologists perform diagnostic imaging using ultrasound and perform surgery in a difficult area (*i.e.,* the pelvis). Furthermore, anatomic understanding of the birth canal is required in obstetric care.

Curriculum plans mainly focus on the numbers of surgical procedures, CanMeds and Entrustable Professional Activities (EPA), without clear descriptions of expected knowledge [9, 10]. For example, in the Netherlands, gynaecologists who complete training are expected by the Dutch Society of Obstetrics and Gynaecology (NVOG) to have attained a level of competence in surgery and be able to independently manage a range of common gynaecological conditions and emergencies. The training and assessment of anatomy and its application to obstetrics and gynaecological surgery are not defined in the current training program [9]. The standards of training for women's health in Europe, launched by the European Board and College of Obstetrics and Gynaecology (EBCOG), does not include a chapter describing the level of knowledge expected for trainees [10].

During postgraduate training in the Netherlands, formal education in anatomy consists of two 1-day courses of anatomy training. In Belgium, there are no obligatory anatomy courses. Informal opportunities to learn anatomy are decreasing due to a shift in therapeutic approaches toward more conservative therapy. Examination of anatomical knowledge seems to play a minor role. A study analysing 10-year progress testing in showed that only 54 (3.3%) of the 1637 questions were related to anatomy [11].

These findings suggest that anatomy is unimportant in O&G postgraduate training. The present study analysed the current role and significance of anatomy in the practice of O&G and the relationship between the importance of anatomy and the acquisition of anatomical knowledge.

Methods

Design
Relatively little is known about the role of anatomy in postgraduate medical education and most previous studies focus on assessed knowledge. Therefore, we conducted an explorative qualitative study to analyse the role and significance of anatomy in the practice of obstetrics and gynaecology and the relationship between the importance of anatomy and the acquisition of anatomical knowledge during O&G postgraduate training. Anatomy is one of the oldest branches of medical education. At present, anatomy is taught because it is useful, not because it is obligatory or because of its longstanding inclusion in medical education. This explorative qualitative study was therefore approached based on the utility principle.

Because the complex role of anatomy in medical education likely cannot be summed by a single interpretation, a social constructivist paradigm was chosen in designing this study.

Participants and procedure
To ensure a rich input this study included both gynaecologists and gynaecology trainees from two neighbouring countries: Belgium and the Netherlands. Possible participants were identified through various contacts in both countries. To widen the scope of the study and obtain relevant information, gynaecologists with surgical subspecialties, such as urogynaecology, oncology or minimally invasive surgery, were recruited from various academic and non-academic teaching hospitals in both countries. Trainees at different time points in training were also recruited from various academic and non-academic teaching hospitals in both countries. Data were collected until information redundancy was achieved. Of the 15 participants asked to participate by email, 12 (80%) agreed to participate and were scheduled for online interviews. Reasons for not participating included lack of time and a belief that their profile did not meet study requirements for surgical subspecialties.

Semi structured interviews were performed by two researchers (DK and MV) between February 2020 and June 2020. All interviews were audio recorded and transcribed verbatim.

Interview development
A setup for the semi-structured interviews was developed based on the purpose of this research, previous studies and available information about the inclusion of anatomy in undergraduate medical education [12, 13]. The interview started with several general

questions about each participant's medical education and perceived role of anatomy to gain insight into the background of the participants. Thereafter, the interview questions were centred around five topics related to the daily practice of O&G:

1. Relevance of anatomy
2. Motivation to study anatomy
3. Testing of anatomical knowledge
4. (in)Security about own anatomical knowledge
5. Anatomy and imaging

Analysis

Interviews were analysed using a phenomenographical inductive coding approach. Subsequently codes were categorized codes and deductions made about the themes detected, which described and helped to understand the role of anatomy (the phenomenon) in the daily practice of O&G. Interim deductive analyses during this process provided guidance about the interviewing process and the inductive collection of rich and diverse data.

After each interview, two researchers (DK and MV) inductively identified codes and categories separately, after which they met to compare codes and categories and reach agreement. Codes and categories were verified during subsequent interviews until information redundancy was reached. Finally, the entire research group discussed the outcomes of the analysis and the themes detected.

Ethical approval

The Medical Ethics Committee of MUMC+/UM confirmed that the Medical Research Involving Human Subjects Act (WMO) did not apply to the present study and approved the study protocol (METC 2021-2634).

Results

Twelve participants were interviewed, including three gynaecologists and three trainees in Belgium and three gynaecologists and three trainees in the Netherlands. Demographic and education characteristics of these 12 participants are shown in table 1.

The current role of anatomy

The role and significance of anatomical knowledge in the practice of O&G were deduced from the answers to the interview questions. Analysis showed that anatomical knowledge played a role in three domains: 1. during daily activities, 2. for a feeling of self-efficacy and 3. to gain respect.

Table 1. Demographic and education characteristics of the 12 participants

	Country	Gynaecologist/ Trainee	Subspecialty/years of postgraduate education	Female/ male	Type of hospital
1	Belgium	Trainee	3	Female	Non-academic
2	Belgium	Trainee	5	Male	Academic
3	Netherlands	Gynaecologist	MIS	Female	Academic
4	Netherlands	Trainee	2	Female	Academic
5	Netherlands	Gynaecologist	Oncology/MIS	Female	Non-academic
6	Netherlands	Gynaecologist	All round surgery	Female	Non-academic
7	Netherlands	Trainee	5	Female	Non-academic
8	Belgium	Trainee	3	Female	Non-academic
9	Netherlands	Trainee	6	Female	Academic
10	Belgium	Gynaecologist	MIS/and urogynaecology	Male	Academic
11	Belgium	Gynaecologist	Endometriosis and urogynaecology	Male	Non-academic
12	Belgium	Gynaecologist	Urogynaecology	Female	Non-academic

MIS = Minimally Invasive Surgery

1. During daily activities

Knowledge of anatomy is needed in every aspect of the specialty. First, anatomical knowledge is needed in the operating room to safely perform surgery at an adequate speed, and to communicate with and assist trainees and nurses, providing them knowledge about next steps and what to expect. Second, anatomic knowledge is needed in the outpatient clinic to diagnose and examine patients. Third, communication of anatomical knowledge is necessary to explain diagnoses and treatments to colleagues and patients. Finally, anatomical knowledge is crucial to interpret the results of radiological imaging, including ultrasound, magnetic resonance imaging (MRI) and computed tomography (CT).

Quote 1: “Clinical reasoning, setting up a differential diagnosis and asking the right questions. For example, a patient with an anovulation. You have to think about the anatomy to determine the levels of a problem, such as the ovaries, pituitary gland, or hypothalamus. If you do not know the anatomy, you will not be able to determine possible diagnoses and the proper questions to ask to distinguish among diagnoses. Although most diagnoses are easy, less frequently encountered diagnoses require a knowledge of anatomy.” (Dutch gynaecologist)

Quote 2: "For diagnosis, as in a patient with endometriosis. Patient complaints can provide direction to the localization of endometriosis. A good knowledge of anatomy helps inform the patient about the disease and the expected effects of interventions. This results in a well-informed patient, who has better expectations of treatment and additional risks". (Belgian gynaecologist)

2. For the feeling of self-efficacy

Self-efficacy is defined as individual's belief in his or her ability to succeed in specific situations or to accomplish specific tasks. Self-efficacy can play a major role in how an individual approaches goals, tasks and challenges [14]. A good knowledge of anatomy provides feelings of confidence and certainty. Doctors with this level of confidence are not afraid of difficult situations or complications because they know they can rely on their anatomical knowledge. Self-efficacy in anatomy also results in increased diligence and shortens learning curves.

Quote 3: "When you have a good knowledge of the anatomy you will be inclined to search for important structures, preventively dissecting certain structures to work more safely. When you perform surgery on patients with serious endometriosis, it is important to know the relevant anatomy and not be afraid of structures. So, you visualize and dissect these structures preventively." (Belgian gynaecologist)

Quote 4: "It is not necessary to perform 50 hysterectomies before you are able to perform one on your own. You need to know anatomy thoroughly and possess some surgical skills. If you have those two, you will be able to perform a hysterectomy on your own after three or four times. But it all starts with knowing anatomy." (Dutch gynaecologist)

3. To gain respect

Doctors with more anatomical knowledge are more respected. Colleagues regard a broad knowledge of anatomy as an expression of creativity and experience. Doctors with good knowledge of anatomy are regarded as able to perform more complex surgeries, to be better prepared, to be more diligent and to be able to think beyond usually encountered diagnoses and pathophysiology. Although all participants agreed that a good doctor requires more than anatomical knowledge, they regarded less detailed knowledge as associated with doctors who are less informed and take more risks.

Quote 5: “In my opinion a doctor with more anatomical knowledge is more respected. I really look up to people with good knowledge of anatomy. It suggests a broader spectrum of knowledge in general. That they can look beyond the obvious and not overlook any detail in patients with more difficult pathology.” (Belgian trainee)

Quote 6: “I think I will rate somebody with good knowledge of anatomy higher than myself, because I think he/she will be able to perform more complex surgery.” (Belgian gynaecologist)

Acquisition of anatomical knowledge

The acquisition of knowledge is possible through several sources, starting with, for example, lectures, e-learning, and practical courses in medical education. During postgraduate medical education knowledge of anatomy can be obtained during daily activities, from formal courses and from self-study. Use of these sources and knowledge acquisition is influenced by self-motivation. Analysis of the interviews showed that this self-motivation to learn anatomy is affected by both facilitating and hampering factors.

Facilitating factors include 1. responsibility, 2. examinations, 3. supervisors, 4. patient problems and 5. new techniques.

1. Responsibility

Increased responsibility is associated with a greater need for anatomical knowledge. However, this realization of the importance anatomical knowledge generally came late during postgraduate training or even after becoming a gynaecologist. Some gynaecologists attain this realization only after encountering patients with complications.

