Cadaviz: A DICOM-Derived Framework for Integrated Anatomical and Clinical Education

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Introduction

The evolution of anatomical education has consistently mirrored advances in technology, yet few innovations have redefined the discipline as profoundly as the data-driven virtual dissection tables (VDT). At the technological apex of this evolution stands Cadaviz, a state-of-the-art VDT that seamlessly bridges foundational learning with clinical application, by delivering anatomically precise representations of the human body across age, gender, and physiological conditions[1].

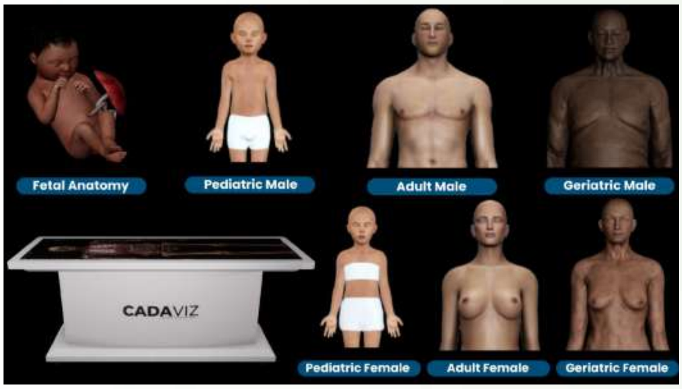

Figure 1: Cadaviz enables interactive visualization of human anatomy, from fetal to pediatric, adult, and geriatric stages, within a unified, DICOM-derived 3D framework.

As demonstrated in Figure 1, Cadaviz features a suite of highly detailed, life-sized digital cadavers, including paediatric male and female, adult male and female, and geriatric male and female digital bodies. Learners can examine how anatomical relationships evolve across the lifespan, recognising variations in structure, proportion, and spatial arrangement. Such exposure fosters a more nuanced understanding of normal variation, an aspect that is often underrepresented through conventional approaches.

A particularly compelling dimension of Cadaviz is its integration of cross-sectional exploration (Figure 2). Through precise sectioning along sagittal, coronal, and transverse planes, learners can traverse successive anatomical layers while preserving the continuity of spatial relationships between systems. This approach allows musculoskeletal, vascular, neural, and visceral components to be understood as interconnected networks rather than isolated structures. The ability to dynamically orient, isolate, and revisit anatomical features further strengthens spatial reasoning, enabling the formation of accurate and enduring mental representations of complex human anatomy.

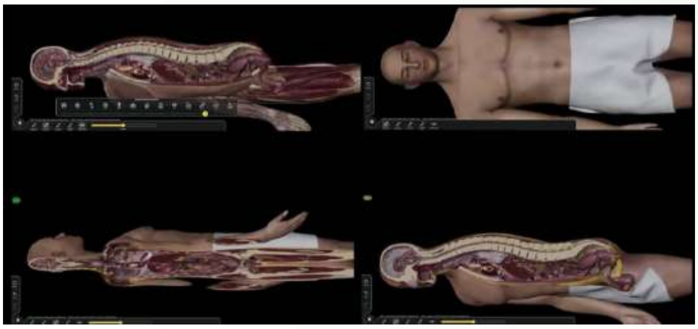

Figure 2: Multi-planar and interactive visualization of the Cadaviz digital human model demonstrating sagittal and longitudinal sections.

DICOM-Derived Anatomy: From Data to Digital Anatomy

What enables this seamless exploration is not only technological sophistication but also the integrity and origin of the underlying data. Cadaviz is built upon high-resolution DICOM datasets acquired through imaging modalities such as computed tomography and magnetic resonance imaging, ensuring that the resulting models reflect true human anatomy rather than constructed approximations.

