

Practical pregraduate teaching in Human Anatomy: A review

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SUMMARY

There is a general agreement in all fields of sciences that practical pre-graduate education in human anatomy is absolutely necessary. It constitutes an inseparable partner with theoretical learning on the path to knowledge. As such is it critical to (1) establish the set of specific objectives for each practical session (PS), and (2) define more precisely the outcomes (i.e., knowledge, skills and attitudes) that are expected by students. The principle for efficiency of practical sessions (PSs) is that they should take place immediately after didactic sessions of the corresponding topic(s). In this way, students could best reinforce their learning. Considering that the morphology of the human body can be learned by means other than direct observation/dissection of anatomical donors, media, models and imaging

have also gained popularity as “anatomy learning tools” in recent years. Imaging is a perfect complement for teaching in the dissecting room, but always in correlation with the reality of body-donor sections, prosections and dissections of the same region. Anatomical models and computer programs express the reality of the human body, however, anatomical variations and many other qualities (i.e., surgical skills, ethics, pathology, professionalism) can only be appreciated via hands-on use of an anatomical donor to science. Therefore, the anatomical donor remains the *Gold Standard* for anatomy teaching, especially topographical Anatomy.

Key words: Anatomy – Education – Human Anatomy – Practical session – Dissection – Body-donor

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ABBREVIATIONS

Practical Session(s) (PS/PSs)

INTRODUCTION

As in all fields of sciences, practical teaching in Human Gross Anatomy is absolutely necessary, and there is a general agreement in this concept since it constitutes an inseparable partner with theoretical learning on the path to knowledge (Konschake and Brenner, 2014). The practical class is the direct confrontation of facts with reality; in this way Cajal's quotation is recalled, "Much teach books, but much more teaches nature, reason and source of all the books." (Ramón y Cajal, 1940).

Human Anatomy has, in recent decades, been considered by some authors as a hangover from the renaissance, even leading to the disappearance of the Departments of Human Anatomy in some universities (Drake et al., 2009; Dyer and Thorndike, 2000; Ramsey-Stewart, 2014; Zumwalt et al., 2007). Yet, it appears to be a general agreement that the discipline of Human Anatomy is one of the fundamental pillars of medical training (Alyafi et al., 2012; Cappabianca and Magro, 2009; Garment et al., 2007; McLachlan and Patten, 2006; Mompeó and Pérez, 2003; Moon et al., 2010; Ramsey-Stewart, 2014). Nonetheless, there is still a latent debate on the "crisis" of the role of Human Anatomy and the importance of dissection of the human body in medical education (Benninger et al., 2014; Di Dio, 1999; Korf et al., 2008; Older, 2004; Ramsey-Stewart, 2014; Sugand et al., 2010; Winkelmann, 2007). This controversy is revived from time-to-time, coinciding with the design of new training syllabi and new technologies. Moreover, anatomy teaches the scientific method essential in any professional of health sciences (Bunge, 2012). Still further, skilled team-dissection in the anatomy laboratory promotes the learning of communication and problem-solving skills, teamwork, and understanding of pathological and ethical (or end-of-life) issues – all of which are essential to healthcare professionals. Lastly, with the decrease in time devoted to anatomy and modernization of medical education curricula, peer-teaching during PSs has become another tool in the anatomy laboratory, and students are requesting more time

with PSs (Drake et al., 2009; Elizondo-Omaña et al., 2010; Moxham and Plaisant, 2007; Talarico, 2010).

In the present work, the focus is on the practical teaching of human gross anatomy by a review of the essential components that create a successful practical teaching session. The main aim of practical teaching in anatomy is to help the comprehension of concepts and anatomical details encountered during didactic (i.e., theoretical) sessions. The student can acquire new information and reinforce learning new and prior concepts. Students not only gain knowledge of identifying structures, but also acquire skills in handling instruments, tactile and observational skills, and in scientific methodology and the ability to analyse results (Cox and Ewan, 1988; Newble and Cannon, 2001). The success of the process relies not only on student initiative and ability, but also on the interaction of anatomy and clinical faculty with student learners and the organization of the session. The advantages and disadvantages of practical teaching in traditional dissection and using the peer-learning approach in Table 1 (Cox and Ewan, 1988; Miller, 1961).