Quote 7: “I think trainees are not fully cognizant of the importance of anatomy. They do go to courses and ask questions, but this is incidental. During daily practice, too little attention is paid to this subject; therefore, trainees do not deem it relevant, regarding anatomy as just a list of difficult names that they have to memorize. Of course, this is not true.” (Dutch gynaecologist)

Quote 8: “After becoming a gynaecologist, I encountered a patient who experienced a complication because I did not really know the course of the ureter and the proper method of dissection. For me, this was the moment that I realized that I could not work like this.” (Dutch gynaecologist)

Most trainees reported that criticism for not understanding or properly treating a complication, disapproval of their supervisor or being asked to leave the operating room for not knowing their anatomy rarely occur. Because of this, they assume that anatomy is not that important. Towards the end of postgraduate education, responsibility increases causing trainees to realize that their actions can result in complications and misdiagnoses, which could have been prevented by better anatomical knowledge.

Quote 9: “Postgraduate education is like undergraduate education, in that criticisms rarely occurred. Having some basic knowledge of anatomy was enough to ‘survive’ in the operating room and during tests. Therefore, trainees invest their time in the things appreciated by their supervisors. However, when you are responsible for a procedure and there is no back up from your supervisor, you start to realize that you need anatomical knowledge to perform the procedure safely.” (Dutch trainee)

Quote 10: “As a trainee you start with easy surgical procedures, and your supervisor solves the complications. As your education continues, you start to realize one day that you are responsible and need to anatomical knowledge to perform surgical procedures safely.” (Dutch gynaecologist)

2. Examinations
Examinations can act as a stimulating factor in several ways. All the interviews agreed that postgraduate education should include more frequent tests of anatomical knowledge. Analysis of the interviews indicated a preference for testing during practice instead of theoretical testing. In general, an examination stimulates individuals to pay attention to the subject and shows that it is important. For trainees this leads to a desire to make time available to study anatomy, thereby enabling trainees to reflect on their knowledge of anatomy.

Quote 11: “When there is an exam you study more than when somebody advises you to read about it. For an exam you really plan time to study, while otherwise it is completely non-binding” (Belgian trainee)

3. Supervisors
Supervisors who pay attention to the subject of anatomy are like exams. They make trainees study anatomy more. This motivation to study comes from a reward point of view, trainees Increased study do not want to fail in front of their supervisor. In addition, drawing attention to this field of study by the supervisor informs trainees of the importance of anatomy.

Quote 12: "When I started performing laparoscopic surgery, a gynaecologist gave me an assignment in which I had to know anatomy; otherwise, I was not allowed to participate. As a result, I really studied hard to know everything I could. And in the end, I realized he was right, that you really need to know anatomy before performing surgery." (Belgian trainee)

4. Patient problems
When encountering more difficult complaints or new diagnoses, both trainees and gynaecologists review the relevant anatomy to find answers and to design treatments.

Quote 13: "Sometimes you face a patient problem that you cannot explain directly. For me it mainly occurs when patients report neuropathic pain. Then I really need to consult anatomy textbooks to look for the course of nerves and their innervation to find answers. So yes, depending on the pathology I am facing, I specifically search for answers in by reviewing the relevant anatomy." (Belgian gynaecologists)

5. New techniques
Both trainees and gynaecologists use anatomical knowledge to get familiar and feel secure with new techniques. In this case, anatomy is used as a guide.

Factors hampering the acquisition of anatomical knowledge include 1. feelings of insecurity, 2. a lack of a reference about essential knowledge and 3. a lack of an efficient/effective way to study.

1. Feelings of insecurity are fed by 2. a lack of a reference about essential knowledge
This leads to a situation in which trainees do not ask question because they think they should possess this knowledge and are afraid to be seen as fools.

Quote 14: "When there is a specific case during the weekly digital ward round and I have questions about the anatomy, I do not dare ask these questions in front of all the gynaecologists. Rather, I make a note to myself because I do not want to look like a fool in front of everybody. However, by the time I get home I feel like other things are more important to study and I end up forgetting to look the answers to my questions." (Belgian trainee)

Quote 15: "I do not know what knowledge level is expected because there are almost no exams and during daily practice I am barely asked about my anatomical knowledge. This lack of a reference makes me insecure." (Dutch trainee)

3. Lack of an efficient/effective way to study
Trainees report that they find it hard to find the right sources, which is partly due to the lack of a reference. Anatomy atlases show many details and surgical procedure movies mainly focus on steps rather than anatomy. Therefore, trainees who study the surgical steps on the basis of anatomy find it hard to make the translation from 2D images to 3D clinical practice.

Quote 16: "I try to review the relevant anatomy in preparation for an operation. For example, at the moment I am doing the urology part of my training. I therefore try to study the anatomy of the pelvic floor. But it is all self-study, as there is no guide on what to know. Sometimes I find this difficult. You can look at anatomy textbooks that we all know, such as Sobotta and Netter. However, anatomy encountered during actual surgery looks different than the anatomy shown in these books. That I find difficult." (Belgian trainee)

Discussion

This explorative qualitative study showed that anatomical knowledge and use is not just there because we are used to it, but because it plays an important role in the practice of obstetrics and gynaecology from utility perspective.

Specifically, current anatomical knowledge played a role in three domains: 1) during daily activities, such as performing surgery, consulting and communicating with patients and colleagues, and interpreting the results of radiological imaging; 2) in enhancing a feeling of self-efficacy, defined as an individual's belief in his/her ability to succeed in specific situations or accomplish tasks; and 3) in gaining respect as a physician.

Our study also provided insight into the process of acquisition of anatomical knowledge. Our results showed that this process is negatively affected by the late realization of the important role of anatomy. Where motivation was central to the process of acquiring knowledge.

Interpretation and implications
Our finding, that motivation plays a central role in the acquisition of knowledge, is consistent with the Theory of Reasoned Action (TRA). The TRA hypothesizes that an individual's decision to engage in a particular behaviour, acquisition of anatomical knowledge in this case, is based on the outcomes the individual expects will result

from this behaviour [15]. The determinants of this behavioural intention are people's attitudes and norms [16]. The facilitating and hampering factors identified in this study may be related to these attitudes and norms and can therefore influence the process of knowledge acquisition.

Both, gynaecologists and trainees report that increased responsibility was associated with the realization of the need for anatomical knowledge. Mainly because of the fear of making complications or worse, afterwards after the complications have already been made. Concerns about the association of a lower level of anatomical knowledge with reduced patient safety and the rise in medico-legal claims exist already for long time [17-19]. Nowadays patient safety is regarded as of paramount importance. Therefore, increased knowledge of anatomy should be a high priority. Because of the lack of attention to anatomy during postgraduate medical education, trainees think anatomy is not important [17]. For example, when performing surgery, trainees are mainly judged by their knowledge of the procedure and the execution of its steps. Trainees, however, reported that they were rarely asked about what structures they encounter or the risks encountered during each step of the procedure.

So, a first step in the process of knowledge acquisition should be to gain more attention to the importance of anatomy from the start of postgraduate education. Since anatomy is everywhere in the daily practice of O&G, although often not emphasized, it won't require rigorous changes.

Attention to anatomy and the motivation of trainees to learn anatomy may be enhanced by increase responsibility earlier in postgraduate education, including responsibility for complications.

Reversing the postgraduate medical educational process, from performing a procedure based on known steps, to performing a procedure based on anatomy will better emphasize the importance of anatomical knowledge. Simultaneously with gaining attention to anatomy and the importance of anatomy knowledge, knowledge of anatomy can be increased by informal and formal testing and by providing trainees a reference of what they are expected to know. Supervisors should discuss the relevant anatomy before starting a procedure, pose questions to trainees about blood- and nerve supply during the surgery, and discuss possible complications in reference to anatomy.

After gynaecologists and trainees are motivated to learn anatomy, it is important to optimize the learning process. Two important hampering factors were encountered: the lack of an effective way to study due to the difficulty of translating 2D images to 3D anatomy in clinical practice and feelings of insecurity. The problems translating 2D images to 3D clinical practice have also been encountered in undergraduate medical education [20-22]. These difficulties may be overcome by several new techniques, including augmented reality, virtual reality and games [23]. Active learning techniques generally result in greater acquisition and retention of knowledge than passive methods [24]. More specifically, when compared with traditional methods such as cadavers and mannequins, virtual and augmented reality techniques were found to improve students' anatomical learning skills and long-term retention of knowledge of gross anatomy [25, 26]. Most studies of anatomic knowledge during postgraduate training have focused on improving surgical skills rather than on acquisition of knowledge [24, 27]. However, a randomized intervention-controlled clinical trial found that immersion of orthopaedic surgeon trainees in virtual reality not only improved their learning efficiency, but also improved their knowledge and skill transfer [28]. Thus, these new techniques, provided that they are presented with the right references, can not only help to overcome the problem of translation of 2D images to 3D clinical practice and create an effective way to study anatomy, but can also play a role in shortening the learning curve for surgical skills, thereby reinforcing self-efficacy.

The second hampering factor, a feeling of insecurity or uncertainty, is frequently encountered in healthcare. Uncertainty compromises multiple meanings, partly depending on the issue addressed. An individual's uncertainty about his/her knowledge, as in our results, can be best described as a subjective, cognitive experience, with uncertainty being a form of metacognition – a knowing about (not) knowing [29]. This uncertainty reported by our interviewers seemed largely fed by the lack of a reference and a fear of losing face. A Delphi study on the need to know knowledge provided a core list of 86 structures essential for safety and competency [13]. This list can serve as a reference and might help trainees to overcome this aspect of their uncertainty. Furthermore, as in every teaching-learning environment, it is important that trainees feel safe to learn and ask questions.

Strengths and limitations

By including gynaecologists and trainees from two neighbouring countries with different medical and teaching cultures, this study ensured a rich input on the topic of anatomy in daily practice. This study not only addressed the current role of anatomy in O&G, but also provided insight into the acquisition of knowledge, leading to suggestions for improvements in the postgraduate training of O&G. The design of the study and the phenomenographical inductive analysing approach enabled the researchers to provide the analysis with a theoretical foundation without being restricted by it.

