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UNITY THROUGH DIVERSITY IN TEACHING VETERINARY ANATOMY

UNITATE PRIN DIVERSITATE ÎN PREDAREA ANATOMIEI VETERINARE

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ABSTRACT | REZUMAT

Nowadays, the graduate of a veterinary school should know the Anatomy of a wide variety of animals as a starting point to diagnose and treat any abnormal condition. Therefore, the information acquired must be as extensive and precise as possible. However, this is quite difficult due to the number of contact hours with the students which has decreased, and so has the number of species studied. In general, the Anatomy is taught in a descriptive manner and in a comparative way, giving more attention to clinical Anatomy. The teachers mix the classical with modern methods of teaching, trying to make the courses easy and agreeable. The expression "seeing is believing" confirms that the cooperative argumentative dialogue between individuals (professor and students) is very necessary. Also, the contact of the students through dissection with the anatomical structures is essential. Therefore, the stratigraphic dissection on fresh specimens opens the door for surgery, cardiology, ophthalmology, all of the clinical disciplines, and for medical diagnostic investigations. However, when fresh specimens are not available, embalmed cadavers are used, but more blamed because of the noxious influence of formaldehyde. For avoiding this, the "*Infutrace*" can be used, and the results of using it are excellent. It produces a significant reduction of formaldehyde and phenol vapors up to 95%, and is very safe for personnel use and the entire laboratory environment.

Keywords: anatomy, teaching, dissection, formaldehyde, Infutrace

La momentul actual, absolventul de medicină veterinară ar trebui să cunoască anatomia unei mari varietăți de animale, ca punct de pornire pentru diagnosticarea și tratarea oricărui aspect anormal. În consecință, informațiile acumulate trebuie să fie cât mai extinse și mai precise. Acest lucru devine destul de dificil de realizat datorită scăderii numărului de ore de activitate cu studenții, la fel și a numărului de specii studiate. În general, anatomia este predată într-o manieră descriptivă și comparativă, acordând însă mai multă atenție anatomiei clinice. Profesorii combină metodele clasice de predare cu cele moderne, încercând să facă prelegerile ușoare și plăcute. Expresia "dacă nu văd nu cred" confirmă faptul că dialogul argumentativ cooperant între participanți (profesor și studenți) este foarte necesar. De asemenea, contactul studenților prin disecție cu structurile anatomice este esențial. Prin urmare, disecția stratigrafică pe piese proaspete deschide orizonturile pentru chirurgie, cardiologie, oftalmologie, toate disciplinele clinice și pentru investigații medicale în scop de diagnostic. Cu toate acestea, atunci când nu sunt disponibile piese proaspete, se folosesc cadavre conservate prin formolizare, metodă mult blamată datorită efectului nociv al formaldehidei. Pentru a evita acest lucru, se poate utiliza "*Infutrace*" iar rezultatele utilizării sale sunt excelente. Produce o reducere semnificativă a vaporilor de formaldehidă și fenol până la 95% și este foarte sigură pentru utilizarea de către personal și pentru mediul de laborator.

Cuvinte cheie: anatomie, învățare, disecție, formaldehidă, Infutrace

All over the world, Anatomy (gross Anatomy) is part of the fundamental disciplines of the curriculum in medical, as well as in veterinary medical schools (11). Moreover, all of the preclinical and clinical disciplines are based on the knowledge of Anatomy, according to the aphorism "Anatomy is the foundation of medicine and veterinary medicine alike" (30).

Human Anatomy is dealing with only one species, whereas Veterinary Anatomy studies various species of mammals, birds, (domestic and wild), reptiles, fish(es). Anatomy of the domestic mammalian species in Romania before 1989 was focused on farm animals (large ruminants) and on horses (all of them called livestock) (19). In Columbia, Missouri, USA, gross Anatomy is taught on embalmed dogs, cats and laboratory animals in the first semester, and horses, large ruminants, prosected pigs, chickens, and reptiles in the second semester. As embalming fluid, the best choice is using the *Infutrace* (1).