OBJECTIVES

Before starting the practical protocol, it is necessary to: (1) establish a specific set of learning objectives for each session, and (2) define the learning outcomes (i.e., the knowledge, skills and attitudes, etc.) that students are expected to achieve at the end of each PS. Session level objectives should be matched to overall course objectives, as well as institutional objectives. Learning outcomes are specific statements of what students will be able to do when they successfully complete a learning experience (whether it's a project, course or program). They are always written in a student-centered, measurable fashion that is concise, meaningful, and achievable.

How are learning outcomes different from learning objectives (i.e., learning goals)?

These terms are often used interchangeably, and they are all related to the teaching and learning that is expected to take place in the classroom or laboratory. However, the difference between goals or objectives and outcomes lies in the emphasis

on who will be performing the activities. Learning goals and objectives generally describe what an instructor, program, or institution aims to do, whereas a learning outcome describes in observable and measurable terms what a student is able to do as a result of completing a learning experience (i.e., the PS). To summarize, a learning outcome (also known as a terminal or performance objective) is a statement in specific and measurable terms that describes what the

learner will be able to do as a result of engaging in a learning activity, or PS, whereas learning objectives (i.e., goals or enabling objectives) address a component of the learning outcome and help track the learner's progress towards that objective (Fig. 1 and Table 2).

PSs must be conveniently planned to achieve the defined objectives. Therefore, objectives never should be too complex or difficult for students to accomplish.

Table 1. Advantages and Disadvantages of Practical Teaching Session.

Traditional Practical Session		Peer-Teaching Practical Session	
Advantages	Disadvantages	Advantages	Disadvantages
Provides the student an opportunity for direct experience for correlating the theory with the reality of human body.	They have an important cost in infrastructure, equipment and staff.	Provides the student an opportunity for direct experience for correlating the theory with the reality of human body.	They have an important cost in infrastructure, equipment and staff.
Provides an opportunity for learning and practice different skills and develop some important clinical attitudes.	They have no sense if the student is not adequately prepared.	Increases sense of accountability to the team. Increases motivation (a "need to know" attitude). Requires preparation and verbalization (enhancement of organizational and communication skills).	
Students could work at their own rhythm.	They have no sense if the students adopt a passive attitude, just as merely observers.	Offers education to students on their own cognitive level (less distance between peer teachers than professors).	
Provides an opportunity to the personal relationship between teacher and student.		Fosters a more comfortable and safe educational environment; reduces barriers to asking questions.	
Permits the student to evaluate their emotions in the process of learning.		Supports development of independent learning by learning how to self-reflect; "one way to learn to reflect and teach is by being a teacher for others" (Ten Cate & Durning 2007).	
Creates a strong anatomy learning community.		Creates a strong anatomy learning community.	
		Fosters a sense of empowerment ("I know more and am experiencing more"), which increases student confidence and contributions to the group.	
		Interval of peer instruction and communication can be likened to future patient care "pass off" between clinicians leaving/coming on service –effective communication of anatomic information is vitally important for continuity of learning by all members of the team.	

The establishment of the specific objectives have to be done not individually for each teacher of the Department, but they should be established by consensus between all members for being more effective. In this way, objectives will have more consistency and accuracy by matching different experiences (COMMITTEE, 1996). The collaboration of students can be particularly useful to get a list of affordable and achievable objectives, and to promote active participation and accountability of students in their own learning (Steele et al., 1987).

The specific objectives should consider the taxonomic fields of knowledge, skills and attitudes (Seaman, 2011). They could be formulating as: to identify, to interpret, to understand, to resolve. With respect to PS in anatomy, it is important to consider relevant anatomical details from the clinical point of view, however, anatomy educators should be cautious as to not include details that are not relevant (Sañudo et al., 2004). In general, a useful guideline to keep in mind when developing the specific objectives of the Human Anatomy course is to consider the main statements approved in the 2nd Pan American Association of

Anatomy Congress (Caracas, Venezuela, 25-31 July, 1969) in relation with “general problems of teaching Morphology” (Sañudo et al., 2004).

Morphology teaching should be based on an active method, scientific, and directed study, in which the student’s individual work has vital importance. It should project the dynamic knowledge of a living patient relative to findings during the course of dissection; thus, allowing the student to understand the functional, pathological, psychological, social aspects of human disease. Both didactic (i.e., theory) sessions and PSs must have the unified purpose of preparing students for self-directed learning and self-training.

