Available online at www.sciencedirect.com

ScienceDirect

Procedia - Social and Behavioral Sciences 103 (2013) 109 – 115

Procedia
Social and Behavioral Sciences

13th International Educational Technology Conference

An Overview Of The Technologies Used For Anatomy Education In Terms Of Medical History

Engin KURT[a]*, S.Eray YURDAKUL[b], Adnan ATAÇ[c]

[a] *Gulhane Military Medical Academy, Faculty of Military Medicine 06010,Ankara, Turkey*
[b] *Gulhane Military Medical Academy, Faculty of Military Medicine 06010,Ankara, Turkey*
cGulhane Military Medical Academy, Faculty of Military Medicine 06010,Ankara, Turkey

Abstract

The term anatomy is coming from Greek Ana 'on, upon' and Temno 'I cut'. Today, the basis of anatomy education is the work performed on cadavers. However, due to difficulties in modern and alternative approaches to participate in the educational process, an essential element of today's educational process. In recent years for both time and training costs advantages and in order to ensure a healthy laboratory conditions, such methods, computer-assisted learning, simulation-based training, using true-to plastic anatomical models, plastination started to be used.

Keywords: Anatomy, Education, Technology, Cadaver, Plastination

1. INTRODUCTION

The human anatomy, one of the basic medical sciences, is one of the initial branches of medicine that studies the normal shape, structure and the organs of the human body as well as the structural and functional relations between these organs. Within an etymological frame, the term anatomy is formed by the combination of two ancient Greek words, Ana (remove) and Tomy (cut). It is expressed in the form of separation by cutting and removing. The term anatomy is 'Dissection' for Latin. Recently 'Dissection' is a term being used as a method for the examination of cadavers.

* Corresponding author. Tel.: +90 312 304 32 05.
E-mail address: enkurt@gata.edu.tr

doi:10.1016/j.sbspro.2013.10.314

2. THE HISTORICAL PROCESS OF ANATOMY

Physicians need to know how the combination of all subsystems of the body works in harmony, in order to understand if there is a pathology in any part of the body or not. This is why anatomy is important for the medical education. When we look at the historical process of the anatomic studies, during the first period, we see the drawings of scientists that the internal organs of animals, as well as external images on the walls.

The first written records of Anatomy is said to have begun with Alcmeon from Craton 500 years before (Gürbüz, Karlıkaya & Mesut, 2004). The scientific and experimental style of today's medicine began at 3. Century BC. with the dissection experiments allowed by Ptolemy (Ronan, 2003). During this period, Herophilus, in particular on the work of the human anatomy, and Erasistratus exploration in dissection and physiology came into prominence (Lyons & Petrucelli, 1997; Garrison, 1921). To investigate the structure and the working system of the human body. Herophilus and Erasistratus make dissection on human cadaver in an objective manner firstly (Atabek & Görkey, 1998). After Erasistratus and Herophilus such scientists as Aristotle, Galleons, Avicenna, Leonardo Da Vinci, Andreas Vesalius, Claud Bernard have worked on the anatomy.

Knowledge of anatomy, from Hippocrates until Vesalius was obtained by the superficial structures of the human body and animal dissection. Along with Andreas Vesalius (1514-1564) dissecting desks have been introduced by physicians and medical students. Studies on cadavers formed the basis of anatomical education. Knowledge has increased rapidly as a result of these studies with human cadaver (Gürbüz, Karlıkaya & Mesut, 2004). In line with the recent technologic developments, today it has been started to be found difficult to study with the cadavers by the people and consequently the final developments led to the shift in the direction of the technology.

The method of "Parafinizasyon" has been developed by Deegener and Brendt in 1914, Hochstetter and Schmeidel in 1924. Since the structure of the samples are dry in this method, the natural image of them are shown as to be resistant to external forces. However, they are heat-sensitive and are not protected against flammability (Buyruk, Groen, Kempermann & Altuniçn, 1990). In 1977, Gunther von Hagens developed plastination, which has been more useful and increasingly used method at present. He organized an exhibition of plastination in Japan in 1995 for the first time. A similar exhibition was held in Istanbul, Turkey in 2010, and in 2012 another one followed it in Ankara.