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Nowadays, interest in all domestic species has increased, as well as interest in exotic animals. Therefore, Anatomy of domestic and selected exotic animals should be part of the curriculum. The graduate of a veterinary school should know the Anatomy of a large palette of animals as the starting point to be able to diagnose and treat any abnormal condition (7, 22). In addition, the graduate should know how to handle exotic animals, which should also be taught during the teaching of Anatomy. In the USA, the Anatomy is taught in the first year only (with some exceptions), whereas the higher education in veterinary medicine lasts 4 years. Twenty, thirty years ago, the students dissected also small ruminants and pigs, turkeys, pigeons, and parrots. The number of contact hours with the students has decreased, and so has the number of species (30, 31).

Giving the same importance of anatomical structures to all species, the students during the clinical rotations, as well as the graduate should know how to approach, diagnose, and treat different conditions, species by species. Large ruminants are different from sheep and goats (5, 6), dogs are different from cats, domestic birds are different from wild or exotic birds as far as particular anatomical detailed differences, and so on.

Anatomy is taught in Romania in the first two years of the total six years of the higher education according to the curriculum, and it is part of the fundamental disciplines. Anatomy is taught in a descriptive manner and in a comparative way. The corollary of Anatomy is topographical Anatomy, which is taught in the fourth semester. In the recent years, in two Faculties of Veterinary Medicine, Anatomy has been enriched by landmarks and approaches of the anatomical structures susceptible to clinical intervention, following the model of the Clinical Dissection Guide for Large Animals.

In Columbia Missouri, one of the co-authors introduced clinical Anatomy, and is the author of the first clinically oriented dissection guide in veterinary medicine (5, 6). He also made Anatomy easy to teach and for the students to learn, by asking the heads of the clinical disciplines to mention what anatomical structures a student coming into the clinical rotations should know (13). With this information in hand, Anatomy is taught without all details he was teaching in Romania, focusing the attention of students on the clinically important anatomical structures. However, equal importance is given to all chapters of Anatomy, with less details. And this is because the era of teaching Anatomy in a descriptive way as 60, 80, 100 years ago is over. For example, the origins of skeletal muscles are mentioned by the level of the bones (distal humerus, proximal tibia etc), sometimes by specific anatomical structures (the biceps brachii on the supraglenoid tuberosity of scapula). However, in the Anatomy laboratory, the students dissect the muscles and are aware of all points of origin of muscles. And the above example is also applicable to all chapters of Anatomy (blood vessels, peripheral nervous system, viscera).

It is important to know that in Columbia, Missouri, in the first semester (16 weeks long) the students dissect all structures in 135 laboratory-hours, and in the second semester (also 16 weeks long) in 232 laboratory hours (26 lecture-hours in the first semester, and 40 lecture-hours in the second semester). The 120 students are not separated in groups as they are in Romania, all students dissecting simultaneously in the same room, with all faculty members as instructors, present.

Several years ago, Developmental Anatomy was separated from gross Anatomy, and is taught in the second semester in 12 lecture-hours, plus 4 examinations of one hour each. Recently, teaching Neuroanatomy became independent from gross Anatomy, and is taught in 23 lecture-hours and 21 laboratory-hours, plus 2 examinations of 3 hours each. In Romania, Anatomy is taught in two years, each semester lasting for 14 weeks. Per total, the lecture-hours are 112, whereas the laboratory-hours are 140. If we compare the teaching of Anatomy (lectures and laboratory) in these two countries including the examinations, the number of hours is different under so many circumstances.

The lectures include new information each year, selected from publications, attending national and/or international congresses, and interaction with our peer (2)**.** Most of the information are provided by clinical cases, or case reports. In function of the personality of the professors, associate professors, or assistant professors, and his/her knowledge on the subject matter, the teacher mixes classical with modern methods, trying to make the course easy and agreeable for the students (19). The teachers with artistic talent accompany the lectures with color chalk sketches on the blackboard (23). The audio-visual methods of teaching are used by teachers in a personal manner (20). The students often use handouts, laptops or cell phones to take notes. The handouts should be posted on the computer, or internet, depending on the availability, and this is the case in Columbia, Missouri. In addition, one co-author of this report is teaching Anatomy in Columbia, Missouri using the Socratic method, which is a form of cooperative argumentative dialogue between individuals (professor and students), based on asking and answering questions to stimulate critical thinking and

to draw out ideas and underlying presumptions (12).

