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Virtual atlas of topographic anatomy: a protocol for recording images

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Abstract: Resources available as virtual atlas of anatomy were listed after a brief bibliographic survey. The parameters for recording the image of the human body dissected in the topographic perspective were defined, and a protocol for the photographic record was presented as a theoretical-practical visual script of the collection of natural pieces. The virtual atlas of anatomy is a tool that facilitates learning by allowing the visual recording of practical study material, making it accessible to the student.

Keywords: Virtual atlas; topographic anatomy; human dissection.

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Atlas virtual de anatomia topográfica: proposta de protocolo para registro de imagens

Resumo: Recursos disponíveis no formato atlas virtual de anatomia foram listados após breve levantamento bibliográfico. Foram definidos os parâmetros para o registro da imagem do corpo humano dissecado na perspectiva topográfica e apresentado um protocolo para o registro fotográfico como roteiro teórico-prático visual do acervo de peças naturais. O atlas virtual de anatomia é uma ferramenta facilitadora da aprendizagem, pois permite o registro visual do material de estudo prático, disponibilizando-o de forma acessível ao estudante.

Palavras-chave: Atlas virtual; anatomia topográfica; dissecação humana.

Atlas virtual de anatomía topográfica: propuesta de protocolo para registro de imágenes

Resumen: Tras un breve estudio bibliográfico, se enumeraron los recursos disponibles en formato de atlas virtual de anatomía. Se definieron los parámetros para el registro de la imagen del cuerpo humano disecado desde una perspectiva topográfica y se presentó un protocolo de registro fotográfico como guía teórico-práctica visual para la recogida de piezas naturales. El atlas virtual de anatomía es una herramienta que facilita el aprendizaje, ya que permite el registro visual del material práctico de estudio, poniéndolo a disposición de forma accesible para el alumno.

Palabras clave: Atlas virtual; anatomía topográfica; disección humana.

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1 INTRODUCTION

The study of anatomy is present in different areas of health as an important basis for understanding the functioning of the human body, allowing a correct diagnosis of injuries and morphology altered by diverse pathologies, aiding clinical and surgical procedures (Arráez-Aybar; Bueno-Lopez; Moxham, 2014). The didactic material usually consists of natural human parts that have undergone specific preparation, fixation, and preservation processes to avoid decomposition. Although they provide a near-natural result, the fragility of the material and factors such as handling, exposure to sunlight, heat, and dehydration cause the material to deteriorate over time (Da Rocha; Barros; Fazan, 2021).

Neuroanatomical specimens, in particular, have a short lifespan in anatomical collections and are often recorded after preparation (Halle; Demeusy; Kikinis, 2017). Anatomical techniques have been developed to support alternative fixation solutions. Printing of artificial models can be a complementary resource, although it does not reproduce the characteristics of natural parts. Photographic recordings of natural materials seem to complement teaching resources for an effective practical approach (Smit; Bruckner, 2019; Schwartzman; Ramamurti, 2021; Ackerman, 2022).

Currently, it is challenging for Higher Education Institutions (HEIs) to obtain human remains for scientific purposes (Simão et al., 2016; Volanek; Rissi, 2019; Cordeiro; Menezes, 2019). Technological developments and human identification resources have led to a reduction in the number of unclaimed individuals. Voluntary donation, through registration in Body Donation Programs (PDC), is a reality in the country, promoted by national and international associations and supported by Law N. 10,406 (Brazil, 2002). However, the culture of burial due to the presence of public cemeteries in the country, the lack of knowledge about the possibility of donating the body for study, and the difficulty of finding donation programs in the interior of Brazil, are factors that negatively influence the availability of human material for study in HEIs (Da Rocha; Barros; Fazan, 2021).

In this sense, recording the entire collection of biological material prepared in the human anatomy laboratory makes it possible to create a theoretical-practical script that is easily accessible to students so that they can visualize the structures to be studied in the human body (Spitzer, 1994; D'alessandro; Bergman, 1995; Hoa; Micheau, 2008; Rosa; David; Silva, 2011; Wilkinson, 2012; Smit;

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Bruckner, 2019; Schwartzman; Ramamurti, 2021; Da Rocha; Barros; Fazan, 2021). This paper presents a protocol for capturing images of the human body from a topographic perspective to build a virtual human anatomical atlas. The topographic approach should be explored in a way that applies to the practice of health professionals, using protocols that protect the identity of the human body and are accessible to students of human anatomy (Barry et al., 2019).