As the study was limited to just one discipline (O&G), the findings may not be directly applicable to other medical specialties. The generalizability of the present results can be increased by performing similar studies in other medical disciplines.

Conclusion

The results of this study showed that anatomical knowledge plays an important role in O&G medical practice from the perspective of utility. Because the importance of anatomical knowledge was not recognized until late in postgraduate training, it could negatively affect knowledge acquisition and have a negative impact on patient safety. Trainees need a reason to acquire anatomical knowledge early in their curriculum. A change in the way trainees are motivated and innovations in teaching methods may optimize this process of knowledge acquisition, with the overarching goal being to educate doctors who work safely and with a high degree of self-efficacy.

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8

General discussion

General discussion

This thesis examined *what is known* about anatomical knowledge of medical students and trainees in obstetrics and gynaecology (O&G); and *what should be known* about anatomy according to the daily practice of a gynaecologist to ensure safe and competent practice.

In this chapter, I will discuss the results of this thesis and propose future directions, *i.e., the unknown*.

The contradiction between the importance and the acquisition of anatomical knowledge

Anatomical knowledge facilitates the learning of pathophysiology, supports the examination of a patient, facilitates reaching a diagnosis, and contributes to the communication of these findings to the patient and other medical professionals [1]. A description like this suggests that anatomy is important for medical education. From the literature it is known that, indeed, students at all stages of their medical training consider anatomy to be important. However, students also admit that they have, on average, insufficient anatomical knowledge [2-4].

In **chapter 2** of this thesis we confirm that almost 80% of the students consider anatomy very important or extremely important. Nevertheless, students spend relatively little time studying anatomy. In addition, in **chapter 7,** we show that also gynaecologists and trainees in O&G recognize the importance of anatomical knowledge in the practice of obstetrics and gynaecology from a utility perspective. Trainees experience this important role only late in postgraduate education or once they are gynaecologists. This late realisation is also reflected in their knowledge, which is below the level we expected it to be (**chapter 6**).

This is an interesting contradiction; anatomy and anatomical knowledge is considered important. However, those involved feel that their knowledge is insufficient, but they do not invest time to improve it.

> *How to dwindle the gap between the importance of and the investment in anatomical knowledge?*

The self-directed learning perspective

An explanation for this contradiction in importance of and the investment in anatomical knowledge might be found from the perspective of self-directed learning theory of adult learning. There are many different ways of explaining how adults learn and none of the theories fully explain what is happening when an aspiring health professional is engaged in learning [5]. In general, learning includes the acquisition of three domains: knowledge, skills, and attitudes. Self-directed learning is defined as a learner who takes the initiative for their own learning [6], a life-long learner, one that identifies their own learning needs and seeks to address those needs. If we look at this self-directed learning theory for the contradiction in anatomical knowledge, it seems that the needs are identified but not met and that the 'task' anatomical knowledge has entered the dissonance phase where the learner's existing knowledge is challenged and found to be incomplete. There are several factors that influence whether the learner will engage with the dissonance phase. So, if we want to understand the contradiction and improve the anatomical knowledge, perhaps we should look at those factors that are required to perform a task and whether they are fully fulfilled.

Is there sufficient foundation to build on?
The entire learning process starts with what a learner already knows, followed by the encouragement to articulate this prior knowledge. Learning is the process of constructing new knowledge on the foundations of what one already knows. But, what if the foundation is insufficient? With the reduction in hours anatomy teaching and anatomy being intertwined in case histories it might be more difficult for students to gain adequate anatomical knowledge, meaning it will be harder to construct new knowledge, ending up in a vicious circle.

Resources for learning
To complete a task, *i.e.,* gaining anatomical knowledge, one should consider the resources. Where resources can be divided in time and physical resources such as books, e-learnings, and, movies. In this context, time means sufficient time to study, evaluate, and assess the task. The majority of the students do not find anatomy attractive to study and do not invest much time in it (**chapter 2**). This cannot be fully attributed to the physical resources, since there are many attractive options to study anatomy. On the internet several courses of online dissection and/or interactive anatomical and surgical live-stream lectures can be found. If it is not about the physical resources, is it about the factor time? In general, time is precious and it is invested in subjects which are worth it, in terms of appreciation or needed to survive. Translated to the subject of anatomy, this might suggest that students and trainees do not invest time in it because

they think that they can survive with just a little anatomy knowledge and/or the subject is insufficiently appreciated. **Chapter 7** refuted the idea that O&G trainees think that they can survive with a minimum of anatomical knowledge. The literature, as well as this thesis (**chapters 2,6, and 7**), confirm that there are (indirect) signs that the factor time is not fully utilized in terms of appreciation, teaching hours, and evaluation. A study performed in acute NHS hospital trusts in England showed that only eight of the 95 responding trusts offered anatomy teaching to junior doctors. These eight acute hospital trusts offered a mean of 2.3 (SD 1.0) hours anatomy teaching in the first year and a mean of 2.7 (SD 2.0) hours in the second year of the training [7].

In conclusion, looking at the resources, the factor time seems to be an impairment due to minimum hours of anatomy teaching and the appreciation students and trainees experience for having anatomical knowledge.

The context of learning anatomy
Context in medical education can be categorised in three contextual dimensions of learning. The physical dimension of context which pertains to the environment in terms of the learner's physical environment. The cognitive dimension, where the knowledge of the learner and the information in the context which can be used to perform a task align. The commitment dimension covers all aspects of context that affect a learner's motivation for a learning task [8].

In the postgraduate training of obstetrics & gynaecology, the physical dimension is usually the clinic. The cognitive dimension is about knowledge application, and needs to be exploited in this physical environment. To gain knowledge and subsequently apply this knowledge, it is important that the learner develops the ability to construct meaning [5]. The literature shows that improvements can be made here. Focus groups with medical students showed that they perceive anatomy as learning the names of structures without paying any attention to how structures are related to clinical signs and symptoms [9, 10].

Creating or emphasizing situations where anatomical knowledge can be applied, and challenging students to do so, will construct meaning and can make a positive contribution to their anatomical knowledge. Examples are explaining a symptom or complication from anatomical perspective, or name which blood vessels and nerves are involved in a certain organ or procedure during surgery.

So, the educational environment should offer context to connect anatomy knowledge to the task.

Motivation

The learner's motivation is another important factor for successful self-direct learning. Motivation can range from a lack of motivation through extrinsic motivation to intrinsic motivation. Intrinsic motivation is associated with better learning, better conceptual understanding, better academic performance and achievement, and higher levels of well-being [11]. Considering this, you want to achieve or at least know if students and trainees are internally motivated to gain anatomical knowledge. The self-determination theory can help to understand and influence motivation. This theory is based on the principle that humans are growth-oriented and naturally inclined to develop, internalise, and integrate psychic elements to build an integrated and unified sense of the self [12]. Three innate psychological needs are central in this theory: the need for autonomy, a need for competence, and a need for relatedness. Intrinsic motivation requires satisfaction of those needs [11]. How can this be realised taken the task 'gaining anatomy knowledge' into account?

In short, autonomy includes the free will to choose whatever a person desires or considers useful to do. If we want to support autonomy we have to anchor that students and trainees not only think anatomy is useful but that they also experience it is useful. Feedback and entrusting professional activities (EPA) can play a role here. Feedback is essential to build a self-image of strengths and weaknesses, whereby it is important to use the right constructive approach [13]. One can think of feedback on an operation performed where a trainee is asked about the structures involved in specific steps. EPAs make it possible to grant full responsibility to trainees for specific tasks in which they have demonstrated mastery. It is the responsibility that generates a sense of competence, autonomy, and, relatedness. This is also seen in **chapter 7**. Last year trainees and gynaecologists acknowledge that with increasing responsibility, the need for anatomical knowledge increases and leads to studying anatomy. By paying attention to anatomy during feedback moments, to anatomy a student or trainee gains insight in their knowledge. By providing responsibility, the internal motivation will be encouraged. Resulting in an internally motivated approach to gain anatomical knowledge. Another option, without the involvement of patients, is near-peer teaching. A student or trainee placed in the position of a teacher of near-peers experiences a different relation with them. Acting as a relative expert will generates feelings of competence, relative autonomy to determine what and how to teach and esteem which can motivate to spend further energy in studying [14]. Recapitulatory, by creating a teaching/clinical environment in which students and trainees are intrinsically motivated to study anatomy can narrow the gap between the importance of anatomy and anatomical knowledge.

Development of the learner

Another factor to consider is the development of the learner. For a doctor it is not enough to just know the right answer in a perfect situation. It is necessary to understand why the answers are right and how they are determined by the circumstances. To achieve this, a development in the approach of learning is needed. In general, medical students are moving from an approach based on duality towards multiplicity [15]. This is not only about acquiring knowledge (surface learning) but also about being able to interpret and use knowledge. For this, an understanding of where things fit is necessary. The latter might be an attributable factor in the contradiction between anatomy importance and anatomical knowledge. In **chapter 7** we show that there is a late realisation of the need for anatomical knowledge to perform good surgery and avoid or solve complications. From the perspective of the development of the learner this might be due the absence of an understanding where things fit. So, in the development of the learner, he/she must be able to attribute meaning to knowledge to apply this knowledge.

In conclusion, from the perspective of the self-direct learning theory it seems that with the current educational environment students and trainees are not fully capable of applying self-direct learning when it comes to anatomy.

The change management perspective

Another perspective in which answers could be found to the contradiction in anatomy importance and (investment in) anatomical knowledge is that of change management. Are changes in education insufficiently implemented when it comes to anatomy? To explore this option, we take a look at the eight steps model in change management of Kotter [16]. Shortly, the change process goes through a number of stages, each lasting a considerable period of time and commitment, and critical mistakes in any of the stages can have an impact on the change process. The eight steps can be clustered into three 'stages': generating, consolidating, and anchoring.