3. DEVELOPMENTS IN TURKEY

Study of anatomy in Ottoman Empire began to show itself with 17th Century. The number of works written on this subject are quite rare, especially the ones containing pictures. One of them is Şemseddîn-i Îtakî's illustrated anatomy book, named 'Kitâb-ı Teşrîh-i Ebdân (Kâhya, 1996).

There was no significant attempt until the beginning of 19th century. From the beginning of the 19th century, The Head Physician Mustafa Behçet Efendi, prevail upon Sultan III.Selim to dissection which is part of the anatomy education. However, these attempts have not been very successful due to the prevailing circumstances. For the second time, during Mustafa Behçet's chief physician period, although the importance of anatomy was emphasized in medical education, the dissection could not be conducted because of the deep-rooted beliefs (Gürbüz, Karlıkaya & Mesut, 2004).

After 1839 anatomy has been included in the curriculum of education. Dr. Bernard from Austria has pioneered the start of training in anatomy. Initially, during the period of 'Tıphane and Cerrahhane-i Amire', it couldn't have been succeeded to work with cadavers for various reasons. However, with the establishment of 'Tıbbiye-i Adliye-i Şahane', Dr. Bernard wanted to carry out training activities

on a cadaver in 1841. Only after having the permission of Sultan Abdulmecit, and the students had the capability to make a cadaver dissection (Erimoğlu, 1988, p.27).

Hristo Stambolski, who has been appointed to medical school in 1868 issued an atlas of anatomy in the same year and by translating from A. Jamin Mazhar Pasha published a book of Topographical Anatomy for the first time in Turkey as some of the frontier contributions to Turkish medical education (Erimoğlu, 1988, p.27).

In 1908, the method of "cadavers' cold storage preservation" by injecting formaldehyde was applied by Dr. Nurettin Ali Berkol (Erimoğlu, 1988, p.28). After the University Reform of 1933, the anatomy dissection education of medical students was continued by Prof. Nurettin Ali Berkol on the one hand and, on the other hand, Assoc.Prof. Hamza Vahit Göğen, Assoc.Prof. Mehmet Ali Oya and Assoc.Prof. Zeki Zeren prepared and presented a textbook of anatomy for the benefit of the students (Erimoğlu, 1988, p.28). After 1951, Dr. Zeki Zeren, worked for localizing the anatomy terms, and significantly contributed to the education system (Erimoğlu, 1988, p.29).

The apparent difficulty in the supply of cadavers since 1960, has reduced the number of cadaveric for education (Erimoğlu, 1988, p.30). Classical methods are applied in many medical schools in our country. The interactive methods, integrated into the education system and computer-based training systems increasing with time.

4. ANATOMY EDUCATION TODAY

The main purpose of the anatomy education for the student is to gain the required information by the practical way and use it properly. To reach this purpose, there are several methods of training.

Using the technology contributes learning even teaching. Using technology also increases motivation of the student. Thereby learning becomes more permanent (Mandıracıoğlu, Hassoy & Karababa, 2011, p.18). Moreover, using model, plastic model and computer assisted simulator technologies instead of traditional methods is preferred as a part of respect to privacy in medical ethics (Balcombe,2001).

4.1. Training with Cadaver:

Currently the practical studies on cadaver are forming the basis of anatomy training. The student can learn the macroscopic structures of anatomic formations, the relationships between them and their vicinity by touching and seeing in the studies on cadaver. However, the difficulties of finding cadaver for medical faculties, loss of form and degeneration of tissue in the post mortem term, diversifications in the structure, colour and smell as a result of the chemical usage for detection make the studies on cadaver unsuitable.

It is known that formaldehyde, the chemical material used on cadaver, causes irritation of respiratory tracts and eyes of people and determines several health problems. (Ohmichi, K., Komiyama, M., Matsuna, Y., Takanashi, Y., Miyamoto, H., & Kadota, T., et.al., (2006); Arts, Rennen & de Heer, 2006).

4.2. Training Based on Simulation:

4.2.1. Simulation:

Simulation is described as comparing to real, imitating the attitudes those exists in reality (Patrik, 2002). Properties of simulators are valued depending on not only the similarity to the truth, but also

the respond to the applications. It can be said that especially the more respond is sensitive, the more qualification is high-level (Mıdık & Kartal, 2010; Patrik, 2002; Maran & Galvin, 2003).