2 METHODOLOGY

A search was conducted for protocols describing the creation of visual resources for teaching human anatomy. Internet search engines and scientific databases were used: PubMed, Excerpta Medica (EMBASE), Virtual Health Library (BIREME), Scientific Electronic Library Online (SciELO) and Mendeley. The search covered the period between 2001 and 2021, for works published in English and Portuguese, using only descriptors registered in the Descriptors in Health Sciences (DeHS) of the Virtual Health Library, developed from the Medical Subject Headings (MeSH) of the United States National Library of Medicine, which allows a single language in the indexing of publications. The following descriptors and their synonyms were used in combination in Portuguese and English: atlas virtual (virtual atlas), anatomia humana (human anatomy) and dissecação humana (human dissection).

2.1 Protocol for recording images

Based on the methodology described in the materials found, a protocol was drawn up for the acquisition of images of the dissected body present in the anatomy laboratory. The following parameters were considered: positioning of the specimen (anatomical planes), illumination, sequence, or series of images to illustrate the human body topographically. Figure 1 shows the anterior view of the left upper extremity after skin resurfacing. Skin resurfacing started from the incision line at the midline of the upper extremity. After standardization, tests were performed to record and edit the images. The AVerVision digital camera (model F50HD, New Taipei, Taiwan) was used to capture the images, resulting in Figure 1. The specimens were placed on the dissecting tables, which are made of non-oxidizable steel to ensure proper hygiene after use.

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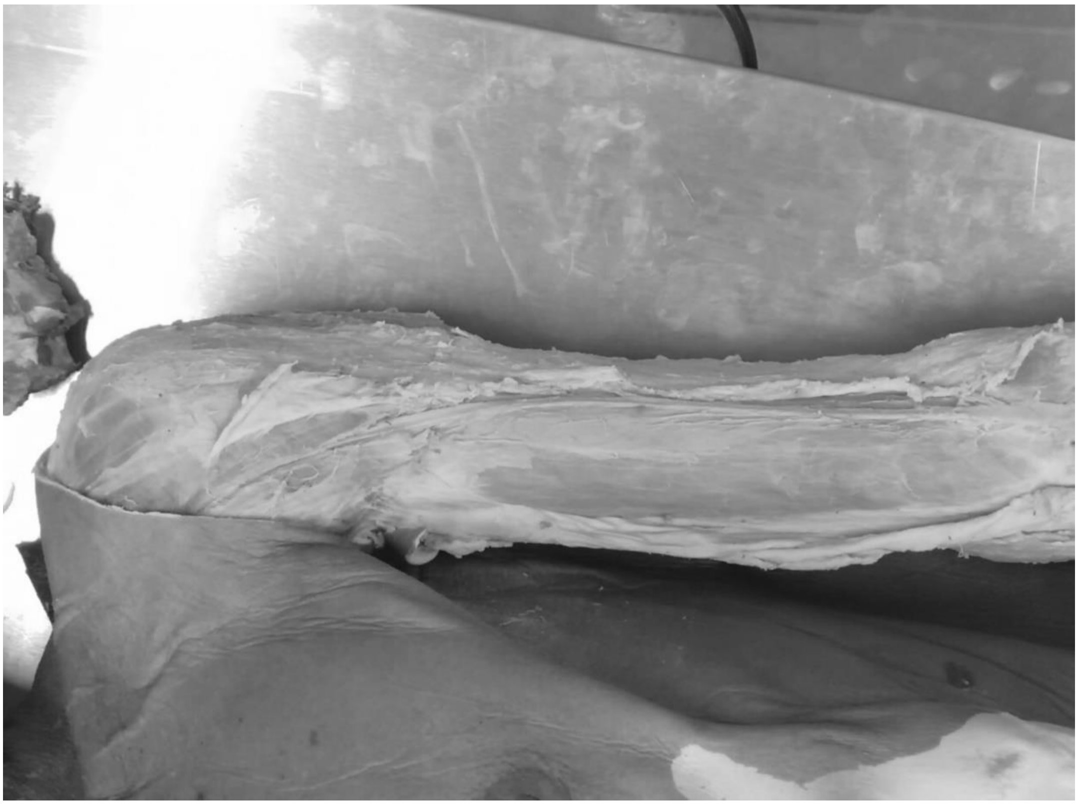
Figure 1: Left upper extremity, anterior view of the arm, after image acquisition.



