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Review Article

CADAVIZ

CADAVIZ - Expanding Digital Horizons of Anatomy and Physiology in Ayurveda - A Review

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Medical education is transforming continuously with respect to its teaching learning processes. The application of newer techniques, digitization made with regards to instruments and equipment's, and advancement in the use of technology aids for various purposes in medical education. One of the primary challenges faced by Ayurveda instructors is with the teaching learning of the fundamental subjects like anatomy-Rachana Sharir and physiology-Kriya Sharir. More over replicating the hands-on experience of practical exposure, including activities such as cadaver dissections, bone demonstrations, histology slide examinations, etc., which foster interactive communication with students and enhance their communication and clinical skills is difficult. In order to make teaching and learning sessions more engaging educators need to incorporate educational technologies into everyday teaching methodologies. The recent approach of digital revolution makes it possible to solve the problems creatively. Competency based medical education and OBE objective-based education which are being used nowadays are based on the hierarchical development of all taxonomic levels (domains) for students, while imparting knowledge. CADAVIZ, a virtual dissection table (VDT), is one such instrument which facilitates the educators and helps them to fulfill their teaching objectives. In this article we review the instrument and give a brief account of its utilities and applications with respect to Ayurveda. CADAVIZ is the world's first simulation table for Ayurveda. It boasts of presenting in a first of its kind, a table with a detailed account of human anatomy from an ayurvedic prospective.

Keywords: Anatomy, Ayurveda, CADAVIZ, Kriya Sharir, Rachana Sharir, Virtual dissection table (VDT)

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Introduction

The discipline of human anatomy is the essence of medical education. It imparts students with a fundamental and deep knowledge of the organization of human body. An effective teaching of anatomy ensures future physicians with better surgical and clinical performances.**[1,2,3]** Traditional approaches for teaching gross anatomy typically involves lectures accompanied by supplemental textbooks, as well as hands-on learning through cadaver dissections and prosections.**[4]**

While still controversial, cadavers, be animal or human are one of the most effective methods of learning about the body.**[5]** Cadavers enable students to grasp the surface anatomy of various structures, gain tactile understanding of tissues and organs, and appreciate the prevalence of anatomical variations, making it the most superior method for learning human anatomy till date.**[6]** However, there are various factors that constrain the cadaver-based teaching methods, such as the increasing demand for cadavers with respect to the number of students, recurring cost of acquiring, maintaining and treating cadavers, longer time involved in cadaveric dissections, difficulty to revisit completed dissections due to damaged structures, constant formaldehyde exposure triggering irritation of mucus membranes and neuropsychological effects, molds/fungus/maggots developed on formaldehyde stored cadavers. Moreover, cadavers stored in formalin tanks show high rigidity and are less lifelike. They need to be lifted out by special hydraulic lifters before actual dissection restricting cadaver positioning, limiting students access. Developing an effective method for teaching human anatomy to medical students has been a long-time goal.**[7]**

In order to enhance the TLE and improve students' understanding of gross human anatomy educators integrate diverse digital tools and resources into their instructional approaches. With the advancement of novel technological tools, namely virtual dissection table (VDT), anatomy education is experiencing a paradigm shift. VDT, allows students to explore anatomical structures in a three-dimensional (3D) way, providing immersive and interactive learning experiences that are difficult to replicate in traditional classroom settings and therefore introducing a new method to approach human anatomy.

They offer a visually perceptible learning opportunity in the absence of or as supplementary to physical specimens.**[8]**

Ayurvedic medicine which is an ancient Indian healthcare system remains moderately explored technologically. Classical Ayurvedic texts Charaka Samhita and Sushruta Samhita, describe plant-based medicines as well as various treatment protocols**[9]** in Sanskrit. With the growth in popularity of Ayurveda, efforts are underway to harness the power of technology to enhance various aspects of Ayurveda in the modern era.**[10]** Ayurveda Medicine is based on the concept of *Prakriti* (psychosomatic approach) which is unique to each individual. The understanding of characteristic *Prakriti* is determined by the predominance of *Dosha* (*Vata, Pitta* and *Kapha*), which enables practitioners to design individualistic treatment regimes. VDTs offer an appreciable learning opportunity as a complimentary source in this respect. In this review we explore the addition of CADAVIZ™ - India's first and worlds only 3D Virtual Dissection Table with Ayurveda module, in Ayurvedic education as a tool to facilitate better comprehension/understanding, retention and reproduction of key concepts and practices of the Ayurveda healthcare system.