4.2.2. Usage of Simulation in Medicals:

First important usage of simulation was Resusci-Anni created by technology and anaesthetists in 20th century (Mıdık & Kartal, 2010; Bradley, 2006; Ziv, Wolpe & Small, 2003). Later in sixties Abrahamson and Denson made a human simulator called "Sim Man". In this simulator it could be carried out: Heart beat, carotis pulse, imitation of human acts, mouth moves, winking, respond to intravenous applications and blood pressure measurement etc. However, it couldn't be produced serial because of those time conditions (Mıdık & Kartal, 2010; Bradley, 2006; Good, 2003). The third development was occurred by utilization of simulators by medical students and it was accepted globally after nineties. To follow on, these praxis were used in post graduated terms further in the clinical skills laboratories (Mıdık & Kartal, 2010; Bradley, 2006).

4.2.3 Benefits of Simulation:

Simulation supports one of the basic principles of bioethics "first do no harm" by providing students to notice their mistakes in different scenarios. Provides equal opportunities for each student (Patrik, 2002). In terms of the patients, it minimizes the risks of damage by the educational processes which would be held on them (Ziv, Small & Wolpe, 2000; Ziv, Wolpe & Small, 2003).

4.2.4. Weaknesses of the Simulation:

The most important weakness is not to replace clinical education, but only supports (Mıdık & Kartal, 2010).

4.2.5. Simulation Tools:

The simulations can be divided into two main groups: Low-tech simulations and High-tech simulations (Mıdık & Kartal, 2010).

4.2.5.1. Simulations Does Not Contain Advanced Technology ;

Three-Dimensional Organ Models; Like skeletal anatomy, lung, heart, larynx models, used in laboratories.

Basic Plastic Mannequins; These Models are used in the basic and advanced life support training and also can be used at physical examination, interventional training and wide range.

Animal Models; These models are used during the training of physiology.

4.2.5.2. Simulations Including High Technology;

Screen-Based Simulations; It is a kind of computer-assisted education (Rasmussen, Mason, Millman, Evenhouse & Sandin, 1998). It is known that different studies were carried out about these subjects. For example, Mary Rasmussen and her friends presented the three-dimensioned structure of the temporal bone virtually. In this way, the difficult and complex structure of this bone became easier and comprehensible by the virtual media (Langrana, Burdea, Ladeji & Dinsmore, 1997). Another study was carried out by Noshir Langrana and his friends. Here, a simulator was generated which enabled the cancered tissues to be inspected. Today, it is possible to examine a variety of cancer types by the use of this simulator (Mıdık & Kartal, 2010).

Realistic, High-Fidelity Procedural Simulators; These are the simulators which imitate the parts of human body and focus on certain responsibilities (Bradley, 2006; Maran & Glavin, 2003; Mıdık & Kartal, 2010).

Realistic High-Tech Interactive Human Simulator; These are composed of models quitely resembling human and computer assistant. A realistic medium is maintained by computer assistant and they give the opportunity of managing these complex clinical situations to the students (Mıdık & Kartal, 2010; Good, 2003).

Virtual Reality and Haptic Systems; Technologic education requiring high-level computer assist which is used especially in surgery education (Maran & Glavin, 2003; Mıdık & Kartal, 2010).

4.3. Education by using cast models and plastination:

People gain knowledge by using visual, auditory and touch senses at most. It can be claimed that the usage of three-dimensioned plastic models in anatomy education raises the learning performance. On the other hand, although the complex structure of cadaver prepared by formaldehyde includes different variations, it may hide the details wanted to be given to the student. However, the subjects introduced by plastic models are easier to be learnt and comprehended by the student (Gültiken, 2012). The use of virtual materials in education, makes the concepts concrete, easy to understand and facilitate the chance of observation and re-using (Mandıracıoğlu, Hassoy & Karababa, 2011).

At the beginning of 20th century, anatomy lessons were taught by plastic models of organs. For example, German students have used these models since 1930's. Anatomist Dr. Gunther von Hagens, who is a researcher in Heidelberg University in Germany, worked for 10 years on development of plastination method in stead of plastic models since the middles of 1970's (Britta, 2012).