Source: Collection of the human anatomy laboratory at the Federal University of Jataí. From the authors (2024).

2.1.1 Image editing

Image editing plays a critical role in revealing details that are often difficult to see at first glance. By clearly displaying anatomical structures in images, topographic dissection allows for a significant increase in visual appreciation. This capacity for visual enhancement is particularly relevant in fields where clarity in the communication of information is essential. Figure 1 underwent an editing process that resulted in Figure 2.

Color correction was applied to ensure faithful reproduction of the tones present in the natural piece. Contrast, saturation, and lighting adjustments reproduced details essential to the location of the structures shown. For example, after the skin has been folded back, it is possible to see different colors for the supporting and filling connective tissue. Beneath the skin, the subcutaneous tissue and superficial neurovascular structures can be seen above the deep muscle fascia.

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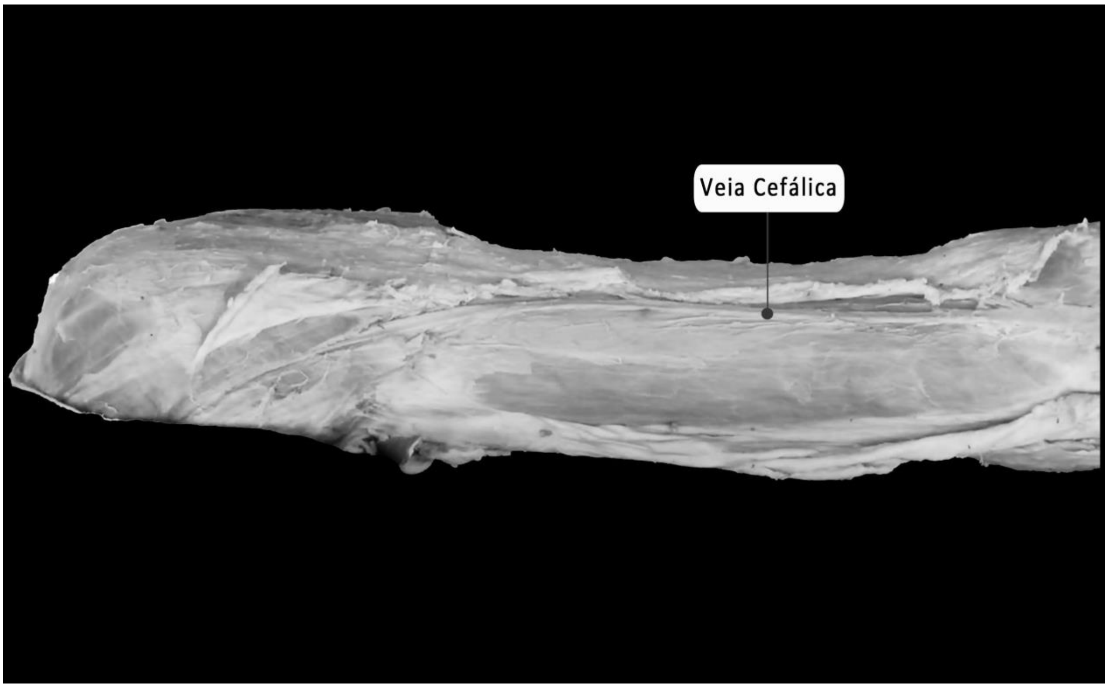
The stainless steel background reflects artificial light and does not provide sufficient contrast to highlight smaller structures. Replacing the background with a solid color highlighted the object of interest in the image and eliminated unnecessary distractions. Finally, the name of the referenced structure was strategically inserted, adding important informational context to the image. The editing not only improved the visual aesthetics of Figure 1 but also transformed it into an effective communication tool. Figure 2 thus provides a visual record of the anatomical structures studied, their syntropy in the human body, and the stratigraphy of the dissection, making it possible to adequately reproduce the depth perspective of the region in the two-dimensional image.

Figure 2: Left upper limb, anterior view of the arm, after image editing.



Source: collection of the human anatomy laboratory at the Federal University of Jataí. From the authors (2024).