Aim and Objectives

1. To understand and review the utilities of CADAVIZ™ instrument in teaching-learning process of medical education.
2. To understand and review the applications of CADAVIZ™ instrument while demonstrating the practical concepts of Rachana and Kriya Sharir.

Methodology

1. Guidelines and manuals of CADAVIZ™ version V1.1.5 (Manual & Notes)**[11-13]**
2. Detailed literature search was performed in Google Scholar, PubMed, and SCOPUS
3. Actual experience of the faculty while sensitizing about CADAVIZ™, understanding the concepts and reviewing the concepts under study (Image 1).

Discussion

The use of cadavers has been the norm for teaching anatomy for hundreds of years and its use remains popular in education.

Along with cadaveric dissection, the use of flat, 2-D structures in didactic portions of anatomy courses impedes the students' comprehension and grasp of anatomy, ultimately limiting the overall effectiveness and quality of the teaching and learning experience (TLE).

Universities have adopted modern integrated curricula incorporating problem-based learning (PBL), case-based learning (CBL), team-based learning (TBL), and other computer-assisted teaching methods in their undergraduate anatomy courses.**[14-18]** These resources provide a visual and interactive approach to learning, allowing for a more comprehensive understanding of the complex structures of the human body.**[19]** With recent advancement in technologies, educators are investigating innovative approaches to enhance the teaching and understanding of anatomy.**[19]** Technological tools such as literature mining, drug discovery, genomic studies, clinical decision support systems, telemedicine, personalized medicine, predictive analytics, education, and data management are being applied in diverse areas of medicine.**[20]** There are a variety of tools including 3-D virtual anatomy applications and anatomical models, newer approaches such as computer-assisted learning models, interactive computer-based software, and radiological images have been introduced.**[21]**

Studies have demonstrated that the incorporation of particular supplementary technologies can improve students' understanding of human anatomy and their academic performance in anatomy and related courses.**[22]** The use of virtual reality (VR), augmented reality (AR) and applications (apps) offers students with immersive learning opportunities, and enabling them to visualize intricate anatomical structures in a 3D environment. **[23-27]** Incorporating technology into classroom instruction where educators can use digital anatomy software to produce interactive presentations and quizzes that promote active engagement and critical thinking can significantly enhance student engagement and comprehension.**[28]**

CADAVIZ**,** acclaimed in the field of virtual anatomy dissection, is a cutting-edge device that features an electronic table with a ultra-wide multi-touch screen, with multiple and simultaneous touch points. It is an educational tool providing a full-scale digital depiction of the human body,

Enabling observation, manipulation, and virtual dissection of 3D models with detailed anatomical components. It offers a comprehensive repository of clinical exams, cases and DICOM images. CADAVIZ has an extensive collection of histology, histopathology and radiology slides. The DICOM viewer enables users to visualize case data from CT, MRI, X-ray, and other imaging modalities and comparative studies, along with patient details required to interpret medical images. It consists of a Clinical library with access to 700+ objective structured practical exams and 100+ clinical simulations covering diverse pathologies and rare conditions.**[29]** The inclusion of virtual dissection tables (VDT)**[25]** as supplementary tools to cadaver dissection is advantageous and need of the hour.