Generating stage

The first step is *establishing a sense of urgency*. The need for anatomical knowledge is emphasized in the literature and in this thesis (**chapter 7**). Thereby **chapter 6** shows that the anatomical knowledge of trainees O&G is below the expected level. However, those trainees are not suspended. The same accounts for medical students; their knowledge is tested in exams which tests knowledge of all kind of fields, but there are no consequences when they answer all the anatomy questions wrong [4].

The direct consequences for practice are less clear and not well researched. Much of the available literature focuses on opinions and reasoned consequences [17-19]. There are a few articles about the relationship between less anatomical knowledge and litigation [3, 20].

A way to create a sense of urgency is with assessments. For anatomical knowledge a variety of assessment tools are available like multiple-choice exams, oral exams, or structured practical exams. These tools reflect the three domains of anatomical training: theoretical knowledge, practical 3D application and clinical/bedside application of this knowledge [21].

The assessment of knowledge is underexposed in postgraduate training, particularly outside the Anglo-Saxon countries. Assessments taken are mainly focused on practice instead of knowledge [22].

Translated into the Dutch postgraduate education of obstetrics & gynaecology, these different forms of assessment are expressed in formative workplace-based assessments, reports of the in-training assessments with the educational supervisor, and the results of the mandatory progress test. During formative workplace-assesments the focus is on surgical performance, hence questions about anatomical knowledge are rarely asked (**chapter 7**).

This first step of establising a sense of urgency seems to be partly taken and can be further enhanced by formal and informal assessment of anatomical knowledge.

Step two is *forming a powerful guiding coalition* which should be based on three key values: level of trust, shared objective, and a right composition. With the changes in medical education we stepped back from traditions in basic science. Meaning that people in charge of the curriculum development gave other subjects more priority, *i.e.,* there is not a shared objective when it comes to anatomy in medical education. There are many people who are concerned about the anatomical knowledge, but it seems that those people do not have the influence to change the educational system when it comes to anatomy [4, 17, 23-26]. Those people have a shared objective, but not the right composition to make a change.

The third step is *creating a vision*. A vision helps to clarify the direction and refers to a picture of the future. Medical education has a clear vision: educating students to become health professionals who perform their work safe and competent. For anatomy, a vision can be understood as 'need to know' knowledge. In the UK, the Council and the

Education Committee of the Anatomical Society have compiled guidelines anatomical knowledge for medical education [27]. The Medical Royal College of Obstetrics and Gynaecology (MRCOG) also provides a description of anatomy requirements, although these are quite vague. *E.g.,* 'surgical anatomy of the abdomen and pelvis'. In the Netherlands or Europe-wide we are missing such a guideline [28, 29]. One can imagine without a clear path or goal, attempts to teach and learn anatomy can easily go in the wrong direction or go nowhere.

In **chapters 4 and 5** we provide a national and international list of structures which are essential for the safe and competent practice of a general gynaecologist when it comes to anatomy, this list of structures can be seen as the vision.

So, while it may have been a misstep in the past, there is a vision available for the future, at least for the O&G postgraduate training.

The fourth step is *communicating the vision*. There are numerous formal and informal possibilities to communicate a vision. A formal option is the curricular plan, whereas an informal option includes the educators and supervisors who can communicate anatomical learning goals.

Consolidating stage

Assuming all previous steps are met, barriers can now be viewed now (step 5). **Chapter 7** describes barriers encountered when it comes to the acquirement of anatomical knowledge: feelings of insecurity, a lack of a reference about essential knowledge and a lack of an efficient/effective way to study. The feeling of insecurity requires a learning climate where trainees feel safe to learn but also to fail, to ask questions and were uncertainty is tolerated. The first barrier is discussed at step three and should no longer be a barrier, at least for the O&G postgraduate training. The latter is discussed above with the self-directed learning perspectives and seems to take time and motivation above all.

Step six includes *short term wins*. Those wins can be achieved using just-in-time learning. This means, the right educational modality, given to the learner at the right time, at the right location, and exactly the amount of time needed. When a student or trainee learns anatomy, they adapt it immediately and by experiencing the benefit, there will be short-term gains. An example can be watching an instruction video on uterine artery dissection prior to a hysterectomy and then performing this step during the actual surgery.

Consolidating improvements is step seven. In the end it is not about a high mark but about safely and competently practicing the practice as a doctor. Several tools to achieve consolidation are available. One tool is repeated learning. In most medical schools, anatomy is taught in de preclinical years. For postgraduate education, the amount of anatomy teaching depends on the specialty and education might be more informal. Formal education is scarce (**chapter 7**) [7]. Another tool might be teaching other students or trainees. This is the highest level in the knowledge pyramid, it shows deep understanding and provides repeated learning in the same time. Consolidation will also be achieved when new situations arise where students and trainees need to apply the knowledge they possess. A last option can be the assessment of anatomical knowledge. Like formal teaching, the assessment of anatomical knowledge is scarce (**chapter 6**). When not only in the preclinical years, but also in every clinical and postgraduate year, anatomy education and assessment are intertwined, it can help to consolidate anatomical knowledge.

Anchoring stage

The last step is *anchoring new approaches in the culture and making change stick.* The change turns into a culture when new forms become the way of doing business. When all the above steps are met, a culture will emerge in which the change is anchored.

In conclusion, from the change management perspective, it seems that not all of the eight steps from Kotter's model have been identified and/or implemented. This may underlie the contradiction between anatomy importance and the acquisition of anatomical knowledge.

Recommendations

Time is precious and needs to be divided over many subjects in medical education, but anatomy is certainly one of them. To optimise the process of gaining anatomical knowledge we should create a learning climate in which the internal motivation of the student and trainee are maximally supported. This can be achieved by assigning responsibility, providing constructive feedback on anatomical knowledge, and introduce near-peer teaching.

It is important that separate anatomy teaching becomes part of medical education again. And in doing so, the available daily sources such as imaging, patient problems, and surgery should be used, so that anatomical knowledge is placed immediately in context and given meaning. Making this change and closing the gap requires not only a motivated student and trainee, but also a motivated supervisor. This should have the attention of those who are responsible for the curriculum.

Future perspectives

This thesis revealed contradictions and leads to improvements in anatomy education in the postgraduate education of obstetrics & gynaecology, but it also left unresolved questions and new questions. We identified which structures are necessary to know for a safe and competent practice of a general gynaecologist.

What we don't know is to what extent those structures should be known. Do trainees need to be able to recognize those structures? Should they be able to recall their vascular and nerve supply? Should they be able to describe their embryological origin?

The question of how much anatomical knowledge is enough, is still not fully answered. Further research into the consequences of the anatomical level of knowledge level for practice may provide an answer to this. Thereby it is important to consider different perspectives such as those of patients, claims, program directors, and trainees.

When we know to which extend those structures need to be known ('what'), we can focus on the teaching method ('how'). For anatomy there are several methods of teaching and learning anatomy available. Dissection has been the primary method of teaching anatomy for over 400 years and has advantages that are not easy to match. It enhances active and deep learning and prepares for clinical practices in several ways [30, 31]. However, it is also time consuming, costly, and not suitable for demonstrating the skeletal anatomy, for example [32]. This means thinking thoroughly who will benefit most from dissection. Trainees obstetrics & gynaecology, especially those with surgical aspirations, might be a group where the pros outweigh the cons. A less expansive, alternative is education with prosected specimen. While progress primarily occurs at the site of the organisation because fewer cadavers are needed and it can be used more than once, trainees can view more anatomical variations in different specimens and saves time as structures and their relations are easy to observe [32]. An upcoming method is computer-based learning (CBL). CBL includes three-dimensional (3D) representations of anatomical structures, virtual reality, augmented reality, and 3D visualization glasses. It is known that obtaining adequate spatial understanding of 3D anatomy from two-dimensional (2D) images is difficult [33, 34]. In addition, medical students as trainees experience difficulties in recognizing anatomy in the clinical setting[35]. Therefore, it seems reasonable that these methods can be useful in obtaining anatomy knowledge. A review showed that most participants prefer to learn anatomical structures using a 3D tool. Other advantages of this method are the flexibility of the source and the stimulation of independent learning [36]. At the same time, however, the evidence that 3D learning methods alone are more effective in means of learning anatomy is heterogeneous [37]. So probably CBL can enhance learning by supplementing rather than replacing the traditional teaching methods [38]. Other methods which can be used or better exploited in the postgraduate education of obstetrics & gynaecology trainees are medical imaging and living anatomy. Ultrasound is used daily by every trainee; computed tomography (CT) and magnetic resonance imaging (MRI) slightly less frequent, but still weekly. Medical imaging provides in vivo visualization of anatomical structure and physiology as well as insight into pathological processes [39]. Given the living anatomy, this can be applied during surgery. One can actually feel the texture of a structure, see the 3D relations between structures, encounter anatomical variation, and discover routes to find structures. By becoming aware or these educational possibilities, an accessible, daily available teaching for anatomy is created in the postgraduate education of obstetrics & gynaecology. However, a teacher, *i.e.,* supervisor, is needed who is willing and able to teach the trainee at those times and repeated learning is needed to anchor the knowledge.

Summarising, there is no consensus in the literature on how anatomy is taught in the most effective way [40]. Future research should focus on the combination of teaching methods to obtain anatomical knowledge in the most effective way.

Lastly, in line with this research, a similar path can be followed for the different subspecialties within obstetrics & gynaecology and other specialties to define essential knowledge for their disciplines.

Concluding message

Anatomical knowledge is important for medical education and postgraduate education of obstetrics & gynaecology from a utility perspective. The time invested in teaching and studying anatomy is disproportionate to the value placed on anatomy. However, the claim that the anatomical knowledge of students and doctors in general is alarmingly low could not be proven. We did show that the level of anatomical knowledge of trainees' obstetrics & gynaecology is below the level we had expected. Further research is needed to determine what impact this has on daily practice. However, we do, provide facilitating and hampering factors for obtaining anatomical knowledge in daily practice. These can be used to improve the anatomical knowledge of trainees' obstetrics & gynaecology.

