



Advances in Anatomy and Its History

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1. Introduction

Anatomy is still considered the most ancient and basic discipline in the medical sciences. Since the work of Andreas Vesalius (1514–1564), anatomy has played a strong role in both medical research and education, being the main axis of medical research over the centuries, to foster novel findings about human bodies and shape the education provided at medical schools. In the second half of the last century, this trend was slightly modified while gross anatomical observations reduced, and education became the primary purpose of anatomy institutes [1,2]. There is also a conservative tendency in anatomic descriptions, with a seeming reluctance among acknowledged anatomists to explore new theories by returning to direct studies of gross anatomy. Although this discipline is considered an undisputed core component of the medical curriculum, anatomical research and education have been reduced in scope and status to accommodate other disciplines [3].

This occurred despite the fields of microscopic and ultramicroscopic anatomy undergoing expansion to explore the micro-world at the molecular level. This has happened despite gross anatomy, which is still recognized as a fundamental discipline, appearing quite obsolete. Such a scenario emerges when shallow perspectives are applied; in fact, in the last few years, some gross anatomical discoveries have been reported, which overturned the long existing dogmas about morpho-functional aspects. For instance, the anatomy of a previously unrecognized, though widespread, macroscopic, fluid-filled space within and between tissues represents a widened and in-depth focus on the classic concept of the human interstitium. The mesenteric continuity, as well as the novel concept of the glymphatic system, have been reported [4,5]. The gross anatomy of myofascia is terminologically evolving through the work of the Fascia Nomenclature Committee [6]. A new field of research is exploring how gut microbiota acts as an “invisible organ” to modulate gastrointestinal functions, as well as the general homeostasis of the body [7]. Apart from the sensational discovery of “new organs”, gross anatomy research remains an important tool to correct or redefine classic concepts and ascertain anatomical varieties. Independently of the approach used (*ex vivo* dissection or *in vivo* imagining techniques), it represents a unique way to explore the human body. Cadaveric dissection has several advantages: (i) gross anatomy research; (ii) the development of new dissection and preservation techniques; (iii) forensic medicine research; (iv) planning virtual anatomy software; (v) surgical training and simulation; (vi) the enrichment of anatomic museums with specific preparations (third mission of the university).

This was the opinion of the Irish anatomist Alexander Macalister (1844–1919): Practical anatomy was considered a discipline of incalculable value, for not only was the knowledge acquired an end in itself, but the method through which it was gained was the most valuable part of a student’s entire medical training. Anatomy occupied a unique position in the curriculum. In all other departments, the student had no alternative but to accept the dictum of their teacher or textbook. Here, the student was trained to use their eyes and



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hands, as well as educated to translate the impression made by the objects of study on their senses into words. This enabled students to check the descriptions in their book or those taught in the lecture room by comparing practical experience with the verbal accounts given by teachers. In the dissecting room, every student could be an investigator [8].

In this respect, the Special Issue *Advances in Anatomy and Its History* represents the best way to inaugurate the new scientific journal *Anatomia* as it provides a broad view on this topic and considers both holistic and humanistic perspectives, taking into account the innumerable connections between the history of anatomy and its recent advances.

All multidisciplinary approaches related to anatomy besides morphological techniques lie within the scope of this Special Issue, including anatomical education. Comparative and veterinary anatomy were also included. At the same time, this Special Issue looks back to the past of this discipline and focuses its attention to the history of anatomy to rediscover a long tradition of morphological investigation from an integrated perspective.

2. An Overview of Published Articles

This Special Issue includes 12 original research articles, 9 articles dealing with anatomical variations, and 8 review articles. This Special Issue captures the diversity of the studies that focus on the anatomical field. The diversity of articles, the depth of the topics, and the relative geographical reach of the authors in this Special Issue confirmed the continued interest of researchers in anatomy.

It is not the purpose of this Editorial to elaborate on each of the articles but rather to encourage the reader to read them. These articles encompass a diverse range of study methods and topics, elucidating the richness of this research field.

Original *Research Articles* represent the most numerous group included in this Special Issue. Four articles consider the important topic of anatomical education. In one *Communication*, a study provides preliminary data regarding the use of immersive virtual reality with 3D holography to improve learning of the anatomy of the heart, concluding that anatomical classes that make use of this technology, although attractive for medical students, are not superior to traditional learning in terms of knowledge retention if such classes are not precisely designed or strictly supervised by academic teachers and the students do not become familiar with the use of virtual reality goggles before anatomical classes (Czaja's article, contribution 22). In another attempt to improve anatomy teaching and learning, the use of virtual anatomy and histology and small portable autostereoscopic 3D screens was beneficial for anatomical education, and the increasing availability of such systems and reduced costs will allow this technology to have a significant impact in the coming years (Otoo's article, contribution 19). In a further study, the educational value and the students' perceptions of the effectiveness and usefulness of surgical and bioengineering technologies' integration into the anatomy course are evaluated, and the authors show that students appreciate in-depth surgical integration much more than in-depth engineering integration, even if those who prefer in-depth surgical studies also appreciate in-depth engineering studies (Miglietta's article, contribution 17). Finally, one study is dedicated to the relationship between neuroanatomy and the evolution of human brain atlases, as well as the impacts of these atlases on the understanding, presentation, and advancement of neuroanatomy, demonstrating that they are excellent ways to represent, disseminate, and support this discipline (Nowinski's article, contribution 16).