Let's compare color chalk sketches on the blackboard versus power point presentations, videos etc, and understand the differences between a step by step systematic drawing and a finished figure with muscles, vessels, nerves and other anatomical structures with tens of labels around (27). The teacher follows the structures one by one, with colored chalk, from the origin to the target. A good example is that of an artery, or of a vein: from the origin of the main vessel, the teacher follows all branches and finishes with the terminal branches calling all of them by names. Then starting with a nerve from a plexus, or from the apparent origin, he/she is doing a similar pattern. In the case of a finished figure the students are scared by the numerous labels and structures all at once, whereas following each structure from the origin to the last branch is easy to comprehend. With the information acquired during the lecture, a complex drawing can be deciphered and understood (22).

It is important here to make a parallel between the standards for instruction in Veterinary Anatomy in Romania and in the United States. As part of the team of heads of Anatomy of all four veterinary institutions in the 70s in Romania, one of the co-authors of this report remembers that the uniformity of the Anatomy curriculum was established for all veterinary institutions. In 1978 a "Common Handbook" = a standard manual of ve-terinary Anatomy was published. Things evolved after 1989, and now we witness a similar standard manual for teaching, with different authors, and also separate manuals from each faculty of veterinary medicine. However, minimum standards for instruction in Veterinary Anatomy are not yet established. In the United States the Minimum standards (9 pages) are adopted by the American Association of Veterinary Anatomists, the forum which sets and recommends those universal minimal standards, essential to a veterinary curriculum. The practical activity is performed in Romania in the Anatomy laboratories, by groups of students under guidance. Since there is not a unique dissection guide, at the beginning of each session, the instructors expose all anatomical structures by dissection of fresh specimens, demonstration on prosected specimens (fresh or embalmed), or viscera obtained from the cadavers, or from the slaughter houses (8). Then, the students start identifying the structures, looking at the color, consistency, shape, and particular features (13). This kind of activity challenges the students to explore reality and to learn by themselves through personal experience, under the instructors' guidance. A goal which became necessary is to write and illustrate dissection guides for major mammalian and avian species, as they are available in the United States (13). Thus, the students initiate an inductive discovery, which based on particular data and knowledge leads to knowledge and operations with a high degree of generalization (26).

In Romania, by learning in small groups, the students are encouraged to express themselves, and, as a result, a deductive discovery is obtained by syllogisms and argumentations (12). In the United States, with all students in the laboratory at once, they are encouraged to read the Dissection Guide first, and then to start the dissection (17). If they need help, the instructors are ready to help them or start the dissection and show students how to perform the next steps. The final goal of activity in the Anatomy laboratories is to dissect and to learn how, to keep in mind the images of the dissected structures, to seed in the student mind the importance of Anatomy, and how to use the information in their clinical rotations and after graduation (7).

A sine qua non (essential element or condition) to reach this point in their higher education is to learn Anatomy in an organized and systematic manner, and not randomly (14). The muscles for example cannot be learned and understood in their role without a regional systematization (neck, trunk, abdomen, pelvic and thoracic limbs, and head). After this classification (taught fifty, sixty, seventy years ago by Profs. Ghetie and Pastea in Romania) it is easy to understand their actions: cranial muscles with proximal action are extensors of the carpus and metacarpus, and those with distal action are extensors of the digit(s). One more step: all extensor muscles of the forearm are supplied by the radial nerve with some exceptions: the biceps brachii supplied by the musculocutaneous nerve; the instructor should mention this particularity of the radial nerve, while the extensor *carpi ulnaris* muscle, flexor of carpus in unguligrades, is also supplied by the radial nerve, coming to the point that a flexor muscle is supplied by an extensor nerve. The flexor muscles are supplied by the median and the ulnar nerves, the longest nerves of the limb. As far as the blood supply, the student should follow by systematization the branches of the brachial and the median arteries feeding the muscles of the forearm. The students learn how to memorize the anatomical structures, with their nerve and vascular supply. With this example the report/analysis responds to its title: Unity and diversity. The unit is a muscle, and the diversity is applied to the nerve and artery supplying it. The systematization of the anatomical structures should be taught in the lecture room. Coming

to the laboratory the students will bring this information and check the structures on the cadaver.