2.1.2 Available visual human anatomy resources

178 studies on similar teaching tools were found in the following databases: PubMed (92), EMBASE (36), and Mendeley (50). The results of the bibliographic survey and the search sites are shown in Table 1, which lists the visual tools found as educational resources. In terms of available

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platforms, 15 virtual sites and 6 apps were found. Four applications serve Android (distributed through APK files) and Apple (IOS) platforms.

In terms of available languages, 16 tools are in English, four are in Portuguese and two are in other languages. The resources available on these platforms are varied and can offer more than one form of visual presentation: drawings in two dimensions, photographs of parts in a study, seven in video format, nine in three-dimensional (3D) images, and four offer image scans. In terms of pricing, 11 have free versions and 6 are exclusively paid.

The parameters of the photographic record were established based on an analysis of the atlases found (Table 1). After collecting the main parameters and carrying out five tests, 8 criteria were considered to be standardized: 1) Lighting: ambient light in the laboratory with the help of artificial lighting (camera flash); natural lighting should not be used due to the variations that occur during the day, which can significantly alter the color pattern in the image; 2) Registration planes: the images are observed using the planes of description and orientation of the human body in the anatomical position of description; 3) camera positioning: 90º in relation to the part to reduce image distortion; 4) removal of artifacts and instruments: guarantees the focus of the structure to be highlighted, as well as avoiding the production of reflections in the image; 5) file format: JPEG, due to its great compatibility with various devices, good preservation of image data and wide color spectrum; 6) Storage location: memory card (SD) and later stored in the cloud, to allow only researchers and human anatomy laboratory staff to work on it, ensuring the exposure of the image of the dissected body; 7) Editing: changing and standardizing the size, adjusting the lighting, contrast, saturation and adding a solid black background; 8) Identifying the structures and adding a caption.

Table 1 - Atlas and visual resources virtually available

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Name*	Authors	Year	Idiom/resource	Presentation
Atlas of anatomy	Artner, *et al.*	2004	English/webpage	Systemic drawings. Macro and microscopic
Asclépios	Rosa, David & Silva	2011	Portuguese/ webpage	Systemic in images of parts. Macroscopic.
Acland's Wolters Kluwer Health	Acland.	2022	English/webpage, social network	Topographic videos
Anatomy atlases	D'Alessandro, Bergman.	1995	English/webpage	Drawings and image scans
Anatomy.TV Primal Pictures	Wilkinson.	2012	English/webpage	Systemic, Topographic, 3D, Macro and microscopic
Homo sapiens dissecatus: visible human male - secciones transversales.	Jastrow.	1998	English, German, French, Spanish/webpage	Images from The visible human project
Radiopaedia.Org	Hacking	2005	English/webpage	Only topographic imaging scans
The visible human project. NIH NLM	Spitzer.	1994	English/webpage	RMI cross-sections
Radiology Assistant.	Smithius, R., Smithius, F.		English/webpage	Drawings, image scans
Zygote Body (Zygote Media Group Inc.)		2014	English/webpage and mobile app	3D drawings
IMAOS	Hoa, Micheau.	2008	9 idioms	Online atlas and mobile app
KENHUB		2012	Portuguese, English German, Spanish, Russian/webpage	3D drawings, testing videos
Projeto Homem Virtual.	Wen, Böhm, Zagatto.	2003	Portuguese/webpage	3D drawings, testing videos
Brain tutor, Brain Innovation	Goebel	2008	English/mobile app	3D drawings, testing videos
3D Brain DNA learning center		2017	English/mobile app	3D drawings, testing videos
Neurosciences	White	2013	English/webpage and móbile app	3D drawings, testing videos
Sylvius 4.0 online Oxford University Press	White	2013	English/mobile app	3D drawings, testing videos
The Anatomy Education Podcast	Pickering	2021	English/webpage	Audio

Source: Own elaboration (2023). *We have kept the original names

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Capturing images of the human anatomy collection is part of the work protocol focused on producing quality teaching materials. The confidential nature of this material requires a great deal of organizational effort to catalog and archive each prepared specimen and the various stages of cadaveric dissection. It can also be useful for quality control of the protocol for fixation, preservation, and conservation of anatomical specimens. Finally, this protocol proposes the standardization of the recording from a topographical point of view which is easily reproducible and can be used to propose comparisons between dissection techniques since it provides the stratigraphy of the tissues and the syntopy of the structures observed.