Ideally, this method of addressing objectives should be integrated not only into teaching human gross anatomy, but also into all of the related anatomy disciplines (i.e., medical imaging, ultrastructure, embryology, and histology). Further, in developing any program, teaching of these related disciplines are key to integrated learning and clinical application, that should be incorporated as soon as possible in the program. Because of the importance of

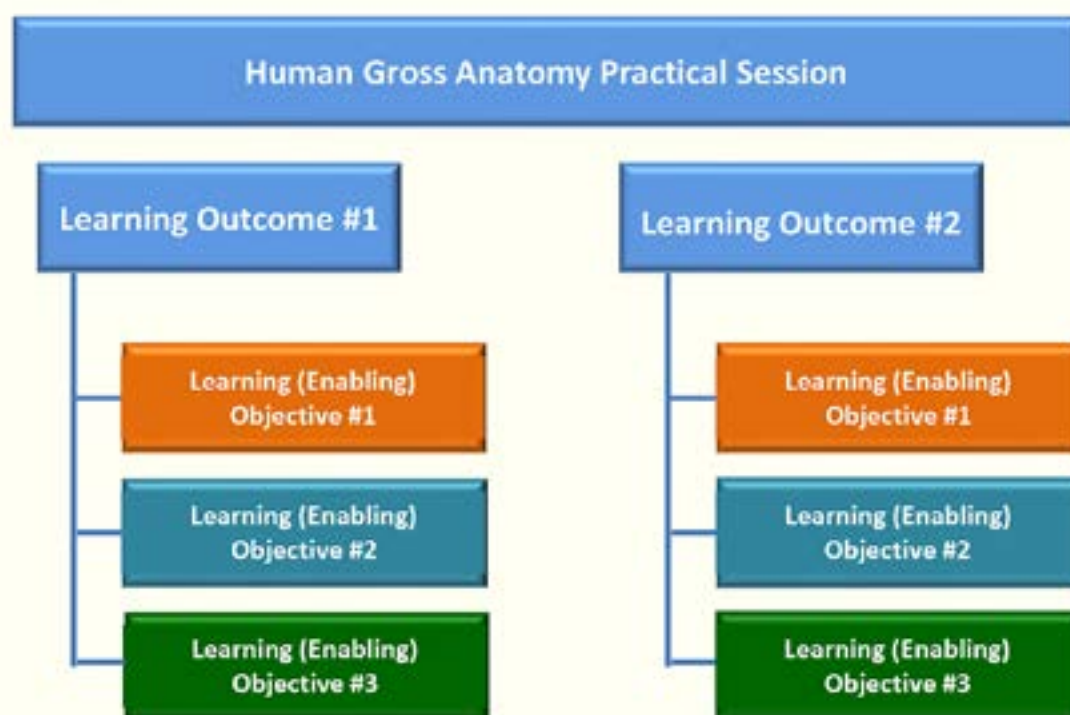


Fig. 1.- Objectives and learning outcomes in anatomy practical sessions. Learning outcomes are specific statements of what students will be able to do when they successfully complete a learning experience. Learning objectives (i.e., goals or enabling objectives) address a component of the learning outcome and help track the learner’s progress towards that objective.

early morphological knowledge of man in health sciences, it is advisable to seek coordination with other basic and clinical disciplines. Thus, it is suggested to adopt the Terminologia Anatomica, not only for the anatomists but also for the rest of member of the health Faculties (Dirckx, 1998).

Table 2. Elements of effective Learning Outcomes.

ELEMENT	DESCRIPTION
Student-Centered	Outcomes are phrased from the perspective of the student and are written in language that can be easily understood by them.
Measurable	Outcomes emphasize higher-order thinking and are consistent with university, college, department, and program learning outcomes or objectives.
Concise	Outcomes are written in short, succinct sentences.
Meaningful	Outcomes emphasize higher-order thinking and are consistent with university, college, department, and program learning outcomes.
Achievable	The total number of outcomes is reasonable for this population of students and is achievable within the time available.
Out-come-Based	Outcomes should specify the skills and knowledge students must demonstrate to prove mastery instead of focusing on the assignment format, such as a quiz or essay. Well-worded outcomes should remain flexible enough to accommodate a variety of formats for a corresponding assessment.

