

Advances and Alternatives in Human Anatomy Teaching: What Next?

Edivaldo Xavier da Silva Júnior*

Department of Physiotherapy, Human Anatomy Teaching and Research Laboratory (LABEPAH), University of Pernambuco, Petrolina, Brazil

***Corresponding Author:** Edivaldo Xavier da Silva Júnior, Department of Physiotherapy, Human Anatomy Teaching and Research Laboratory (LABEPAH), University of Pernambuco, Petrolina, Brazil.

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Human anatomy is one of the oldest sciences in field of biology. The discipline is studied by future healthcare professionals with the objective to know the microscopical and macroscopical structures that build the human body, as well as its functions, correlations and connections, through dissection.

For this purpose, we need an ancient tool, which dates back to 500 BC, by the Greeks - although some authors mention the beginning of its use by the Egyptians -, the cadaveric dissection. The earliest known records of dissection, as the act of cutting bodies to study anatomy, dates back to the third century BC, in Alexandria. Hippocrates of Kos was the first to write about Human Anatomy in the fifth century BC [1].

Over the years, the use of cadavers for anatomical studies, suffered several restrictions which led some anatomists, such as Galen, to dissect animals and correlate these observations to the human body. In the Middle Ages, dissections were banished or neglected for various reasons, such as religious and cultural. This caused some delay in the progress of knowledge of the human body, through weak scientific visibility [2].

In the Renaissance times, dissections were again permitted, to discover the cause of death of influential people, as well as the nature of the pests that plagued in those times [3].

In the sixteenth century, Andréas Versalius became a landmark through this resumption of the advance of anatomical studies. The fundamental basis for his results was human dissection, that led him to publish the famous work *De Humani Corporis Fabrica* in 1543 [4]. This practice, allowed him to produce precise drawings of Human Anatomy, thus allowing anatomists to develop more precise knowledge of human body, as a fundamental tool for the study of Human Anatomy and Physiology. To this "Father of Anatomy", we owe the demonstration that medical students need the fundamental knowledge of Human Anatomy as the basis of their future clinical knowledge [5].

Human cadaveric dissection has since then become the most adequate, coherent, and trustworthy method to study Anatomy, giving rise to great books and treatises that describe, in rich detail, all the structures, organs and systems that constitute the human body. This can never be replaced in teaching of Anatomy, even when complemented with other methods and/or techniques.

Nowadays, cadaveric dissection is still currently performed in some higher education institutions. Nevertheless, many modern students still consider Anatomy as a tedious, monotonous subject, when presented through theoretical expositions to be followed by practical tutorial classes.

Before considering alternative methods to teach Human Anatomy, I should emphasize one extremely important note on the use of the cadavers in practical classes. Some higher education institutions of Europe and North and South America are again abolishing the practice of cadaveric dissections for various reasons such as storage difficulties; toxicity to the health of teachers, technicians and students;

reduction of teaching hours for Human Anatomy discipline; and the development of more modern teaching tools, through technology and interactive media. I believe that these should not be neglected, but must be associated with cadaveric dissection, as a complement. This, and only this, will allow health students to differentiate normal from abnormal in the human body, or what is variable or constant.

Throughout the world, Anatomists are considering to transform this monotony into something more attractive, less memorized and more meaningful, through the use of methods that can complement and corroborate the use of the cadaveric dissection in Human Anatomy Laboratories.

Worldwide, Anatomy Laboratories have been experimenting with alternative methods that allow more attractive practical application. Great success has been achieved through the use of some methodologies to complement the study of cadaveric dissection, such as experimentation; games; multimedia technology; virtual laboratories; 3D virtual tables; imaging tests; theater plays; online courses with use of laboratory; practical training exercises; drawing production; social networks; preparation of teaching materials by students; synthetic anatomical models, as well as those produced by students themselves; functional models; and the use of practical classes scripts.