As illustrated in Figure 3, the acquired imaging data are systematically transformed into anatomically coherent three-dimensional models through a scientifically grounded computational pipeline composed of the following stages[2]

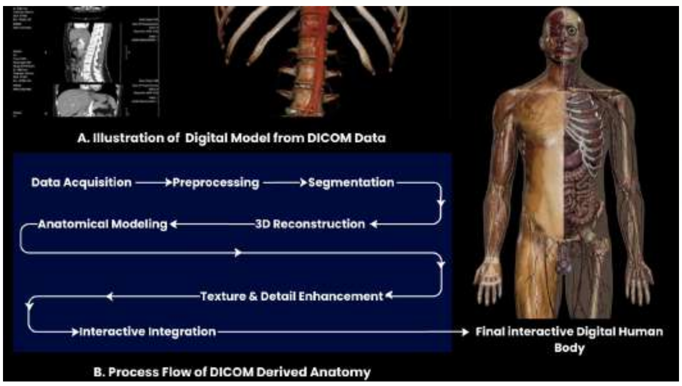

Figure 3: Workflow illustrating the generation of a digital human model from DICOM data

- **Data Acquisition and Preprocessing:** Imaging datasets are obtained from CT and MRI scans. These datasets are standardised, denoised, and optimised to ensure clarity, consistency, and suitability for computational analysis.

• **Segmentation:** Distinct anatomical structures are identified and separated from surrounding tissues. Advanced segmentation techniques enable the precise delineation of organs, musculoskeletal elements, and intricate vascular and neural networks. Arterial, venous, and neural pathways are traced across successive slices, preserving continuity and connectivity.

• **Three-Dimensional Reconstruction:** Segmented image slices are integrated into volumetric representations. This stage restores spatial relationships, allowing structures to be visualised in their true anatomical context.

• **Anatomical Modelling:** The reconstructed volumes are refined to ensure morphological accuracy and correct positional alignment. This step enhances structural coherence and prepares the model for detailed exploration.

• **Texture and Detail Enhancement:** Surface refinement and visual enhancement techniques are applied to improve clarity. Fine anatomical features become more distinguishable, supporting deeper structural understanding.

• **Interactive Integration:** With support for multiplanar visualization and detailed structural analysis, the final models are transformed into dynamic, user-responsive environments that allow learners to manipulate, dissect, and explore the anatomy in real time.

Maintaining the fidelity of the original imaging data, Cadaviz uses this pipeline to produce digital anatomy that is both structurally authentic and clinically meaningful.

From Conception to Creation: The Digital Anatomy of Human Emergence

Extending this data-driven foundation into developmental anatomy, Cadaviz enables learners to visualise embryonic and fetal progression alongside corresponding radiological imaging, thereby establishing a clear connection between anatomical development and clinically relevant interpretation.

Understanding developmental anatomy has long been limited by the transient nature of early human structures. Rapid morphological change, small anatomical scale, and variability in imaging often disrupt continuity. As a result, fetal development is frequently presented as a sequence of isolated stages rather than a unified progression3. Cadaviz addresses these limitations by situating fetal anatomy within a coherent, DICOM data-driven framework.

Figure 4: Integrated visualization of fetal anatomy and radiological imaging within the Cadaviz platform.

As illustrated in Figure 4, Cadaviz integrates three-dimensional fetal models with corresponding multiplanar radiological views. This combined visualization enables direct correlation between anatomical structures and imaging planes. It strengthens spatial understanding and reinforces the relationship between developmental processes and diagnostic practice.

While using the fetal development module in Cadaviz, students can trace progression across successive gestational stages with clarity and continuity. The general embryology module enables learners to follow the transformation from cellular origin to a fully formed human body, capturing, in essence, the complete narrative of human emergence. With Cadaviz, students can systematically explore foundational developmental processes, beginning with gametogenesis, including spermatogenesis and oogenesis, followed by the first week of development encompassing fertilization, cleavage, and blastocyst formation. This progression continues into the second week with the formation of the bilaminar germ disc and early implantation, and into the third week with gastrulation, the establishment of the trilaminar germ disc, and notochord development. The embryonic period, spanning the third to eighth weeks, highlights organogenesis, during which the three germ layers differentiate into major organ systems.

Further exploration includes the development of the primitive gut and body cavities, along with the formation of associated structures such as the diaphragm and serous membranes. The fetal period, extending from the third month to birth, focuses on growth, maturation, placental development, and the anatomical basis of parturition. Within this context, Cadaviz also facilitates understanding of clinically significant gestational conditions, including placenta previa, placental abruption (Figure 5) and the placenta accreta spectrum, by relating anatomical positioning and placental attachment to potential obstetric complications.

(A) Spectrum of placenta previa, including complete, partial, and marginal placenta previa in comparison to normal placental placement.