Two works deal with animal anatomy. The rostral epidural rete mirabile structure in giraffes (*Giraffa camelopardalis*) is recognized as an essential blood flow regulatory mechanism balancing physiological difficulties arising due to the extensive heart-to-head distance, and it might fulfill the same function in other long-necked artiodactyls (van der Walt's article, contribution 22). In one *Communication*, the transition from wolf to dog is observed through the study of skeletal features, accompanied by a series of parameters useful for understanding this evolutionary shift. A diminution in size occurs early in the process of animal domestication; this phenomenon is characterized in many animal species rather than just dogs. This study suggests that in order to differentiate between ancient wolf skele-

tal specimens of *Canis lupus* L. and similar specimens of *Canis familiaris* L., it is necessary to carry out several morphological studies, since there is not one single significant parameter that can be used alone for this investigation (Coli's article, contribution 18).

The pathological investigation is the topic of other two studies. This first study evaluates ultra-low-dose computed tomography protocols regarding the detectability of pulmonary nodules. The impacts of tube current settings, kernels, strength levels of third-generation iterative reconstruction algorithms, and pitch are investigated. A chest phantom with artificial spherical nodules of different densities and diameters is examined using a third-generation dual-source CT. Scanning and post-processing protocols, tube current levels, and ultra-high and non-high pitch modes are applied. This chest phantom study shows no difference in nodule detection when using ultra-high pitch protocols compared to a regular pitch mode (Leitzig's article, contribution 15). The second study investigates the diagnostic and prognostic value of different quantitative analysis methods assessing adrenal gland parameters on contrast-enhanced CT scans in patients bearing septic shock conditions, demonstrating that there is no additional diagnostic value in performing time-consuming semi-automated whole-organ adrenal gland segmentation analyses (Milberg's article, contribution 1).

The other three relevant studies refer to pure anatomical studies. One study details the morphology of the incisive or naso-palatine canal, showing that there are different anatomical features, including the absence of this canal (Iamandoiu's article, contribution 5). Another study examines, via a cross-sectional analysis, the development of hippocampal dentation in healthy children and adolescents, considering that it is associated with episodic memory in healthy adults. This is the first study indicating wide variability in the degree of hippocampal dentation (Beattie's article, contribution 3). The third study investigates three-dimensional variations in the shape of the volar rim of the distal radius with the aim of proposing a personalized implant shape design corresponding to the individual morphology for the treatment of fractures. The authors find individual differences in the shape of the radius epiphysis and suggest the development of several types of semi-custom plates with correlated sagittal and transverse bending angles. This allows for osteosynthesis with minimal soft tissue invasion while accommodating the anatomical diversity of the volar rim (Yoneda's article, contribution 10).

Moreover, in a historical article, the medical pictorial cycle devised in the annex of the villa of Flaminio Rota, a 16th century anatomist who worked the University of Bologna, is examined, revealing an interesting cultural dimension that provides new information about Rota's academic life (Armocida's article, contribution 14).

Nine original articles are dedicated to anatomical variations. Seven of them are *Case Reports*. Three articles explore blood vessel variations in greater depth: a rare bilateral variation in the branches of the internal thoracic artery (Hawi's article, contribution 27), a duplicated inferior vena cava (Klansek's article, contribution 21), and a rare configuration origin of the superior thyroid, lingual, and facial arteries in a pentafurcated common carotid artery (Zaccheo's article, contribution 12). These studies emphasize that such unexpected variations may be asymptomatic, as well as associated with severe symptoms and complicated surgical procedures.

The nervous tissue is the topic of two articles: they cover a very rare anatomical variation, namely the anastomosis between the median and musculo-cutaneous nerves (Barone's article, contribution 4), and an unusual morphologic variant related to the clinical pathological features of neuroblastoma-like schwannoma (Mortazavi's article, contribution 13).

Another two articles focus their attention on the muscular tissue: the presumed very uncommon presence of extensor indicis and digiti medii communis muscles (Penkwitz's article, contribution 20) and the distribution and appearance of the arrector pili muscle in the skin of the faces of Rhesus monkeys, showing regional differences in the distribution of hair follicles and associated arrector pili muscles (May's article, contribution 2). A similar matter is discussed in an *Opinion* article, where the authors propose a new classification of the variant cleido-occipital muscle (Silawal's article, contribution 7).

In a *Technical Note*, the author identifies and correlates oro-facial anatomy discrepancies as biometric data and the impact of its rehabilitation as an educational, forensic approach for human identification (Corte-Real's article, contribution 9).