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9 Summary

Summary

In **chapter 1** we discuss the development in anatomy teaching over the past century. Traditionally, anatomy served as a leading science in the founding of medical schools mainly from a deontological stance. This stance implies that an action is considered morally good because of some characteristics of the action itself, not because the product of the action is good. During the century a more utilitarian stance got the upper hand, meaning that right and wrong are determined by focusing on outcomes and usefulness, and problem-based learning (PBL) was introduced.

PBL is a process that uses identified issues within a scenario to increase knowledge and understanding. It follows a constructivist approach to learning where students activate prior knowledge and build upon existing conceptual knowledge frameworks. The idea is that concepts or information from basic sciences are recognized by students and studied as learning objectives. Though, critics question the ability of students to ask the right questions to uncover the scientific basis of the problems. Critics' concerns regarding PBL and basic sciences were supported by feedback from the field. Program directors, medical doctors and trainees claim to be worried that medical students and trainees are ill-prepared in anatomy when entering the clinical part of their education. Medical students and trainees themselves feel insecure and concerned that their anatomical knowledge is not sufficient for clinical practice since PBL was introduced. In addition, around the year 2000 a 7-fold increase is reported in claims related to anatomical errors submitted to the Medical Defence Union of the United Kingdom.

The question arises as to whether the changes in medical education over the past century may have gone too far when it comes to basic sciences such as anatomy. Should we overthink our medical education to find the right balance between theory and practice?

The overall objective of this thesis is to provide insight in the different aspects of anatomy knowledge and acquisition of anatomy knowledge.Part I of this thesis aimed to determine how medical students learn anatomy and what is known about the level of anatomy knowledge in general. Part II focusses on anatomy in the speciality obstetrics and gynaecology. We aimed to define what is need-to-know knowledge for a general gynaecologist, the level of anatomical knowledge and the use and acquisition of this knowledge in the daily practice. We approach the role of anatomy from the principle of utility.

Anatomy is seen as one of the basic pillars of medical education and gaining sufficient anatomical knowledge seems indispensable for a medical doctor. Factors that can influence how well students learn anatomical structures include available sources, learning time and study assistance. In **chapter 2** we explore the attitude and appreciation of medical students for studying anatomy at different phases of their training. A focus group was used to develop a questionnaire. Five principal themes were featured in the questionnaire: 1) importance of studying anatomy, 2) appreciation for studying anatomy, 3) assessment of the student's own knowledge, 4) learning tools that could be used to improve anatomical knowledge, and 5) attitude about studying anatomy in the bachelor phase compared to that in the master phase. The study showed that 78,7% of the students considered it very or extremely important to have a solid knowledge of anatomy. Of the master students, 68,8% found anatomy education more important in their current training phase compared to their bachelor phase of the curriculum. Although they consider it important, the majority do not find anatomy attractive to study and students spent a relatively little time on studying anatomy. Almost all students (92,7%) use anatomical textbooks as a learning source. Ideally, they would like to use more three-dimensional tools related to a clinical scenario to make studying anatomy more attractive.

Chapter 3 describes what is known about measured anatomical knowledge. As the ongoing debate about the level of anatomical knowledge seems to be mainly based on opinion, a literature review was conducted to gain more insight into the level of anatomical knowledge based on published measurements among medical students, trainees, fellows and specialists. Thirty relevant studies were found. In these studies participants took a variety of anatomy tests, varying from identification of labelling structures, multiple choice formats and open-ended questions. The scores ranged from 22,5% to 82,4%. The main conclusion after critically reviewing the literature is that the level of anatomical knowledge is hard to establish, mainly due to the lack of standardization in the way anatomy is tested. In addition, it's unknown how much anatomy is actually required for safe clinical practice.

Obstetrics and gynaecology (O&G) is a broad and diverse branch of medicine, including surgery and diagnostic imaging. Therefore, an adequate understanding of anatomy can be considered to be particularly important in the field of O&G. In **chapter 4** we aimed to define the anatomical structures that should be taught to ensure safe and competent practice among general gynaecologists. The Delphi method was used to answer the research question. At the start of the Delphi process a list of 123 items, conducted through focus groups and interviews, was send to 60 gynaecologists and O&G trainees in the Netherlands. The panellists scored the items on a Likert scale between 1 (not relevant) and 5 (highly relevant). Consensus was defined when ≥ 70% of the panellists scored the item as relevant or very relevant and the average rating was ≥ 4. After two rounds 86 structures were identified as relevant to the safe and competent practice of a general gynaecologist. Those structures can be used to guide gynaecology postgraduate training.

Chapter 5 presents the international validation of the above described Dutch Delphi study. Worldwide trainees are educated to become skilled, competent gynaecologists. Every country has its own curriculum, which not only differs in length but also in structure and content. It is known that the difference in length does not influence the surgical skills or cognitive knowledge, but that difference in content can influence the quality of care. Therefore, it seems reasonable to aim for an international speciality-specific standard to guarantee a high quality of care and patient safety worldwide.

A total of 192 surveys were filled out with panellists from seven countries (Belgium, Germany, Norway, Oceania, Sweden, United Kingdom and United states). Out of the 123 initial structures, a total of 72 (58,54%) were internationally found to be relevant. When the 86 relevant structures derived from the Dutch Delphi study were compared to the 72 relevant structures from the international Delphi, 70 structures (81,4%) matched. With diminishing time and resources devoted to anatomical education, defining what is essential knowledge helps to provide a sufficient knowledge base. The results of this study can be used to standardize and guide gynaecology postgraduate training worldwide.

After we defined what essential knowledge is for the safe and competent practice of a gynaecologist, we assessed the anatomical knowledge level of Dutch trainees in O&G in **chapter 6.** We hypothesised that trainees possess a good knowledge of anatomy and would correctly answer at least 80% of the questions on the previously defined essential structures in an annual progress test. The anatomy questions from the annual progress test from 2010 to 2019 were analysed. Over a 10-year study period, there were 54 anatomy-related questions out of a total of 1637 questions (3,3%). Of these 54 questions, 38 (70%) were concerned with essential structures that are included in the Delphi list. The overall correct response rate of the year 4-6 trainees was 64,5%. This correct response rate was lower than we expected. These results increase awareness of the importance of testing and improving anatomy knowledge of postgraduate O&G trainees.

In **chapter 7** we present an explorative qualitative study to analyse the role and significance of anatomy in the daily practice of O&G, and the relationship between the importance of anatomy and the acquisition of anatomical knowledge. Semi-structured interviews with gynaecologists and O&G trainees from Belgium and the Netherlands were used to answer the research question. After 12 interviews we concluded that anatomical knowledge plays a role in O&G practise: 1) during daily activities, 2) in the feeling of self-efficacy, 3) in gaining a respected name as a doctor. This realization seems to come quite late during postgraduate training or even while being already a gynaecologist. Motivation plays a central role to which extent anatomical knowledge is obtained. In addition to motivation, we also found facilitating factors such as supervisors, patient problems, exams and hampering factors, such as feeling of insecurity and lack of a reference about essential knowledge. This information can be used to optimise anatomy education with the overarching goal to educate future gynaecologists who work safely and with a high degree of self-efficacy.

In **chapter 8** we discuss how to dwindle the gap between the importance of and the investment in anatomical knowledge.

We recommend to optimise the process of gaining anatomical knowledge by creating a learning climate in which the internal motivation of the student and trainee are maximally supported and where anatomy is taught more explicit.

Future research should focus on how this essential knowledge can best be addressed to the O&G trainees and investigate the consequences of the anatomical level of knowledge for practice in order to answer the question how much anatomy is enough.

10 Nederlandse samenvatting

Samenvatting

In **hoofdstuk 1** bespreken we de ontwikkelingen van het anatomieonderwijs in de afgelopen eeuw. Traditioneel was anatomie een van de basispijlers binnen het medisch onderwijs, voornamelijk vanuit een deontologisch standpunt. Deontologie houdt in dat een handeling als moreel goed wordt beschouwd vanwege een aantal kenmerken van de handeling zelf, niet omdat het product van de handeling goed is. In de loop van de eeuw kreeg een meer utilitaire houding de overhand, wat inhoudt dat goed en kwaad worden bepaald door te focussen op resultaten en bruikbaarheid, en werd probleemgestuurd onderwijs (PGO) geïntroduceerd.

PGO is een actieve leervorm waarbij geïdentificeerde problemen binnen een scenario gebruikt worden om kennis en begrip te vergroten. Het volgt een constructivistische benadering van leren waarbij studenten hun eerder opgedane kennis activeren en voortbouwen op bestaande conceptuele kenniskaders. De gedachte hierbij is dat kennishiaten met betrekking tot de medische basisvakken van de geneeskunde zoals anatomie, fysiologie en pathologie, door studenten wordt herkend en bestudeerd. Critici twijfelen echter aan het vermogen van studenten om binnen het proces van PGO de wetenschappelijke basis van de problemen te achterhalen en te bestuderen. De zorgen van critici over PGO en het opdoen van kennis in de basisvakken worden ondersteund door signalen uit de praktijk. Opleiders, artsen en arts-assistenten geven aan bezorgd te zijn dat geneeskundestudenten en arts-assistenten slecht voorbereid zijn als het op anatomie aankomt, op het moment dat ze het klinische deel van hun opleiding ingaan of op de werkvloer starten. Geneeskundestudenten en arts-assistenten voelen zich onzeker en bezorgd dat hun anatomische kennis niet voldoende is voor de klinische praktijk. Daarbij wordt op medico-legaal gebied gezien dat er rond het jaar 2000 een zevenvoudige toename werd gerapporteerd van claims met betrekking tot anatomische fouten.