(B) Spectrum of placental abruption demonstrating varying degrees of premature placental separation, including partial, marginal, and complete (concealed) abruption, contrasted with normal placentation.

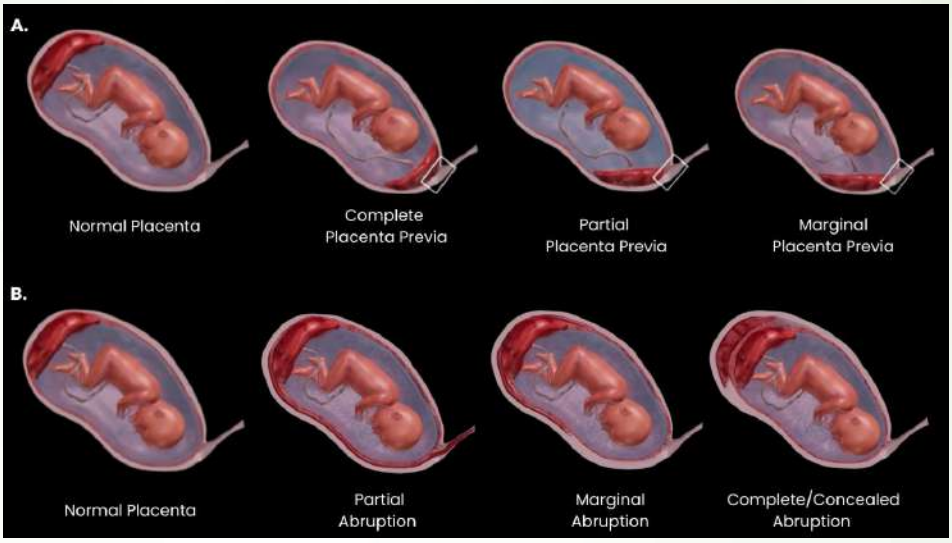

Figure 5: Comparative visualization of normal placentation and placental pathologies in Cadaviz.

Functional Integration: Blood Circulation and Neural Pathways

The human body is not merely an assembly of organs, but a coordinated network in which circulation and neural communication sustain life and enable responsiveness. Structural relationships gain deeper meaning when viewed through the lens of function, where movement, regulation, and adaptation are continuously maintained.

Cadaviz extends this understanding by enabling visualization of physiological processes within their anatomical context. It allows learners to trace pathways, follow continuity across regions, and appreciate how distant structures remain functionally interconnected. This perspective shifts learning from static observation to dynamic interpretation, where anatomy is understood not only in terms of form but also in terms of flow and signalling.

(A) Representation of systemic blood circulation illustrating the heart and continuous arterial and venous networks reconstructed from DICOM-derived data, enabling visualization of vascular pathways and flow continuity.

(B) Visualization of neural pathways demonstrating the central and peripheral nervous systems as interconnected networks, allowing detailed tracing of nerve origins, branching patterns, and distribution.

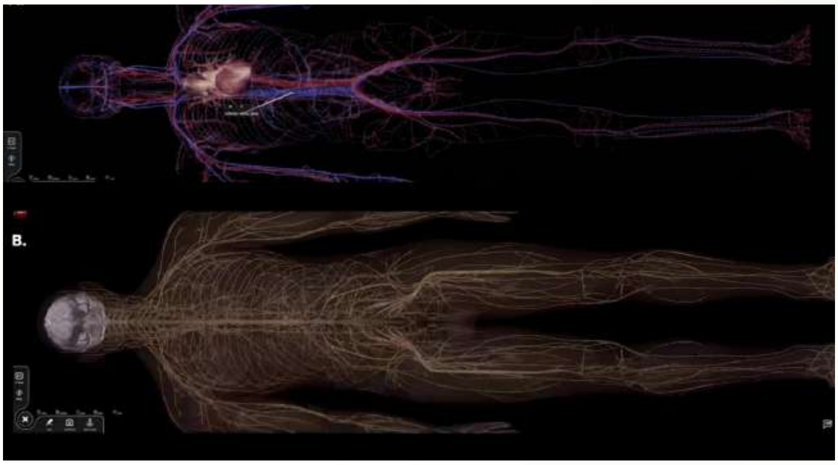

Figure 6: Integrated visualization of functional integration of vascular and neural systems within the human body.