Some people, in the name of so-called "diversity", and "new stuff", try to convince people that dissection can be substituted by audio-visual teaching tools, books, drawings, and artificial structures, which show the anatomical structures two-dimensionally (19, 23). In our opinion, this is wrong, because dissection first shows the anatomical structures in 3D, and opens the door for surgery, cardiology, ophthalmology, for medical diagnostic investigations (29). The students learn how to handle the scalpel and the forceps, how to reach superficial and deep structures and, moreover, how to expose them. Dissection, which means "cutting apart or separating the tissues of the body for study", and "in an operation, to separate different structures along the natural lines by dividing the connective tissue framework" is a detailed examination or analysis, and comes from Latin *dissecare* "cut in pieces," from *dis-* "apart" (see dis-) and *secare* "to cut".

We should not forget that Michelangelo Buonarroti (1475-1564) had a life-long interest in anatomy that began with his participation in public dissections in his early teens, when he joined the court of Lorenzo de' Medici and was exposed to its physician-philosopher members. By the age of 18th, he began to perform his own dissections. "*…there is no animal whose anatomy he would not dissect, and he worked on so many human anatomies that those who have spent their lives at it and made it their profession hardly know as much as he does*" (3). Performing a dissection on a human cadaver was considered as a heresy, strictly forbidden by the Church, and the only place he could do it was in a basement of a church. In exchange for permission to study corpses, the prior of the church of San Spirito, Nicoló Bichiellini, received a wooden Crucifix from Michelangelo. And as we all know, Michelangelo's masterpieces are all anatomically correct. Andreas Vesalius (1514-1564), known as the Father of Modern Anatomy, contemporary to Michelangelo, in his *De Humani Corporis Fabrica* (1555) emphasized the priority of dissection, which is essential to the learning and practice of medicine. Dissecting and comparing humans and animals, Vesalius can be considered as the promoter of Comparative Anatomy. Coincidentally, both Vesalius and Michelangelo died in the same year, two titans, one the anatomist, the other one, the artist ("Andreas Vesalius on the 500th anniversary of his birth", a presentation by Constantinescu G.M., Ellis Library, 2014).

Unfortunately, a half-millennium later, there are at least in the United States colleges/schools of medicine in which the dissection is performed much less than it should be, even colleges/schools in which the dissection is (was) not performed (31)**.** Residents in surgery or related disciplines learn anatomy for the first time, leaving the rest of the graduates with less than a minimum knowledge in anatomy.

Long time ago, in a Continuing Education journal in the US, a resident in ophthalmology complained about the total lack of knowledge of the eye anatomy (including dissection) until he started his residency program. In other colleges /schools of medicine, the anatomy is studied on mural plates, or power point lectures, all two-dimensional !

Some of our colleagues don't see the dissection as a mandatory technique in the Anatomy laboratory, and try different methods of learning Anatomy (9). The state of Missouri is a "Show me state", which confirms the expression "seeing is believing". This is a strong alarm signal for all medical and veterinary medical schools, as to train students to dissect all anatomical structures of the body. By dissecting fresh cadavers, the color, consistency and shape of the structures are similar to those of humans and live animals (23)**.** The fresh specimens can be replaced by embalmed specimens. The only disadvantage of dissecting embalmed cadavers is that the color and consistency of the structures disappear. Dissection can be performed by the students using dissection guides, or by the instructors. In this latter case, the instructors start the dissection and guide the students in the next steps, monitoring the ability and accuracy of the students' dissection. In addition, audio-visual learning tools can be used. In the United States small monitors distributed all over the Anatomy laboratory project either power points, steps of dissection, or only drawings (we prefer drawings, black and white or color, vs. photographs), accompanied by legends (22)**.** The students are encouraged to dissect by themselves, to enhance their skills and precision in handling and manipulating the scalpel, the forceps and scissors.

In addition, the students are guiding themselves by embalmed prosected specimens (the small pieces are preserved in jars with formaldehyde), and by dissected and dry specimens (28). Mural large drawings hung on the walls are also helpful.

There is a very important issue using embalmed cadavers: the noxious influence of formaldehyde. However, there are substitutes of formaldehyde used all over the world. At the College of Veterinary Medicine in Columbia, Missouri, "*Infutrace*" is the embalming fluid of choice (1).