De vraag die dit oproept is of de veranderingen in het medisch onderwijs in de afgelopen eeuw niet zijn doorgeslagen als het gaat om basisvakken zoals anatomie. Moeten we ons curriculum van de medische opleiding herzien om weer de juiste balans te vinden tussen theorie en praktijk?

De doelstelling van dit proefschrift is om inzicht te geven in de verschillende aspecten van anatomische kennis en het verkrijgen van anatomische kennis. Deel I van dit proefschrift heeft tot doel vast te stellen hoe medische studenten anatomie leren en wat er bekend is over het niveau van anatomische kennis in het algemeen. Deel II richt zich op anatomie binnen het specialisme obstetrie en gynaecologie. Het doel hierbij is om te definiëren wat voor een algemeen gynaecoloog vereiste kennis is, wat het kennisniveau is gekeken naar deze vereiste anatomische kennis, en hoe anatomie wordt gebruikt in de dagelijkse praktijk. Hierbij benaderen we de rol van anatomie vanuit het utiliteitsperspectief.

Anatomie wordt gezien als een van de basispijlers van de medische opleiding en het opdoen van voldoende anatomische kennis lijkt onmisbaar voor een arts. Factoren die van invloed kunnen zijn op het leren van anatomische structuren, zijn onder meer beschikbare bronnen, beschikbare tijd om te studeren, en studiebegeleiding. In **hoofdstuk 2** hebben we gekeken naar wat geneeskundestudenten, in verschillende fases van hun opleiding, van het vak anatomie vinden.Middels een focusgroep werd een vragenlijst ontwikkeld om inzicht te krijgen in hun mening over en hun waardering voor het vak anatomie. Hierin kwamen vijf hoofdthema's naar voren: 1) belang van het bestuderen van anatomie, 2) waardering voor het bestuderen van anatomie, 3) beoordeling van de eigen kennis van de student, 4) leermiddelen die kunnen worden gebruikt om anatomische kennis te verbeteren, en 5) houding over het bestuderen van anatomie in de bachelor fase ten opzichte van die in de masterfase. De vragenlijst werd ingevuld door 495 studenten en toonde dat 78,7% van de studenten het belangrijk of zeer belangrijk vindt om een gedegen kennis van anatomie te hebben. Van de masterstudenten vindt 68,8% anatomieonderwijs belangrijker in hun huidige opleidingsfase dan in hun bachelor fase van het curriculum. Hoewel ze het belangrijk vinden, vindt de meerderheid anatomie niet aantrekkelijk om te studeren en besteden studenten relatief weinig tijd aan het bestuderen van anatomie. Bijna alle leerlingen (92,7%) gebruiken anatomische leerboeken als leerbron. Idealiter zouden ze meer driedimensionale tools willen gebruiken waarin casuïstiek wordt aangeboden die anatomie met een klinisch scenario verbindt.

Hoofdstuk 3 beschrijft wat er bekend is over getoetste anatomische kennis. In de huidige literatuur is er veel discussie over het anatomisch kennisniveau onder (aanstaande) medici. Deze discussie lijkt echter vooral gebaseerd te zijn op meningen. Vanuit die gedachte is een literatuuronderzoek uitgevoerd om meer inzicht te krijgen in het anatomische kennisniveau op basis van gepubliceerde metingen onder geneeskundestudenten, arts-assistenten, fellows en specialisten. Hierbij zijn dertig relevante studies gevonden. In deze onderzoeken deden de deelnemers verschillende tests om hun anatomie kennis aan te tonen, variërend van identificatie van gelabelde structuren, meerkeuzevragen en open vragen. De behaalde scores varieerden van 22,5% tot 82,4%. De belangrijkste conclusie van dit literatuuronderzoek is dat het anatomische kennisniveau moeilijk is vast te stellen, met name door het gebrek aan standaardisatie in de manier waarop anatomiekennis wordt getoetst. Bovendien is het niet bekend hoeveel anatomische kennis er daadwerkelijk nodig is om veilig en bekwaam te kunnen functioneren in de klinische praktijk.

Obstetrie en gynaecologie (O&G) is een breed en divers specialisme binnen de geneeskunde, waarbij onder andere chirurgie wordt verricht en gebruik wordt gemaakt van diagnostische beeldvorming. Een adequaat begrip van anatomie kan dan ook als bijzonder belangrijk worden beschouwd binnen het gebied van de O&G. In **hoofdstuk 4** hebben we de anatomische structuren gedefinieerd die essentieel zijn om als algemeen gynaecoloog te beheersen zodat een veilige en competente praktijk kan worden gewaarborgd. Hiervoor hebben we gebruik gemaakt van de Delphi-methode. Aan het begin van het Delphi-proces is een lijst van 123 items, samengesteld aan de hand van focusgroepen en interviews, verzonden naar 60 gynaecologen en arts-assistenten in opleiding (aios) tot gynaecoloog in Nederland. De panelleden scoorden de items van de vragenlijst op een Likertschaal tussen 1 (niet relevant) en 5 (zeer relevant). Consensus werd gedefinieerd als≥ 70% van de panelleden het item als relevant of zeer relevant beoordeelde en de gemiddelde beoordeling ≥ 4 was. Na twee rondes werden 86 structuren geïdentificeerd als essentieel voor een algemene gynaecoloog. Deze 86 structuren kunnen gebruikt worden om het anatomie onderwijs in de postdoctorale opleiding obstetrie en gynaecologie richting te geven.

Hoofdstuk 5 presenteert de internationale validatie van het hierboven beschreven Nederlandse Delphi-onderzoek.

Wereldwijd worden artsen opgeleid tot bekwame, competente gynaecologen. Hierbij heeft elk land zijn eigen curriculum, dat niet alleen verschilt in lengte, maar ook in structuur en inhoud. Het is bekend dat het verschil in lengte geen invloed heeft op de chirurgische vaardigheden of kennis, maar dat verschil in inhoud wel van invloed kan zijn op de kwaliteit van zorg. Het lijkt daarom redelijk om te streven naar een internationaal specialisme-specifieke norm voor de inhoud om wereldwijd een hoge kwaliteit van zorg en patiëntveiligheid te garanderen.

In totaal werden 192 enquêtes ingevuld met deelnemers uit zeven landen (België, Duitsland, Noorwegen, Oceanië, Zweden, het Verenigd Koninkrijk en de Verenigde Staten). Van de 123 initiële structuren werden er in totaal 72 (58.54%) internationaal essentieel bevonden. Wanneer de 86 essentiële structuren uit het Nederlandse Delphi-onderzoek worden vergeleken met de 72 essentiële structuren uit de internationale Delphi, komen 70 structuren (81,4%) overeen. Met de verminderde tijd en middelen die in het huidige curriculum beschikbaar zijn voor anatomie onderwijs, helpt het definiëren van wat essentiële kennis is om een zo een voldoende hoog kennisniveau te bereiken. De resultaten van dit onderzoek kunnen worden gebruikt om het anatomie onderwijs binnen de postdoctorale opleiding gynaecologie wereldwijd te standaardiseren qua inhoud.

Nu gedefinieerd is wat essentiële kennis is om een veilige en competente praktijk voor een algemeen gynaecoloog te verzekeren, hebben we in **hoofdstuk 6** het anatomische kennisniveau van Nederlandse aios O&G onderzocht. Onze hypothese luidde dat aios O&G in het bezit zijn van goede anatomische kennis en ten minste 80% van de vragen over de eerder gedefinieerde essentiële structuren in de jaarlijkse verplichte voortgangstoets (VGT) correct zouden beantwoorden. Om de hypothese te onderzoeken zijn de anatomische vragen uit de jaarlijkse voortgangstoets van 2010 tot 2019 geanalyseerd. Over een periode van 10 jaar waren er 54 anatomie gerelateerde vragen op een totaal van 1637 vragen (3,3%). Van deze 54 vragen gingen er 38 (70%) over de essentiële structuren die in de Delphi-lijst zijn opgenomen. Het percentage vragen wat goed werd beantwoord door de aios uit jaar 4-6 betrof 64,5% en was daarmee lager dan verwacht. Deze resultaten vergroten het bewustzijn ten aan zien van het belang om anatomische kennis te testen en het verbeteren van de anatomische kennis binnen de postdoctorale opleiding tot gynaecoloog.

In **hoofdstuk 7** presenteren we een verkennend kwalitatief onderzoek om de rol en betekenis van anatomie in de dagelijkse praktijk van de gynaecoloog te analyseren. Daarbij is ook gekeken naar de relatie tussen het belang van anatomie en het verwerven van anatomische kennis. Semigestructureerde interviews met gynaecologen en aios O&G uit België en Nederland werden gebruikt om de onderzoeksvraag te beantwoorden. Na 12 interviews kwamen we tot de conclusie dat anatomische kennis een rol speelt in de dagelijkse praktijk O&G: 1) tijdens dagelijkse activiteiten, 2) in het gevoel van self-efficacy, 3) bij het verwerven van een gerespecteerde naam als arts. Dit besef lijkt relatief laat te komen tijdens de opleiding tot gynaecoloog en in sommige gevallen pas wanneer de opleiding al is afgerond. Motivatie speelt een centrale rol in de mate waarin anatomische kennis wordt verkregen. Naast motivatie vonden we ook faciliterende factoren voor het verkrijgen van anatomische kennis zoals supervisors, patiëntproblemen en toetsing. En belemmerende factoren, zoals een gevoel van onzekerheid en een gebrek aan referentie over essentiële kennis. Deze informatie kan worden gebruikt om het anatomie onderwijs te optimaliseren met als overkoepelend doel om toekomstige gynaecologen op te leiden die veilig en met een hoge mate van self-efficacy werken.

In **hoofdstuk 8** bespreken we hoe we de kloof tussen het belang van en de investering in anatomische kennis kunnen verkleinen.

We raden aan om het proces van het verkrijgen van anatomische kennis te optimaliseren door een leerklimaat te creëren waarin de interne motivatie van de student en aios maximaal wordt ondersteund en waar anatomie explicieter wordt aangeleerd.