Utility of CADAVIZ in anatomy for Ayurveda medical students

Cadaviz is the worlds' first simulation table for Ayurveda, correlating ayurveda with modern science. The study of anatomy, explains the operation of different anatomical regions & their connections, especially gaining experience on the anatomical/pathological (Image 3a, 3d) variants that exist in the human body. In ayurveda, the human body is considered as a complex web of life energy flowing through channels called *Nadis*. *Marma* points are the vital energy junctions where energy is concentrated (Image 2). Understanding the precise working of these points helps in the treatment to heal and also to enhance overall health and well-being. Professional ayurvedic practitioners are trained to use *Marma* therapy for various ailments. The practitioners need to be well versed with the Sanskrit terminology (Image 3b) used in the basic Vedas (scriptures/books) of Ayurveda, especially for the study of *Sankhya Sharir, Asthi Sharir* and *Sandhi Sharir. Sankhya Sharir* concerns with the enumeration of body parts, *Asthi Sharir* is the study of human body in terms of anatomy of bones while *Sandhi Sharir* is the study of joints of the body (Ayurvedic Arthrology). It explores the basic concepts of Ayurveda with the help of *Sharir Rachana* and *Sharir Kriya* (Image 3c), in accordance with Sanskrit shlokas and terminologies. It has a detailed account of human anatomy from an Ayurvedic prospective with the help of *Mamsa, Asthi, Sira, Snayu, Sandhi* etc. Along with *Panchakarma* treatment simulation. It supplements the learning of human physiology from an ayurvedic prospective with interactive simulations.

It has the potential to be used in the learning process, as a system to scientifically examine and identify ayurvedic prakriti classification and therapies (case library). It could be used to identify the variations and differences between *Prakriti* types that determine the predisposition to diseases and response to treatments (Image 3a, 3d). Animal anatomy, *Ayurveda Sandhi Sharir* simulations, *Asthi Sharir* static body with details and *Marma* simulations are added as newer advancements which makes instrument fulfilling and usable to *Ayurveda* anatomists & other department faculties.

In medical curriculum: Content is aligned with competency-based medical education (CBME curriculum). It includes 12+ subjects including gross anatomy, muscle motion, osteology, histopathology, histology, regional anatomy, anatomy of organs, block dissection, clinical examination, embryology etc. It includes 60+ block dissections with precise instructions & interactive simulations. Dissections can be done in any plane of body to understand tissues & organs. Prosections of dissected cadaver or cadaver organs are also imaged in CADAVIZ to have better understanding of details of anatomy of a particular organ. Anatomy of specific organs is visualized in a realistic manner. Contents include 2000+ physiology simulations to develop a deeper understanding of different physiological processes of cardiovascular, renal, respiratory, neurology & gastrointestinal systems. Embryology explaining growth of fetus up to 40 weeks has been elaborated with help of interactive & systemic processes & embryonic transformations. Osteology encompasses bone development, classification of bones, structure & functional descriptions which are easy & simple to understand. It provides with 700+ Objective Structured Practical Examination (OSPE) cases & 100+ clinical simulations, exploring real-life patient images & radiological scans. It helps in giving students insight into diagnosis, clinical implications & treatments mimicking real-world scenarios. With help of muscle movement simulations, students can study intricacies of muscular system such as origin, insertion & nerve supply of particular muscles incl. muscle movements. In Paedology, anatomical changes, behavioral changes & developmental milestones in children are well described here. Apart from all these features, CADAVIZ lets user create their own quizzes & puzzle, which is an exce. feature which lets teachers take control & customize instrument as per their requirement.

In residency training: CADAVIZ has more than 1000 radiology slides which can be used in study of radiology. It consists of an inbuilt case library comprising of general and applied radiology modules with various pathological conditions, which serve as references for radiologists during clinical studies. CADAVIZ facilitates radiology workflow with our integrated PACS (picture archiving and communication system) and DICOM (Digital Imaging and Communications in Medicine) viewer to have deeper knowledge. The DICOM viewer enables users to visualize case data from CT, MRI, X-ray and other imaging modalities and comparative studies, along with patient details when required to interpret medical images retrieved from PACS. The integrated 3D technology lets user to zoom in/out with high-quality 3D visualization, to navigate through personalized data and specific anatomical structures