With the use of advanced segmentation technology, Cadaviz excels in capturing the clinical accuracy of the two fundamental systems that underpin human physiology: blood circulation and neural pathways (Figure 6). Derived from real DICOM datasets, these networks are reconstructed as continuous and anatomically faithful systems, allowing learners to visualise and interact with true human vascular and neural connectivity within a unified framework.

Within this environment, understanding blood circulation becomes more intuitive, as learners can trace the flow of blood from central organs to peripheral tissues, appreciating its role in oxygen delivery, metabolic exchange, and the maintenance of tissue viability. This foundational knowledge is essential for interpreting clinical conditions such as ischemia, shock, and cardiovascular disorders.

At the same time, the visualization of neural pathways enables learners to follow the transmission of signals across the body, linking structure with function. It supports a deeper understanding of how the brain forms memories, acquires skills, and adapts through neuroplasticity, while also providing insight into neurological disorders and functional deficits. Through this integrated and interactive approach, Cadaviz fosters a connected, clinically relevant understanding of both systems as dynamic and interdependent networks.

Kinesiology with Cadaviz

Kinesiology is the study of human movement, encompassing the interaction between muscles, joints, and the forces that govern motion. Understanding movement requires the integration of muscular activity with joint mechanics within an anatomically accurate framework. Traditional approaches often separate static anatomy from functional movement, limiting the ability to appreciate how structures interact dynamically. Cadaviz addresses this gap by enabling the study of kinesiology within a DICOM derived, three dimensional environment where structure and movement can be examined together.

Within this platform, muscle motion can be explored in relation to origin, insertion, and functional role. Learners can observe how muscles contract and coordinate during movement, including the interplay between agonists, antagonists, and synergistic groups. This facilitates a clearer understanding of how muscular forces generate motion while maintaining stability and control.

In parallel, joint motion can be analyzed through visualization of movements such as flexion, extension, abduction, adduction, and rotation. The relationships between articulating surfaces, ligaments, and supporting structures can be examined in detail, allowing learners to appreciate how joints enable mobility while preserving structural integrity. Multi planar visualization further supports the study of movement across different anatomical axes.

Cadaviz provides an interface for selecting specific muscles and movement parameters, enabling targeted exploration of musculoskeletal function. This supports detailed analysis of muscle groups involved in particular actions and reinforces the connection between anatomical structure and dynamic movement.

By integrating muscle activity with joint mechanics, Cadaviz offers a comprehensive perspective on human movement. This approach enhances understanding of functional anatomy and supports clinically relevant insights in areas such as rehabilitation, sports medicine, and orthopedics.

Digital Pathology with Cadaviz

A major application of a DICOM derived framework lies in its ability to integrate pathology with anatomical and radiological context, enabling a more connected understanding of disease. By anchoring learning in real imaging data, Cadaviz allows pathological processes to be interpreted in direct relation to true human anatomy rather than as abstract or isolated findings.

The platform incorporates a comprehensive repository of over 500 histology slides, 500 histopathology slides, 700 OSPE cases, and more than 1000 radiology images. These resources are systematically aligned with corresponding anatomical regions, enabling learners to transition seamlessly between gross anatomy, imaging, and microscopic structure.

Central to this approach is pathological mapping, where disease can be examined across multiple levels of organization. Learners can correlate structural changes observed in radiological images with underlying tissue level alterations and microscopic features. This integrated perspective supports a clearer understanding of how disease develops, progresses, and manifests within the body.

Radiological integration plays a pivotal role by linking anatomical models with clinical imaging, strengthening the ability to interpret scans in relation to structural anatomy. Histology and histopathology further extend this framework by revealing cellular architecture and pathological changes, allowing learners to connect microscopic alterations with macroscopic and clinical findings.

Through this multi-dimensional integration, Cadaviz transforms the study of pathology into a cohesive and clinically relevant experience, enabling learners to interpret disease within its full anatomical and diagnostic context.

Learners' Perception and Educational Experience

The impact of Cadaviz on anatomy education is reflected not only in its technical architecture but also in how it is experienced by learners. Student perception provides a meaningful extension of the integrative framework described in preceding sections, offering insight into how visualization, data fidelity, and clinical alignment translate into educational value in practice.