Toekomstig onderzoek zou zich moeten richten op hoe essentiële anatomie kennis het beste kan worden geadresseerd aan de aios O&G en wat de consequenties van het anatomische kennisniveau voor de praktijk zijn om de vraag te beantwoorden hoeveel anatomie voldoende is.

11

Impact paragraph

Impact paragraph

What is the problem?

Medical education has changed dramatically over the past century. We stepped back from traditions when it comes to anatomy education and problem-based learning was introduced. Signals from the working field indicate that we have gone too far in those changes, increasing worries and insecurities about the level of anatomical knowledge to perform safe practice.

What are the results?

This thesis provides insight in the different aspects of anatomical knowledge as *what is known, what is need to know* and what is *unknown*.

The main aim was to answer the question of the general feeling that we lack anatomical knowledge is justified. This thesis showed that the current literature does not provide an answer on the level of anatomical knowledge. Mainly because the lack of standardization in required knowledge and ways of testing. This emphasises the need to define the need to know knowledge. Through a national and international Delphi process we defined the need to know knowledge when it comes to anatomy for a general gynaecologist. An analysis of this need to know knowledge in 10 year of assessments during obstetrics and gynaecology (O&G) training showed that the actual knowledge level of O&G trainees was lower than expected and that the amount of relevant anatomy questions was very limited. We also explored the way anatomy is used in daily practice of gynaecologists and how anatomical knowledge acquisition is influenced by the use of anatomy in daily practice. The results of this thesis provide us with tools to improve anatomy education in postgraduate education of O&G.

Why this thesis is relevant?

The aim of this chapter is to describe the (potential) contribution of the results from this thesis to science and, if applicable, to societal sectors and societal challenges. Since this thesis is a first step in the development of a comprehensive training program for O&G postgraduate training for the subject anatomy, it is difficult to articulate exactly what the society gains from our results. Training a competent doctor involves a multi-year plan and does not come down to one competence or solely good anatomical knowledge. Thereby, the distinction between scientific and societal impact is not that strict. The society will benefit from competent doctors, indirectly pay for the education of doctors, but it is the scientific component which defines 'competent' and determines the curricular content. Where this is expressed in soft markers rather than grades and costs are not so clearly defined. Nevertheless, we think that this first step in the process can already have an impact on daily practice.

For those who are engaged with the postgraduate education of O&G, the presented need to know knowledge provides the possibility to work uniform, not only in the Netherlands but worldwide. The benefits associated with this uniformity are discussed in Chapter 5. In addition to working uniformly, one can also work purposefully. This can help to teach efficiently and may provide trainees with some guidance. This thesis showed that trainees often feel insecure about their anatomical knowledge and, at the same time, that a good knowledge of anatomy leads to a high level of self-efficacy. This feeling of insecurity comes partly due to the lack of a guideline about what is expected of them in terms of anatomical knowledge. So, for trainees it is beneficial to have a guideline of required knowledge.

In the context of efficacy, nowadays conservative therapy, where possible, is the first step in medicine. An example: *30 years ago, when there was a menstrual bleeding disorder and the wish for children was completed, the uterus was removed. Current conservative or minimal invasive options such as hormonal therapy or endometrium ablation are offered first*. The consequence is that the exposure to a procedure and thereby to the intra-abdominal anatomy is limited. With sharply defined need to know knowledge, efficient teaching during those moments of surgery can be applied. Hereby those 'rare' moments can be optimally used in terms of application and teaching of anatomical knowledge.

More specific, the results of this thesis influence the formal teaching of anatomy in the postgraduate education of O&G in the Netherlands. The compulsory anatomy course has been renewed with the results of this thesis. The results from chapters 4 and 5 form the scientific basis for anatomical structures to be taught in this course. Furthermore, the structure of the course is amended. Anatomy is not only taught during this course but a handhold to raise the attention for anatomy during daily practice is introduced. In this handhold the important anatomical structures to perform safe and competent practice are offered in combination with tips & tricks to actively work with those structures in practice. These tips & tricks are based on the facilitating and hampering factors described in this thesis.

More generally, anatomy is important not only to surgeons but for all medical doctor as it supports a patient's examination, facilitates diagnosis, and communicating these findings to the patient and other medical professionals. That means that the results of this thesis can serve as a roadmap for other postgraduate education programs. It helps them define what essential knowledge is and uses the facilitating and hampering factors for the acquisition of anatomical knowledge to teach anatomy.

Companies who are engaged with the development of educational tools might also benefit from the results of this thesis. So far it is unknown how anatomy is taught in the most efficient and effective way. However, it is known that students find it hard to translate 2D images in the textbooks to the 3D view in patients.Several apps and programs are built to overcome this problem. The companies behind it may benefit from the availability of need-to-know knowledge. It will provide them with a scientific base for their content and make their tools more applicable for practice.

From a scientific perspective, this thesis gives a sign to those involved in medical education: self-directed learning requires some reflection and coaching. Self-directed learning is defined as a learner who takes the initiative for their own learning, identifying their own learning needs. This thesis revealed that it seems that, at least for the subject of anatomy, the trainee is not fully able to identify and address those learning needs. This suggests that it is unwise to let the trainee completely free in their learning trajectories. The learning traject of the trainee should be planned with some steering from a supervising colleague.

The future

This thesis focusses mainly on the what: what do we know, what do we need to know and what is unknown? The unknown, *i.e,.* the next step in this process of developing a comprehensive training program for postgraduate training in obstetrics and gynaecology for the subject anatomy, is the how. We have identified essential knowledge and facilitating and hampering factors, these results influence the next step: how can this essential knowledge best be addressed to the obstetrics and gynaecology trainees?

Other examples of research opportunities and implementations for the future are:

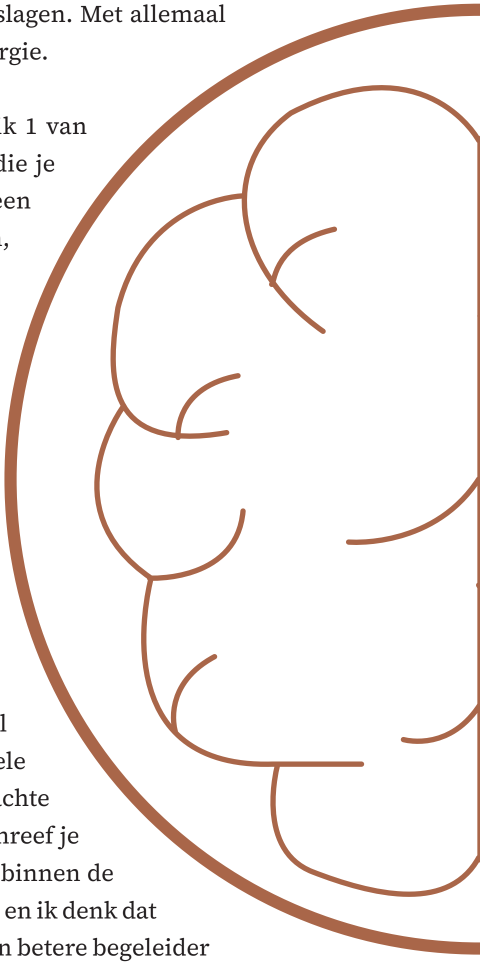
- Research into the anatomical knowledge level compared with anatomical errors/ claims related to anatomical errors.
- Ethnographical study in the operation room to observe how we use and teach anatomy.
- Adjusting the annual progress test with a reasonable number of relevant anatomy question.
- Extend the obligated anatomy course with educational tools with relevant anatomical content for repeated learning.

12 Dankwoord

Dankwoord

Klaar! Iets wat begon als interesse voor het vraagstuk rondom anatomie in de gynaecologie is uitgegroeid tot dit proefschrift. Een traject vol uitdagingen, leermomenten, vreugde en zoals het hoort ook teleurstellingen. Op het resultaat ben ik trots. Iedereen die mij hierbij heeft begeleid, bewust of onbewust, verdient een plekje in het meest gelezen hoofdstuk van mijn proefschrift.

Mijn promotieteam, met recht de eerste die in dit dankwoord een plek krijgen. Voor mij waren jullie het perfecte team om dit project te laten slagen. Met allemaal jullie eigen rol en inbreng was er absoluut sprake van synergie.



Prof. Dr. Kruitwagen, beste Roy, wat een voorrecht dat ik 1 van jouw promovendi mocht zijn. In de verschillende rollen die je hebt vervuld in de tijd dat we elkaar kennen vind ik je een enorme inspirator. Je hebt een gave om situaties te overzien, analyseren, een pakkende conclusie te vormen en deze vervolgens tactisch over te brengen. Altijd beheerst en alles onder controle (althans zo komt het over ;). Tel daar je enthousiasme, betrokkenheid en klinische expertise bij op en je hebt een heel fijn persoon om mee samen te werken. Dank je wel dat je mijn promotor wilde zijn in dit project van een beetje gynaecologie, beetje anatomie en beetje onderwijskunde en de kansen die je me gegeven hebt binnen het onderzoek en als aios.

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en soms stond het huilen ons nader dan het lachen maar het resultaat mag er zijn. Ik vind het dan ook extra speciaal dat je zitting hebt in mijn beoordelingscommissie, dank je wel.