Finally, eight *Review* articles complete the issue. Four reviews provide informative biographies of eminent figures in the field of anatomy. The first article delves into the life and accomplishments of the Spanish anatomist Juan Valverde de Amusco (1525–1587), with a special focus on his masterpiece titled *Historia de la composición del cuerpo humano*, written in the Castilian Spanish language. This book provides the first accurate description of pulmonary circulation, the vomer bone, and four extraocular rectus muscles and corrects several of Vesalius' anatomical observations. In this respect, Juan Valverde de Amusco pioneers the implementation and transfer of post-Vesalian anatomical scientific knowledge (Arráez-Aybar's article, contribution 29). Another article focuses on Jean Cruveilhier (1791–1874) and his book titled *Anatomie descriptive*, which was a great success during the author's lifetime. The masterpiece deals with the anatomy of the human body in a way that can be applied by both students and medical professionals. Due to his scientific rigor, Cruveilhier always investigates the anatomic changes linked to pathological processes, and for this reason, he could certainly be considered a predecessor of evidence-based medicine (Arráez-Aybar's article, contribution 25). Ludwik Henryk Bojanus (1776–1827), the anatomist and co-founder of Polish veterinary education, is also discussed. His most important achievements include the organization and launch of the first veterinary school in Polish lands in 1823, the compilation of a monograph about the anatomy of the European pond turtle "*Anatome testudinis europaeae*" between 1819 and 1821, and the development of methods for dealing with infectious diseases in animals. He is considered one of the most important evolutionists before Darwin (Sobolewski's article, contribution 26). The last biography refers to the Swiss naturalist René-Édouard Claparède (1832–1871), a pioneering protozoologist and comparative anatomist. He made important contributions to diverse areas of natural science, biology, and comparative anatomy, including the structures of infusoria, annelids, and earthworms; the evolution of arthropods; the embryology of spiders; and observations about marine invertebrates (Kollarou's article, contribution 24).

Two of the review articles concern vascular anatomy. The first article considers the anatomy of cerebral arteries with clinical aspects in patients with ischemic stroke. Computed tomography angiography is the main method for the initial evaluation of cerebral circulation in acute stroke, and a comprehensive examination allows for the identification of most abnormalities and normal variants. Anatomical knowledge of the presence of any normal variants, such as fenestration, duplications, and persistent fetal arteries, plays a crucial role in the diagnosis and therapeutic management of acute stroke. Sometimes, it is the clinical picture that allows us to weigh the relevance of an alteration (Barbato's article, contribution 8). The second article explores common anatomical variations in neurovascular canals and foramina that are relevant to oral surgeons. In this respect, all health professionals must continually challenge themselves to learn more about the different anatomical variations that the human body presents and how these may variations affect clinical practice to perform a surgery that is as safe and minimally invasive as possible (Sferlazza's article, contribution 6).

Another review discusses the recent topic of microbiota and refutes the notion that it should be considered an organ, given that an organ comprises tissue of similar or different embryological origins, while the microbiota is a pool of different microbial species originating individually from single replications rather than a common ancestral cellular element. Conversely, the authors present the muco-microbiotic layer as a novel morphofunctional structure (Fucarino's article, contribution 11).

Finally, a very long review in the form of a mini-book addresses the role of chemical communication in mammals, giving special attention to the vomero-nasal system in pheromone-mediated interactions. This intricate sensory system profoundly influences several aspects of social and sexual interactions, encompassing reproductive processes, the formation of hierarchies, maternal bonding, and intraspecies recognition. Furthermore, it is

evident that there is a noticeable range of variability resulting from evolutionary adaptations within this particular system, surpassing the documented variants in the olfactory system. This study opens the doors to the use of innovative approaches for enhancing the well-being and health of both animals and humans (Torres's article, contribution 28).

3. Conclusions

The present Special Issue *Advances in Anatomy and Its History* aimed at reinforcing the attention paid to this basic medical discipline. Indeed, anatomy is still considered a fundamental pillar to understand other medical fields, including pathology, physiology, and surgery. Furthermore, morphological notions are essential for better interpreting the origin, development and resolution of diseases. For these reasons, clinical and functional anatomy have great importance [9]. The advancements in imaging techniques and the availability of modern digitalized devices allow researchers to revive anatomy in living beings. These strategies represent an opportunity to innovate and integrate classic dissection and improve educational anatomy [10–12].

This Special Issue includes several articles that cover the main aspects of the anatomical discipline. A large body of work deals with classic anatomical issues in humans and animals. Cadaver dissection or novel *in vivo* imaging techniques provide useful original information about anatomical variations that must be taken into account during the clinical and surgical activities. Another group of articles considers the need to propose new educational strategies. Modern technological devices and digitalized data will allow us to improve anatomical teaching. The integration of medical imaging into anatomical education provides advantages in understanding and learning about the human body.

Finally, this Special Issue represents a constructive incitement to preserve the memory of this ancient discipline and, at same time, stimulate innovation and improve strategies to connect anatomy to new fields of research. It is also important to continue teaching anatomy as part of the modern medical curriculum. The integration of novel teaching modalities and modern technologies will encourage interest in and the retention of anatomical knowledge and its clinical relevance.

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