ORGANIZATION

The PSs of Human Anatomy in different countries are composed of different elements of gross anatomy, histology and developmental biology. Herein, attention is focused on aspects related to the organization (or development) of PSs in gross anatomy.

One principle for efficiency of PSs is that they should take place immediately after lecturing of the corresponding topic. In this way students could reinforce their learning. If this is impossible, they should be done as close to the lectures as allowed.

During PSs we expect that students, at minimum, receive some knowledge, skills and attitudes in relation with objectives proposed (Seaman, 2011).

This includes:

1. The verification of anatomical details should be not accomplished only by observing, but on interpreting details and anatomical relationships in the spirit of observation. Some teachers recommend drawing specimens presented: bones, topographical sections, prosections, etc. (de Pablo and Díaz, 2008).
2. The acquisition of skills not only arise from the practice of dissection but also reflective and critical thinking of findings. Therefore, it is important to promote discussion between group members about the specific objectives proposed for the session.
3. Learning of clinical reasoning skills, which is important for the development of a systematic and efficient approach to clinical cases that will serve medical trainees in all subsequent educational endeavours and in their careers in medicine (Elizondo-Omaña et al., 2010; Talarico, 2010, 2013; Talarico Jr, 2010).
4. The acquisition of attitudes should be based first on the acceptance of rules previously established for respecting the anatomical body-donor (Talarico, 2010, 2013) and the dissecting room: wear coat with identification, wear gloves, no drinks or meals are allowed, etc. That rules are for sanity and security and should be hang in the entrance of the dissecting room.

Experience by these authors suggests that not all students of the group read guidelines. Therefore, the recommendation is that before starting the session a brief explanation be given to students that contextualizes the PS relative to lectures aims justifying the specific objectives improve student progress.

PSs should be done in small groups, under the direct supervision of a teacher (Talarico, 2010, 2013). It is important that students be responsible and become self-aware and self-directed learners. Therefore, educator should limit help, but should ask provoking questions, assist students in critical thinking and encourage student progress

and learning. In some countries secondary to the student/teacher ratio in the PS, retired surgeons, young practitioners (i.e., in the United Kingdom), near peer instructors volunteer to act in the role of teachers for the PS (Durán et al., 2012; Reyes-Hernández et al., 2015).

Pabst et al. (1986) suggested that, in addition to movies/films focused on individual topographic regions for dissection, those films that included clinical case content are also appropriate in the teaching of Human Anatomy. These films including clinical cases, introduce and explain clinical terms and enable students to understand the relevance of anatomy to their medical studies (Pabst et al., 1986). In addition, students realize the differences in anatomy between embalmed vs. fresh cadaveric materials (Pabst et al., 1986). Aside from movies/films, it is recommended that an area of the dissection laboratory be adapted for the study of clinical imaging (i.e., X-ray, CT, MRI, and ultrasound) relative to the region of the cadaver being dissected. This area should be fitted with computers, high-resolution monitors, etc. Further, the reduction in the cost for ultrasonography devices, make it possible to extend their use to student volunteers (and the cadaver) via portable, hand-held devices. Therefore, objectives, clinical correlations and exercises should be incorporated into PSs that not only involve the exploration of surface and internal anatomy, but also otoscopy, ophthalmoscopy, laryngoscopy, ultrasound (and other imaging modalities), as well as articulation movements, balance, gait and stance. When the use of radiological material is involved, it should focus on the identification and description of anatomical structures when related to dissection, in contrast to when using clinical cases, then the radiology should focus on relating anatomy to what happens within the patient so that students can improve their clinical reasoning skills (Durán et al., 2012).

A critical aspect to each PS is that faculty must never fail to improvise and correlate the use of all materials used within the session. Faculty and graduate teaching assistants/fellows must fully comprehend the objectives, procedures of dissection, and the complementary material (i.e., radiological material, prosections, clinical cases, etc.) being used during the PS. If instructors are

not familiar with them, then students will be frustrated and discouraged, and will lose interest and faith in both instructors and the course. The latter should make it difficult to recover the trust of the student in the staff.

It is important to address that when PSs are based on the use of anatomical donors that an introductory session, possibly named “practice zero” (or something similar) should be incorporated (Talarico, 2010,2013). In this PS, faculty can elaborate on:

1. anatomical donors.
2. the anatomical donation process.
3. care, respect, professionalism and human dignity with regard to anatomical donors.
4. issues of life and death.
5. anatomical variations versus the “ideal anatomy” that is represented in many atlases and textbooks.
6. skilled use of surgical instruments, etc.