Rajan et al. 2025, undertook a quasi experimental study involving 250 undergraduate MBBS students, comparing cadaveric practicals, Cadaviz based learning, and a combined approach. The findings demonstrated that the integration of traditional cadaveric dissection with virtual dissection tables provided the most effective understanding of human anatomy, reinforcing the value of blended learning as a pedagogically optimal model4 (Figure 7).

Khodke et al., 2025 conducted a qualitative, questionnaire based cross sectional study among 200 first year MBBS students following exposure to both cadaveric dissection and Cadaviz. The findings similarly indicated that a combined approach offers the most effective understanding, further supporting the role of virtual platforms as complementary to traditional methods rather than replacements. This preference for integration reflects the broader conceptual design of Cadaviz, where multiple domains are unified to enhance learning continuity5.

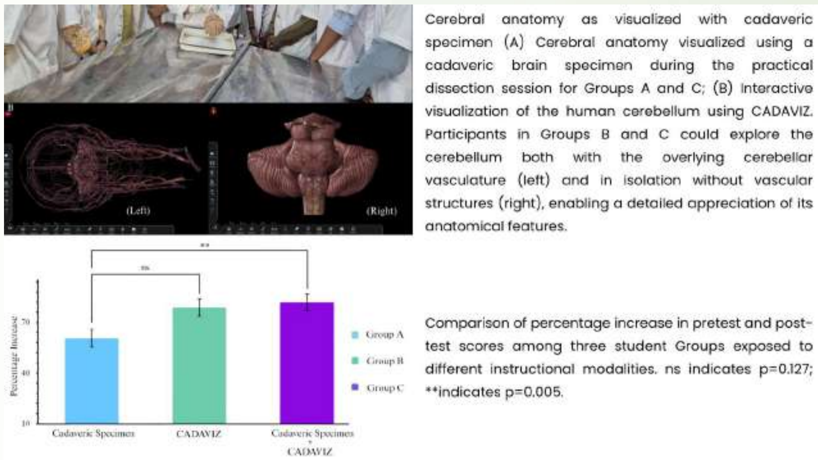

Figure 7: Stills and Data from the study "Exploring the effectiveness of CADAVIZ in enhancing learning outcomes in undergraduate medical students"

Sreenivasan, S. 2025 evaluated learner perception across visualization, spatial understanding, engagement, and usability, with students consistently reporting that the integrated and clinically guided visualizations improved three dimensional comprehension, engagement, and learning confidence. These observations align with the platform's emphasis on continuity across anatomical planes and systems6.

Devi, G. D. 2025 further demonstrated the effectiveness of Cadaviz in embryology education through a cross sectional study involving 250 first year MBBS students. High levels of agreement were observed across domains of knowledge retention, spatial connection, visualization, clinical understanding, and conceptual clarity. The highest scores in spatial connection and retention highlight the platform's strength in enabling learners to construct enduring mental representations of developmental processes7.

Expanding this perspective, Ramnika et al., 2026 conducted an observational study examining cognitive integration, affective engagement, and behavioural adoption among 143 first year medical students. Positive responses across all domains indicated that the platform supports not only cognitive understanding but also learner motivation and sustained engagement, with high scores in visualization and recall alongside increased confidence and reduced learning related stress8.

Collectively, these findings demonstrate that learner perception aligns closely with the structural and pedagogical principles underlying Cadaviz.

Closing Statement

In conclusion, Cadaviz is not merely a tool for virtual dissection, but a comprehensive medical education ecosystem in its own right. It integrates 12+ core medical subjects, including gross anatomy, regional anatomy, block dissection, osteology, anatomy of organs and parts, physiology, embryology, histology, histopathology, radiology, a clinically oriented case library, and prosection, delivering a structured and in depth learning experience from foundational anatomy to clinical application.

At its core, this platform is a DICOM derived framework, where anatomical representation originates from real human imaging data rather than constructed models, so as to ensure structural fidelity while enabling seamless integration across multiple domains of learning. Through this approach, anatomy is not encountered as isolated segments, but as a continuous, interconnected system that reflects its true biological and clinical complexity. Importantly, learner perception further underscores Cadavi's effectiveness as a modern educational tool.