One of the main factors that compromise the use of cadavers in practical classes is the choice of toxic embalming methods. Formaldehyde is the oldest and most effective and still the most widely used method of embalming. Its properties allow the preservation of macroscopic and microscopic features of tissues. It bears disinfectant properties against cadaveric bacteria and most fungi. It is composed of methanol, resins and heavy metals, such as lead and cadmium. It has been proven to have toxicity and a high carcinogenic potential, according to the International Agency for Research on Cancer [6]. It irritates the respiratory, gastrointestinal and ocular mucous membranes and it can cause cardiopulmonary changes [7]. In addition, it darkens and dehydrates tissues, promotes stiffness, coagulates blood very quickly, contracts capillaries, low resistance and texture, limits surgical planes, making it difficult to identify small structures. Because of its strong odor [8] and high power of environmental contamination many labs are considering to ban the use of formaldehyde despite the obvious cost benefit. Many institutions have stopped using cadavers in Anatomy teaching, substituting cadaveric dissection by the use of synthetic models or 3D digital desks.

Currently, anatomists are thriving to find new methods to allow the use of cadavers in practical classes and research. However, in the meantime, there has been a significant decrease in the legal acquisition of human cadavers, in several parts of the world, leading some institutions to develop Body Donation Programs in Life. Several of these programs have been quite successful in international terms, such as professor Andrea Oxley's program at the Federal University of Rio Grande do Sul, Brazil [9,10]; or the Bodies donation program in North American universities, which operate according to laws of each State [10]; and the Body Donation program of NOVA Medical School of the New University of Lisbon, Portugal [2,12,13].

Modern embalming methods are under development to permit longer times of preservation for more updated and viable teaching and research in human anatomy and surgical techniques training. The Walter Thiel embalming technique [14], also known as the Gratz Embalming protocol is currently the most widely known and used in various higher education institutions worldwide. This method preserves the quality and flexibility of the embalmed cadaveric material. It keeps disinfectant properties and has no odor [14]. After death, the bodies are perfused with a solution of water, glycol, various salts, formaldehyde, chlorocresol and morpholine (the last three, in small quantities), after which they are immersed in the same solution for a period of two to three months. After this period, the cadaver may remain immersed in this solution, or wrapped in plastic bags with no necessity of refrigeration or vacuum storage for later use by students and health professionals. In addition, this method allows the injection of dyes, such as colored silica into the vessels, thus adding more realism to classes and surgical training [15].

In 1998, Coleman and Kogan [16] also developed a new different embalming solution to preserve corpses. It is composed of saturated sodium chloride isopropyl alcohol, glycerol, phenol, a small concentration of formaldehyde, and water [16]. This achieved excellent tissue preservation for 12 to 15 months, with preservation of natural color, flexibility and structure of the cadaver material [17]. It is an inex-

pensive and logistically simple method, which preserves the body at room temperature [17], thus allowing its use for teaching, research and surgical training.

Nowadays, the embalming method of excellence for dissections, which preserves texture, color and flexibility, while keeping the disinfectant properties against the cadaveric decomposition process, is proposed by João Erse Goyri O'Neill [12] and collaborators of the Nova Medical School of the New University of Lisbon in Portugal. Their method is referred by Brenner's [8] and Balta's., *et al.* [18] studies in their respective review of the literature, as the most modern and efficient technique in cadaveric preservation. This method uses a mixture of aliphatic alcohols, diethylene glycol and monoethylene glycol to produce a transparent, practically odorless, colorless liquid that is denser than water. They observe that the use of this mixture delayed the process of decomposition, and it only requires refrigeration of body at low temperatures, without submersion. Some of their embalmed specimens have surpassed five years of good quality conservation. This method has promoted good results in several human anatomical studies and PhD Research thesis in this educational institution with publications in magazines of great international scientific relevance, such as Casal [19], Ribeiro., *et al.* [2] or Bettencourt-Pires [13], as well as more than ten successful international Surgical Training and Postgraduation courses in Europe since 2009 [20].

We must remark the extraordinary advances and progress in the field of Human Anatomy studies since the implementation of these new embalming methods and Cadaveric Donation Programs. As for those institutions that do not have easy access to human cadaveric material, working with alternative methods is nowadays the way to solve the problem of teaching Anatomy in the absence of cadaveric material for practical classes. The credible best alternative for such institutions is to start, as soon as possible, a fully legalized Program for Bodies donation in life, and to develop research for the best embalming, lasting and effective methods to keep and conserve longer conditioned collections of embalmed cadaveric material to be used for teaching, research and surgical training. As of today, even six years after its publication, the most effective embalming technique remains that by Goyri-O'Neill's., *et al.* [12], when compared with those of other anatomists of this and other centuries, I should conclude with a note of emphasis for the irrefutable fact that, even with the technological advances to development modern alternative methods of teaching Human Anatomy, the corpse can never and should never be replaced.