Plastination is a method which is formed by banishing oil and water from the subscribed body tissues and replacing them by polimerized materials and hardening the samples by shaping them out (Buyruk, Groen, Kemperman & Altuniçn, 1990). This operation should be carried out in about two and ten days after the death for resembling a living body (Britta, 2012). Highly substantial cadavers which are unwatered, scentless and real-like can be obtained by the use of polimers like resin, silycon and polyester in this method (Sugand, Abrahams & Khurana, 2010). The type of polimere used in the method determines the properties of the plastinized sample, like optic (transparent or opac) and mechanic (flexible or stable). Being unwatered, scentless and substantial, the plastinized samples preserve even their structural properties at the histologic level (Von Hagens, Tiedemann & Kriz, 1987).

Past studies indicate that students are more sensitive to models which are prepared by plastination. At the same time, it is concluded that the material prepared by plastination increases the learning ability (Latorre, Garcia-Sanz, Moreno, Hernandez, Gil, Lopez et.al., 2007). Another determined fact is that the plastinats are less damaged than plastic models. (Sugand, Abrahams & Khurana, 2010). Plastination method was also tried in Turkey, by using cheaper polimers like alkid resin in order to decrease the cost (Gültiken, 2012).

CONCLUSION

We are in an era of educational technologies being used today. Therefore, to engage the modern and alternative approaches into the educational process is an essential element of today's education sector. Teaching anatomy traditionally on cadavers in faculties of medicine is essential because they provide the opportunity of knowing three-dimensional structure and diversity of the body. But in recent years, the bodies as training equipment are being simulated by images, using computer-aided teaching methods; some plastic lifelike anatomical models or other recent methods such as the use of plastination are being used. The use of all these recent and technologically developed methods

allows us to decrease both the required time for training and the cost of education. In addition to these contributions, ensuring the hygienic and healthy conditions in the laboratory environment is becoming a matter of preference as well.

The health problems, which the staff working in education may face because of the conventional cadavers' appearance and unpleasant odors caused by formaldehyde, allows working after removal from the pool wetness, are of great importance considering the model and plastinates. However, all of these models, as it is known, may not create a suitable environment to monitor the anatomic variations of the human body and possible pathological structures. Consequently, although it seems to have some negative aspects dealt with, it is still considered to be appropriate, continuing the use of cadavers in education.

REFERENCES

Arts, J.H.E., Rennen, M.A.J., & de Heer, C. (2006). Inhaled formaldehyde: evaluation of sensory irritation in relation to carcinogenicity. *Regulatory Toxicology and Pharmacology, 44*, 144-160.

Atabek, E. & Görkey, Ş. (1998). *Başlangıçtan Rönesansa Kadar Tıp Tarihi.* (pp.130). İstanbul Üniversitesi Cerrahpaşa Tıp Fakültesi Yayınları, Rektörlük No.:4136, Fakülte No.:219, İstanbul, Dilek Ofset Matbaacılık.

Balcombe, J. (2001). Dissection: The Scientific Case for Alternatives. *Journal Of Applied Animal Welfare Science, 4*, 117-126.

Bradley, P. (2006). The history of simulation in medical education and possible future directions. *Med. Educ., 40(3)*, 254-262.

Britta, M. (2012). Gunther von Hagens' Plastination Technique. *Embryo Project Encyclopedia,* http://embryo.asu.edu/view/embryo:128738 (26.03.2013).

Buyruk, H.M., Groen, G.J., Kemperman, H., & Altuniçn, A. (1990). Bugün Plastinasyon 1: Yöntemin Geçmişi ve Uygulanabilirliği. *The Turkish Journal of Pathology, 6(2),* 73-77.

Erimoğlu, C. (1988). Anatomi. In Unat, E.K. (Ed.), *Dünya'da ve Türkiye'de 1850 yılından sonra Tıp Dallarındaki İlerlemelerin Tarihi* (pp.26-30). İstanbul, Gürtaş Matbaası, Cerrahpaşa Tıp Fakültesi Yayınları.

Garrison, F.H. (1921). *An Introduction to the History of Medicine: With Medical Chronology Suggestions for Study and Bibliographic Data.* (pp.94-95). 3rd ed., Revised and Enlarged, W.B. Saunders Company, Philadelphia and London.

Good, M.L. (2003). Patient simulation for training basic and advanced clinical skills. *Med. Educ., 37*, 14-21.