In diagnosis and research: The DICOM Viewer supports multi-modal imaging, including CT, MRI, PET, USG, and X-ray, allowing for stacked or side-by-side comparisons. It features MPR (multiplanar reformatting) for correlating conditions across planes, and case study thumbnails for easy navigation. Users can customize split layouts for simultaneous viewing of different planes or comparative studies. CT window filters provide optimal contrast for various structures, with manual adjustments available. Viewer supports 3D volume rendering and precise 3D segmentation of anatomical structures. It includes essential image manipulation and annotation tools, HU value tools for tissue density quantification, and supports standard DICOM images and structured reports. It includes 500+ hematoxylin & eosin (H&E) stained hist. & path. specimen, covering healthy & disease conditions. Hematology module also provides insight into funda. of blood cell identification, blood composition & hematological abnormalities.

Image 1: CADAVIZ Demonstration and Training

Result and Conclusion

With the help of advanced technology of this Virtual dissection table, students are able to visualize the exact location of *Marma* points, which are utilized in therapeutic practice.

1. The instrument is as per the current trends and advancements in medical education and technologies. It totally satisfies the outcome-based education (OBE) and competency based medical education (CBME) models and their applications.
2. The instrument gives a virtual interface, overcoming the challenges faced in traditional dissection techniques and related hurdles.

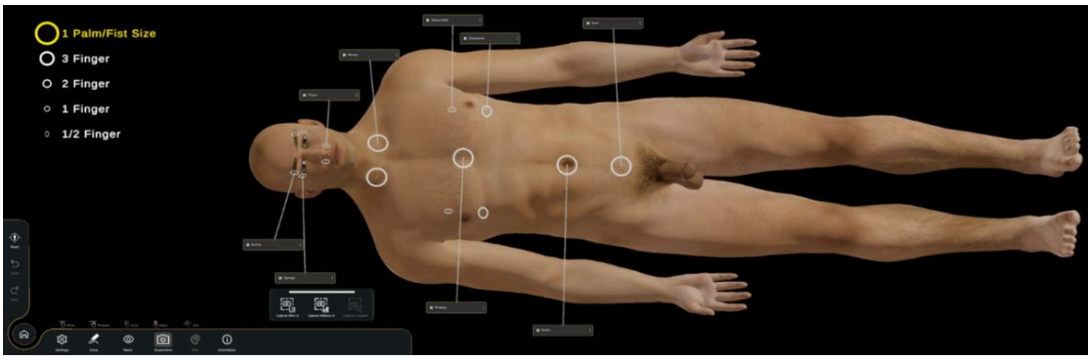

Image 2: CADAVIZ Ayurveda content, Marma points

1. Table is compact, easy to install, effortless to maneuver through various modules & ext. useful for teaching learning processes as per current system.
2. The table is vivid with interactive visualizations of real data. Organs or regions can be viewed by adjusting the complexity to gain a better understanding (rather than dissecting).
3. Multiple screens can be configured by connecting to projectors.
4. Students learn together, and can perform dissections multiple times thus bridging the gap between theory and practical's.
5. The 3D smart technology of the table appeals to the teachers and staff, inspiring them to work on it.
6. The newer additions like physiology, clinical examinations, practical cases, quizzes, puzzles and OSPE, objective structured clinical exam (OSCE) like techniques makes the table a learning package. In addition, new updates are made available frequently.
7. The table serves the needs of medical education and is an excellent resource to be added in medical labs.