3 DISCUSSION

An atlas is defined as a collection of tables, graphs, or illustrations that describe a phenomenon. An anatomical atlas typically presents a series of illustrations of macroscopic structures to identify the morphology of the human body. In the field of imaging, atlas information is often constructed from a collection of regions of interest based on analyzed medical images (Smit; Bruckner, 2019).

The demand for human material for study is increasing, making it imperative not only to improve the processes for preparing dissected human bodies but also to record them. Recording the collection of parts not only complements practical teaching but also promotes the proper handling of materials and increases their durability. Anatomy teaching methods require hands-on activities that often result in material wear from handling. The availability of the virtual atlas allows access to both superficial and deep levels, making it widely available to the academic and scientific community.

From the survey, it was possible to identify different ways of presenting the human anatomical structure, the most common being through multimedia resources, which include macroscopic drawings, photographic records of biological material, video recording of topography, construction of 3D models, and presentation of imaging studies. Each format has its advantages and disadvantages which, when combined with the traditional hands-on teaching model, provide a complementary approach to the practical teaching of human anatomy.

In analyzing the platforms that use drawings to represent human anatomy, it was found that they all simplify the structures represented. Most platforms do not show the details of smaller structures, such as possible anatomical variations, grooves, and bone fissures that are commonly found. Similarly, three-dimensional drawings, although they allow manipulation of the object and three-dimensional visualization of the image, have the same limitation in terms of the variety of structures presented.

Concerning photographic images, it has been found that the records allow the visualization of smaller structures, presenting a high fidelity to the object of study. However, this form of representation requires prior preparation of the biological material using appropriate fixation and preservation techniques that allow the preservation of natural features. Furthermore, there is little incentive in the literature to standardize the acquisition protocol used to present the images, making it difficult to compare material between studies or between anatomical techniques.

In the analysis of multimedia videos, it was found that they generally suffer from the same problems as images, in that they do not show the anatomy in detail. However, they allow the axis of motion to be visualized from different perspectives, making it easier to observe a joint in action, for example. Imaging studies such as radiography, computed tomography, and nuclear magnetic resonance allow visualization using anatomical planes. Serial sectioning makes it possible to visualize the interior of the human body without dissection and to demonstrate the syntopy between body structures and organs. However, there are limitations resulting from the study itself, whether it is the radio transparency of some structures or the presence of artifacts and changes that make it difficult to study normal anatomy.

Other important points in the analysis are related to languages and the cost of using the platforms. It was observed that the predominant language is English, with 70.58% of the platforms having only English, 23.52% having the option of Portuguese and 11.78% being the only option. This shows that language is a barrier for Brazilian academics since only 5.1% of the Brazilian population claims to have some knowledge of English. Regarding the cost of the platforms, it was observed that there is a wide variation, which can reach $98.95. The free resources usually provide a limited anatomical description. The more expensive platforms are more complete and include various multimedia resources. Some platforms are linked to text explanations and present an applied approach to anatomy through illustrative clinical cases.

4 IMPLICATIONS OF THE RESULTS

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The creation of a human anatomy collection is based on voluntary donations, following the Brazilian Civil Code, and requires a strict protocol for the preparation and storage of perishable material. Considering the short survival time and the difficulty of obtaining this biological material, the standardized registration of the prepared pieces contributes to the cataloging of the collection, which is a complementary resource in distance education with accessibility and allows the display of materials for scientific purposes (Queiroz, 2019).

This work adds to the literature criteria for the recording of standardized images for the creation of a virtual anatomical atlas, from a topographical perspective. It presents a compilation of the visual resources available for online teaching of the macroscopic morphology of the human body. The creation of an atlas of standardized images not only facilitates the description of tissue stratigraphy concerning the depth of the structures depicted. It also provides a tool for recording natural parts in an accessible way, so that students of human anatomy can understand the human body in a virtual environment.

It is also an alternative for recording the collection of natural parts available in the human anatomy laboratory. Regarding the visual tools available virtually, there is a limited number of national origin adapted to the profile of the Brazilian student. The availability of the collection of parts in the virtual environment contributes to the accessibility of the didactic-pedagogical resources developed in the human anatomy laboratory environment, and to the transparency of the body donation process at the national level, when it guarantees the confidentiality of the donors' personal information and restricts the use of this material to scientific purposes only. Finally, it demonstrates the need to involve the community in body donation programs, the source of such valuable material, for better training of health professionals.

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