Bibliography

1. Miyazaki RS. "A ciência da carne: a linguagem gráfica da Anatomia Humana". Monografia de Conclusão de Curso de Graduação em Artes Visuais - Universidade Estadual Paulista "Júlio de Mesquita Filho" (UNESP), São Paulo (2013): 1-67.
2. Ribeiro FS., *et al.* "Repensar a Cialgia Perante Variação Anatômica Bilateral do Nervo Isquiático, com Origem Baixa e Divisão Alta: Importância Histórica, Anatômica e Clínica". *Acta Médica Portuguesa* 31.10 (2018): 568-575.
3. Araújo Júnior JP., *et al.* "Desafio anatômico: uma metodologia capaz de auxiliar no aprendizado de anatomia humana". *Medicina* 47.01 (2014): 62-68.
4. Silva Junior EXD. "Avaliação do uso de modelos anatômicos alternativos para o ensino-aprendizagem da anatomia humana para alunos do ensino fundamental de uma Escola Pública da cidade de Petrolina, Pe". Dissertação (Mestrado em Educação em Ciências: Química da Vida e Saúde). Universidade Federal do Rio Grande do Sul, Porto Alegre - RS (2015): 1-98.
5. Anyanwu GE., *et al.* "Dark age of sourcing cadavers in developing countries: a nigerian survey". *Clinical Anatomy* 24.7 (2011): 831-836.
6. Smoke T and Involuntary S. "IARC monographs on the evaluation of carcinogenic risks to humans". IARC, Lyon (2004): 1-1452.
7. Onyeka OC., *et al.* "Effects of Formaldehyde Inhalation on Cardiopulmonary Functions on Medical Students of College of Health Sciences, Nnamdi Azikiwe University during Dissection classes". *American Journal of Physiology, Biochemistry and Pharmacology* 7.2 (2018): 86-94.
8. Brenner E. "Human body preservation - old and new techniques". *Journal of Anatomy* 224.3 (2014): 316-344.
9. Da Rocha AO., *et al.* "The body donation program at the Federal University of Health Sciences of Porto Alegre: A successful experience in Brazil". *Anatomical Sciences Education* 6.3 (2013): 199-204.

10. Da Rocha AO, *et al.* "Using body donor demographics to assist the implementation of donation programs in Brazil". *Anatomical Sciences Education* 10.5 (2017): 475-486.
11. Champney TH. "The business of bodies: Ethical perspectives on for-profit body donation companies". *Clinical Anatomy* 29.1 (2015): 25-29.
12. O'Neill JG, *et al.* "Improvement of the embalming perfusion method: the innovation and the results by light and scanning electron microscopy". *Acta Medica Portuguesa* 26.3 (2013): 188-194.
13. Bettencourt-Pires MA, *et al.* "The supinator muscle and radial nerve entrapment". *Acta Scientiae Anatomica* 1.1 (2018): 3-13.
14. Thiel W. "Die Konservierung ganzer Leichen in natürlichen Farben". *Annals of Anatomy* 174.3 (1992): 185-195.
15. Healy SE, *et al.* "Thiel embalming method for cadaver preservation: a review of new training model for urologic skills training". *Urology* 85.3 (2015): 499-504.
16. Coleman R and Kogan I. "An improved low-formaldehyde embalming fluid to preserve cadavers for anatomy teaching". *Journal of Anatomy* 192.3 (1998): 443-446.
17. Burns DM, *et al.* "Saturated salt solution cadaver-embalming method improves orthopaedic surgical skills training". *Journal of Bone and Joint Surgery-American Volume* 100.15 (2018): e104.
18. Balta JY, *et al.* "Human Preservation Techniques in Anatomy: a 21st century medical education perspective". *Clinical Anatomy* 28.6 (2015): 725-734.
19. Casal D, *et al.* "A rare variant of the ulnar artery with important clinical implications: a case report". *BMC Research Notes* 5.1 (2012): 660.
20. Goyri O'Neill JE, *et al.* "The Lisbon Dissection Room". In XXII International Symposium on Morphological Sciences. Abstracts (2012): 185.

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