This “zero session” permits to contextualise the dissecting room in the life of the students as future professional of health sciences. Finally, to promote this and the interest and responsibility of students, it is recommended that knowledge, skills and attitudes be assessed at the end or during developing of the PSs. This can be done by:

1. individual or small group presentations
2. steeplechase (or laboratory practical)
3. peer-teaching hand-off
4. multiple choice questions

DIGITALIZATION AND MEDIA IN THE DISSECTING ROOM

Every professional educator understands that students remember approximately 20% of what they hear, 30% of what they see and 50% of what they hear and see (Howe, 1977). Therefore, the use of appropriate audio-visual media will enhance the level of understanding of a topic at the same time promote long-term retention of information.

In medical education the use of audio-visual media has a long history (Ramey, 1964):

Although useful, they should not replace cadaveric dissection. Cadaver dissection remains the *Gold Standard* in anatomy teaching. However, PSs might be recorded, stored (i.e., in a digital library) and therefore, accessed for student use at request (on their own time and at their own pace). Recorded PSs can be used as a supplement during dissection to help students to solve doubts that are frequently presented during the dissection practice (Omaña and Vilchez, 2006).

Moreover, the use of videotapes facilitates the extension of this type of information to a greater number of students (Cox and Ewan, 1988). In addition, recordings are useful for teaching specifically dynamic activities such as procedures of dissection or joint movements. An additional tool is live recording with direct transmission to dissection rooms/theatres of more sophisticated dissection procedures as demonstrated by professionals (i.e., correct opening of the orbit from above).

There are many different media products: videotapes, computer programs, CD-ROM, DVD, etc. These products have the advantage of lower cost. However, the major disadvantages is the inability to interact directly with them; the exception being some computer programs (Brenton et al., 2007). Yet, the incorporation of computer video projector dissecting rooms, associated with the development of multimedia programs suitable and easy to use, has facilitated a vast array of products (Carmichael and Pawlina, 2000). These programs allowed genuine multimedia presentations that incorporate diagrams and tables, images, movies and sound (Newble and Cannon, 2001). Currently, the most widely used program is Microsoft PowerPoint (*Microsoft Corporation*, Redmond, WA, USA). This program also allows text, images and sound can occur with a diverse variety of effects, among which is included the use of animation (Carmichael and Pawlina, 2000). However, faculty must exercise caution because such effects, if abused, can cause interference with the primary objective of the presentation which is to convey in the most realistic possible information. Still further, the projection of videos are not generally adequate to accomplish during the PSs because they need

a darker room that results in the interruption of the normal course of the class (Katz et al., 1978; Randall, 1987). However, if the films are clear and well done, they can be an excellent complement to PS. It is the recommendation herein, that it is more convenient to project them at the beginning or at the end of the session, always ensuring that their content enrich student learning.

COMPUTER AIDED INSTRUCTION

There are many computer-based anatomical programs like: ADAM (Animated Dissection of Anatomy for Medicine), MacMan, Digital Anatomist, The Visible Human Data Set, Anatomage, etc. These programs are usually categorized into self-assessment packages, tutored exercises, simulated models and clinical problems. From the point of view of the authors, computers can be particularly effective to facilitate self-assessment. However, the programs dedicated to simulation or to illustrate dynamic processes and their application clinical scenarios are also useful (Katz et al., 1978; Randall, 1987). Simulated clinical problems cover all aspects of patient management that a future physician may encounter; thus, students can face “real-life” situations, examine the results of their decisions, and reflect and review for improvement. Although more inherent to teaching courses in clinical years, multidisciplinary collaboration in drafting the integration of such modalities into medical education curricula facilitates students’ understanding of the relationships, value and importance (Bidwell et al., 1985).

A disadvantage is that many programs are more specific and available only in the institutions that they were created. Therefore, objectives and learning outcomes of the “institutional package” may not coincide with your own PS requirements. And, if faculty desire to develop or adapt the “institutional package” to their own specific requirements, then the cooperation of specialists in programming and systems design may be needed, and the costs prohibitive. A final disadvantage is that although qualitative studies on these computerized programs exist, an extensive literature survey shows no studies that quantitate and validate improvements in student outcomes.