Gültiken, M.E. (2012). Plastik Model Kullanımı Veteriner Anatomi Eğitiminde Alternatif Olabilir mi?. *Animal Health, Prod. and Hyg.,1*, 53-58.

Gürbüz, H., Karlıkaya, E., & Mesut, R. (2004). Kadavra Bağışı Üzerine Görüşler. *Turkiye Klinikleri J. Med. Ethics, 12,* 234-241.

Kâhya, E. (1996). *Şemseddîn-i İtâkî'nin Resimli Anatomi Kitabı.* (pp.VIII). Atatürk Kültür, Dil ve Tarih Yüksek Kurumu, Atatürk Kültür Merkezi Yayını, Sayı:95. Ankara.

Langrana, N., Burdea, G., Ladeji, J., & Dinsmore, M. (1997) Human Performance Using Virtual Reality Tumor Palpation Simulation. *Computers & Graphics, 21(4)*, 451-458.

Latorre, R.M., Garcia-Sanz, M.P., Moreno, M., Hernandez, F., Gil, F., Lopez, O., Ayala, M,D., Ramirez, G., Vazquez, J.M., Arencibia, A. & Henry, R.W. (2007). How Useful Is Plastination in Learning Anatomy? *Journal of Veterinary Medical Education, 34(2)*, 172-176.

Lyons, A.S. & Petrucelli, R.J. (1997). İskenderiye'deki Tıbbi Merkez ve Mezhepler. Güdücü, N. (Çev.), *Çağlar Boyu Tıp*, (pp.229). İstanbul, Roche İlaç Firması Yayını Omaş Ofset A.Ş.

Mandıracıoğlu, A., Hassoy, H. & Karababa, A.O. (2011). Halk Sağlığı Eğitiminde Film Kullanımı. *Tıp Eğitimi Dünyası, 31*, 17-28.

Mayer, R.E., & Moreno R. (1998). A Cognitive Theory of Multimedia Learning: Implications for Design Principles. "http://spnd423.com/SPND%20423%20Readings/A%20Cognitive%20Theory.pdf" (Erişim Tarihi: 23 Mart 2013).

Maran, N.J., & Glavin R.J. (2003). Low-to High–Fidelity Simulation-A Continuum of medical education. *Med. Educ., 37*, 22-28.

Mıdık, Ö., & Kartal, M. (2010). Simülasyona Dayalı Tıp Eğitimi. *Marmara Medical Journal, 23(3),* 389-399.

Ohmichi, K., Komiyama, M., Matsuna, Y., Takanashi, Y., Miyamoto, H., Kadota, T., Maekawa, M., Toyama, Y., Tatsugi, Y., Kohno, T., Ohmichi, M., & Mori, C. (2006). Formaldehyde Exposure in a Gross Anatomy Laboratory Personal Exposure Level Is Higher Than Indoor Concentration. *Environ Sci & Pollut Res, 13 (2,)* 120-124.

Patrik, J. (2002). Simulation. In Patrik, J., (Ed.), *Training:Research and Practice* (pp.487-508). London: Academic Press.

Rasmussen, M., Mason, T.P., Millman, A., Evenhouse, R., & Sandin, D. (1998). The virtual temporal bone, a tele-immersive educational environment. *Future Generation Computer System, 14*, 125-130.

Ronan, C.A. (2003). Dünya Kültürlerinde Bilimin Tarihi ve Gelişmesi. In Türkcan E. (Ed.), İhsanoğlu E. & Günergün F. (Çev.), *Bilim Tarihi* (pp.125-126). 3.Basım, Ankara, Tübitak Yayıncılık, Başak Matbaacılık.

Sugand, K., Abrahams, P.. & Khurana, A. (2010). The Anatomy of Anatomy: A Review for Its Modernization. *Anatomical Sciences Education, 3*, 83-93.

Von Hagens, G., Tiedemann, K., & Kriz, W. (1987). The current potential of plastination. *Anat. Embryol., 175*, 411-421.

Ziv, A., Small, S.D., & Wolpe, P.R. (2000). Patient safety and Simulation-Based Medical Education. *Med. Teach., 22(5)*, 489-494.

Ziv, A., Wolpe, P.R., Small, S.D., & Glick, S. (2003). Simulaton Based Medical Education: An Ethical Imperative. *Acad. Med., 78*, 783-788.