A very detailed study has been performed in India by Kundu & Gangrade (2015), who stated in conclusions that "Formaldehyde remains the most potent agent to be used as an embalming solution or to be mixed with other similar solution". However, no name of Infutrace was found in the Kundu & Gangrade paper, albeit the Infutrace is on the market since 1989. The *Infutrace* is a "formaldehyde & phenol vapor reducing agent", and the results of using it are excellent. *Infutrace* produces a significant reduction of formaldehyde and phenol vapors up to 95%, and is very safe for personnel use (students, instructors, technicians) and the entire laboratory environment (1). The concentration of *Infutrace* varies from embalming to spraying the dissected parts of the embalmed specimen. In the United States only embalmed cadavers are used, for economical purposes, i.e. dissecting the same cadavers the entire semester. In addition, the vascular tree is injected with latex (red for the arteries and blue for the veins), making the dissection of the arteries and veins, easier. For several years, the *Infutrace* was and is still used in the anatomy laboratory during the dissection sessions and the practical examinations. There is a very detailed protocol for embalming human and animal cadavers , different for large animals, horse and cow, and for small animals, dog and cat, also for smaller specimens (re-perfusion, point of injection & spray method, even the preferred method for removing formalin from brain tissue which was originally fixed in 20% to 37% formaldehyde solution). The protocol is associated with detailed embalming procedures. The formaldehyde exposure from the *Infutrace* solution should be checked in all anatomy laboratories.

Plastination is a technique or process used in anatomy to preserve bodies or body parts, first developed by Gunther von Hagensin (1977). The water and fat are replaced by certain plastic materials, yielding specimens that can be touched, do not smell or decay, and even retain most properties of the original sample, such as the elasticity (10). Plastinated specimens are identical to the original, but only after dissecting that embalmed body part (15, 16)**.** The professors perform the dissection, which means that the students do not have access to it before the process is done. Painting the plastinated anatomical structures with different colors, or not, adding labels, or not, the exhibit can be used by students in the learning process. This is a very expensive process, and we do not want students to be limited to only learning dissected/prosected structures (28). We need students to dissect, to be accustomed to the use of the scalpel and forceps.

The so-called "palpation on the live animal" is a tea-ching tool in finding the landmarks for identifying not only superficial structures under the skin, but also to outline the area of projection on skin of the thoracic and abdominal viscera. The students should be familiar with these structures, a preview of the diagnosis of any abnormal condition by "inspection", "palpation", percussion" and "auscultation". This is a big step towards the clinical rotations. For the horse and large ruminants, the landmarks and approaches to the anatomical structures susceptible to a clinical intervention are extremely important for nerve block anesthesia, location of the bursae of all kinds, for arthroscopy, arthrocentesis, intraarticular analgesia and endoscopy. Identification of any superficial or deep structure through the skin will be the result of accumulation of information from dissection – unity and diversity.

Radiographs are part of the Anatomy in the laboratory. Radiologists from the clinics provide normal radiographs and different cases, to accustom the students to the differences between normal and abnormal (25). Identifying a fracture or an abnormal condition of bones and soft tissue will also be the result of accumulation of information about bones and viscera – unity and diversity. In this report/analysis, the authors do not exclude the use of the audio-visual teaching tools, books, drawings, and artificial structures, but only as an accessory or guidance to dissection. Unity and diversity cannot be obtained without dissection (29). All of us, the anatomists, should agree that dissection is compulsory for higher education in the schools of veterinary medicine, as well as in the schools of medicine, for reasons already explained.

Given the universal nature of Anatomy, an anatomical language was needed to be universal, precise and with no confusions (4). Thus, the first human international terminology *Nomina Anatomica* (NA) was adopted in 1895, as *Basel Nomina Anatomica*. Starting in 1968, the first edition of the *Nomina Anatomica Veterinaria* (NAV) was published. The last (newest) edition, the 6th, was recently published in 2017 (21), and includes over 6500 anatomical terms. Both NA and NAV cannot be understood without dissection. The NAV is the dictionary of terms, a vocabulary used not only by the anatomists, but by all veterinary professionals, in the clinics, in the large practice of our profession, and in research. It is periodically revised and updated. The instructors should explain some differences from the past editions, giving reasons to accept the newest edition on nomenclature. For example, the word "peroneus" – Greek – has been replaced by "fibula" – Latin –

because the International Committee on Veterinary Gross Anatomical Nomenclature decided to replace as many of non-Latin terms, with Latin terms (NAV op. cit.). There is also a *Nomina Anatomica Avium*.

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