THE HUMAN BODY AND THE DISSECTING ROOM

Considering that the morphology of the human body can be learned by means other than direct observation of anatomical donors, media, models and radiology have been gaining popularity in recent. Therefore, at present there are many departments of Human Anatomy that do not use the anatomical donors for teaching anatomy (NA Moore, 1998). Today, many dissecting rooms are no longer like a field of numerous tables with anatomical donors, but are rooms with computers, anatomical models, internet points, TV screens and DVD or CDs, etc. (Cahill and Leonard, 1999). These anatomical models could be of a great quality but in any case, they lack the expression of the reality of the human body (i.e., age, death, disease, texture of structures and organs, anatomical variations and many other qualities) that can only be viewed, felt and appreciated by hands-on dissection of the body. Therefore, it is opined that the anatomical donor is the best model and the *Gold Standard*.

Radiological images (i.e., X-Rays, CT, MRI, ultrasound, etc.) do not need the plastic format and the source of light for being analysed (Schramek et al., 2013; Swamy and Searle, 2012). In modern times, they can be observed by means of a computer and a screen or video projector. Images of the different modalities as mentioned above, represent one alive instant of a particular patient frozen in time. But does this mean that the anatomical donor is no longer necessary for learning anatomy? One can argue that students can learn anatomy solely with the use of clinical images. However, in the best educational practice, radiological images are a perfect complement for teaching in the dissecting room but in correlation with the reality of body-donor sections, prosections and dissections of the same region. Collectively, this facilitates a student's better understanding of anatomy, 2D radiological images, and disease.

The human anatomical donor represents for most students, the first experience of the contact of the five senses with a real 3D model, not with plastic or digital human models – but a true human body (KL Moore, 1989). Therefore, it is not a surprise that for some authors, dissection could

be considered as a feast for the human senses (Aziz et al., 2002).

Moreover, the value of the body-donor is more, it adds realism and hence it encourages students to reflect and discuss concepts such as morbidity, mortality, variations of the human body, ethics and end-of-life issues (Bergman, 1988; Brennan et al., 1991; Kenschake and Brenner, 2014; Lippert and Pabst, 1985; Marc Rodríguez-Niedenführ et al., 2002; M Rodríguez-Niedenführ et al., 2001; Sañudo et al., 2003; Talarico, 2010, 2013; Tubbs et al., 2016). In addition, another value of anatomical donors is that the hands-on discovering structures and organs and anatomical relationships is essential to the skills necessary for future medical training. No digital programs, models or radiological images can provide the above-mentioned aspects to student. The human body-donor, therefore, can never be replaced.

If the anatomical donor is so important for learning anatomy, how is possible that now cadavers are used in fewer departments? The progressive abandonment of the practice of dissection in the Departments of Human Anatomy are justify for many reasons (Ellis, 2001):

1. The arrival of medical education experts who advocate a model based on the resolution of problems, where the anatomy happens to have a secondary role in medical training.
2. The pressure of researchers to gain new space for its laboratories with the offense involved large spaces containing the dissecting rooms.
3. The “high cost” involved in maintenance personnel, equipment, chemicals and infrastructures of the dissecting room for administration.

Finally, it is important to mention that learning Human Anatomy based on the use of the anatomical donors to science facilitates the student to question aspects such as biological variations and pathological changes - *aspects of great importance in the practice of medicine* (Ellis, 2001; Granger, 2004; Kenschake and Brenner, 2014). Therefore, the anatomical donor introduces students to the medical world by means of death. Like in the

Renaissance (University of Padova, Italy), when in the frontispiece of the main gate of the dissecting room were the phrase “Hic locus est ubi mors gaudet succurrere vitae” (“This is the place where death delights in helping life”). Another beautiful example of such fundamental truth appears at one of the entrances of the Department of Anatomy, Histology and Embryology of the Medical University of Innsbruck (MUI): “Mors auxilium vitae” (“The dead serve the living”).

Recently, different documents (Book or Journal's Supplement) have appeared that examine the dissecting room in a wide sense (i.e., from the donation to preservation and dissection) with the aim of facilitate the study of the Anatomy with the minimum of risk in terms of security and hygiene. Herein, the team of the present work cites an excellent book and supplement for people that would like to learn more about the process for studying with human bodies (Chan and Pawlina, 2015).

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