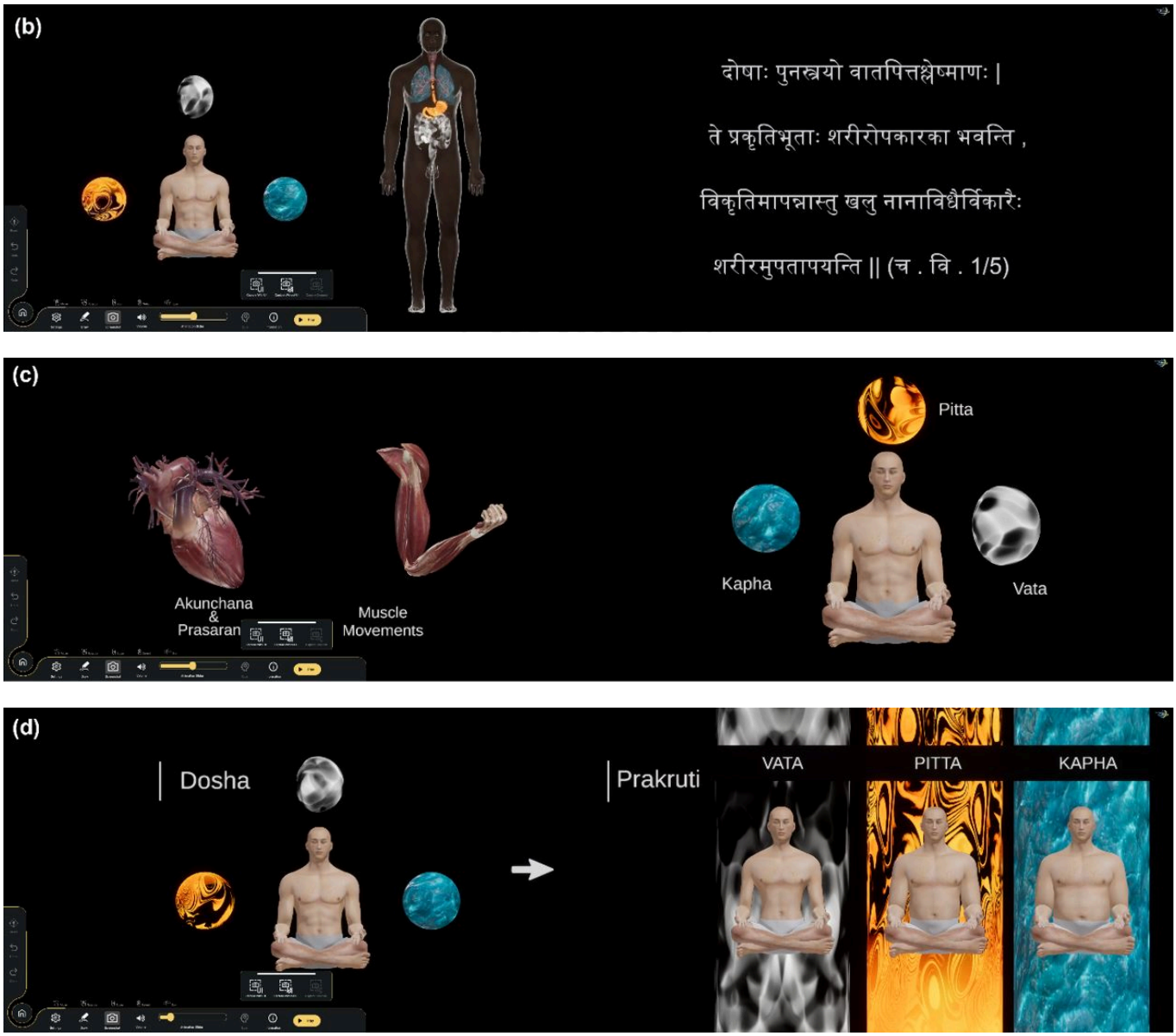

Image 3: CADAVIZ Ayurveda content: (a) *Sharirik* & *Manasik Dosha*, (b) Ayurveda Shloka, (c) muscle movements & (d) *Dosha-Prakruti*

It bridges the gap between theoretical knowledge and clinical applications/practice. VDT enhances the educational experience and aids in better retention of concepts through in-depth explanation, visually compelling and accurate representation of the human body, along with self-evaluation assessments. VDT helps correlate between the English and Sanskrit terminology, interpreting unambiguously, particularly in subjects like *Sankhya Sharir, Asthi Sharir,* and *Sandhi Sharir.*

In conclusion, VDT in combination with traditional ayurveda medical training methods can enhance the effectiveness of teaching learning processes. It could play a pivotal role as an essential resource in the training of Ayurveda health care professionals.

While further research is needed to realize full potential of technology integration whilst retaining core holistic principles of traditional system, it can be incorporated into our current learning system.

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