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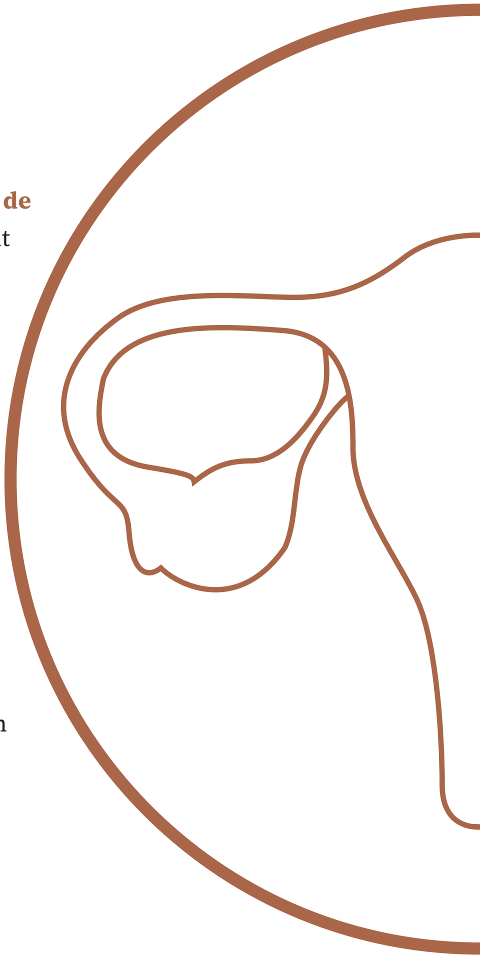

Beste **gynaecologen van het Zuyderland**, door de jaren heen heb ik het Atrium het Zuyderland zien worden en waren er in plaats van 9, 18 gynaecologen! Jullie hebben allemaal op jullie eigen manier bijgedragen aan mijn opleiding tot gynaecoloog.Het enthousiasme en vertrouwen waarmee jullie dit dag in en dag uit doen is iets om trots op te zijn. Het is vaak hard werken maar net zo hard genieten. Dank jullie wel voor jullie interesse in mijn proefschrift en alle leerzame en zeker ook gezellige jaren.

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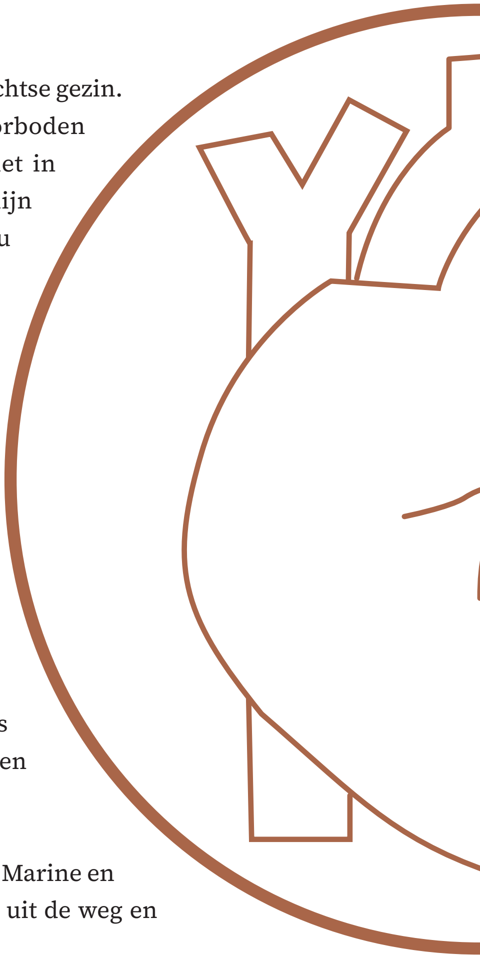

Lieve **broertjes en zus**, verspreid over het land en soms op zee zijn we allemaal onze eigen weg gegaan.

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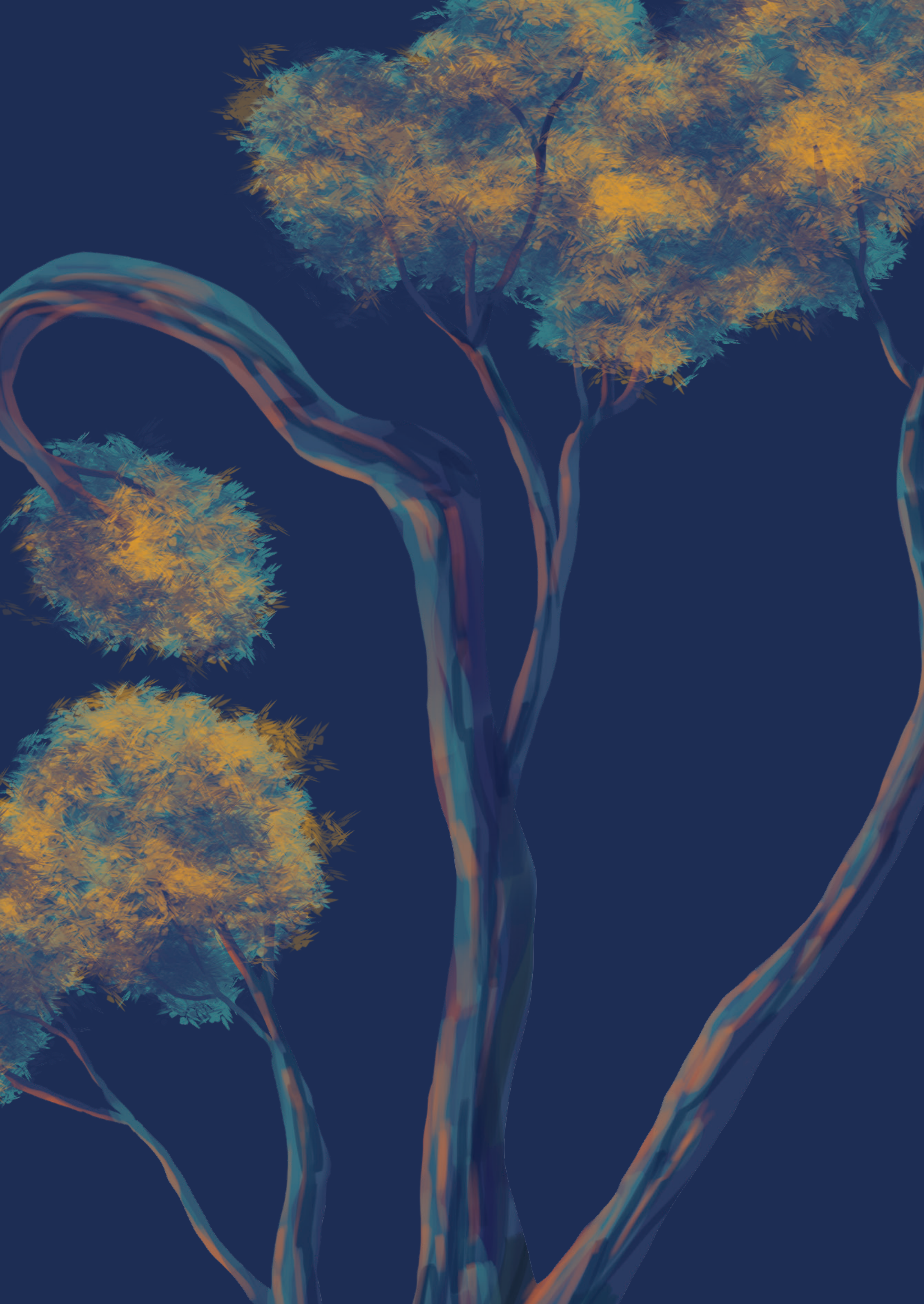

Appendices

A

List of publications

List of publications

Triepels CPR, **Koppes DM**, Van Kuijk SMJ, Popeijus HE, Lamers WH, van Gorp T, Futterer JJ, Kruitwagen RFPM, Notten KJB. Medical students' perspective on training in anatomy. Ann Anat. 2018 May;217:60-65. doi: 10.1016/j.aanat.2018.01.006. Epub 2018 Mar 6. PMID: 29501634.

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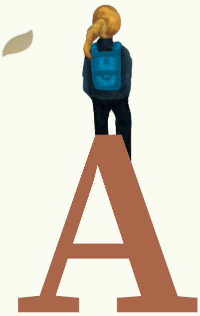

Curriculum Vitae

Curriculum Vitae

Dorothea, roepnaam Dorien, werd op 21 mei 1987 geboren in Singapore. Haar vwo-diploma werd in 2005 behaald aan het Tabor college te Hoorn. Hetzelfde jaar startte zij met haar bachelor geneeskunde aan de Vrije Universiteit van Amsterdam. Na het behalen van de bachelor in 2008 werd een tussenjaar ingelast om wat van de wereld te zien en verdieping zowel binnen als buiten de geneeskunde te verkrijgen. Zij heeft in dit jaar haar propedeuse Religie & Levensbeschouwing gehaald, vakken gevolgd van de master viral oncology, advanced molecular and cell biology en clinical immunology en was werkzaam als student-assistent op de snijzaal. In 2009 hervatte zij haar geneeskunde studie en in 2012 behaalde zij haar artsexamen. Hierna was zij werkzaam als arts-assistent niet in opleiding in het Ikazia Ziekenhuis te Rotterdam.

In 2015 startte zij de opleiding tot gynaecoloog in het Atrium Medisch Centrum te Heerlen. Haar academische tijd vond plaats in het Maastricht Universitair Medisch centrum waarna zij in 2018 terugkeerde naar het Heerlense, om in het Zuyderland Medisch Centrum haar opleiding te vervolgen. De laatste twee jaar van haar opleiding besteedde zij aan de differentiatie gynaecologische oncologie, welke werd gevolgd in het Antonie van Leeuwenhoek ziekenhuis te Amsterdam en de differentiatie urogynaecologie in het Zuyderland Medisch centrum. Het grootste gedeelte van haar opleiding is zij landelijk actief geweest binnen de Vereniging Arts-assistenten Gynaecologie en Obstetrie (VAGO).

Dit promotieonderzoek, onder leiding van prof. Dr. Roy Kruitwagen, prof. Dr. Fedde Scheele, dr. Annelieke Schepens-Franke en dr. Kim Notten, werd medio 2016 gestart tijdens het academische deel van haar opleiding. Met de afronding van dit proefschrift is ook de opleiding tot gynaecoloog afgerond. 1 juli 2022 is zij gestart met het fellowship urogynaecologie.

Dorien woont samen met Sjors Lemmens. In mei 2021 kregen zij een dochter Philou.

APPENDIX