

Stereoscopic Visualization Using *BodyViz* and Clinical Embolization of Benign Brain Tumors

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Clinically induced embolization of benign tumors is a promising procedure which reduces the risk of malignancy. Both physical and chemoembolysis obviate the need for surgery and are the preferred choices depending on the location and accessibility of the tumor. This paper discusses the concept of embolization and its advantages from a clinical perspective. *BodyViz*, a software which allows stereoscopic visualization of 3D images of CT scans and MRI data, was used in this study to explore images of brain tumor in a patient. Students enrolled in the Human Anatomy & Physiology laboratory and lecture courses at the University of Houston have access to this state-of-the-art diagnostic tool for educational purposes.

Keywords: embolization, tumor, *BodyViz*, stereoscopic visualization

Introduction

The present study was conducted to highlight the use of *BodyViz* software by students in Human Anatomy & Physiology labs for exploring human anatomy from a clinical perspective, in addition to gaining an insight into the minute anatomical details in a living subject.

Approximately 700,000 Americans are currently living with a primary brain tumor (ABTA 2017). It is estimated that in 2017, there will be 79,270 cases of primary brain and other CNS tumors in the United States. Of these, 53,200 are expected to be non-malignant. Among children under 19 years of age, brain and other CNS tumors are the most prevalent type of solid tumors and account for most cancer deaths in this age group (Ostrom et al. 2016).

A brain tumor can either be cancerous (malignant) or noncancerous (benign) depending on where the abnormal growth of tissue arises from (CUMC 2017). If it arises from the tissue within or surrounding the brain, it is benign and often has clear borders that do not infect the surrounding lobes (NBTS 2013). Malignant brain tumors can spread to other body regions, disregarding the blood-brain barrier, and thus are not likely to respond to embolization (Fig. 1). Conversely, brain tumors may have their origin elsewhere, e.g. metastatic lung cancer in which secondary brain tumor cells resemble atypical lung cells rather than the usual brain cells (NCI 2017).

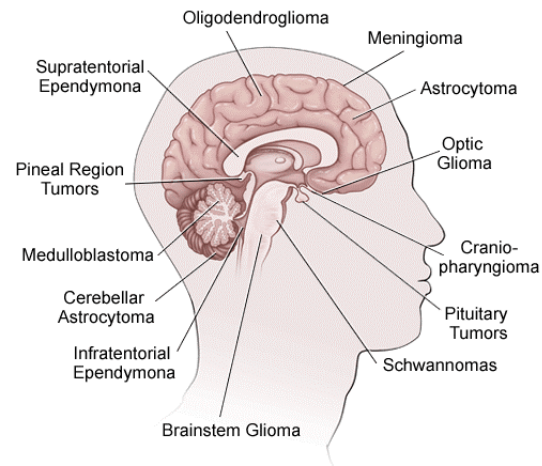


Figure 1. Location of different types of brain tumors.
http://www.nyhq.org/diw/images/ei_0428.gif

We use *BodyViz* as a supplemental resource for students in the undergraduate laboratory courses BIOL 1134: Human Anatomy & Physiology Lab I and BIOL 1144: Human Anatomy & Physiology Lab II. The *BodyViz* software is used to visualize human anatomy in 3D and color. This interactive software uses digital files (DICOM format), which contain CT scans or MRI data from live patients. Therefore, the images that one sees are real rather than based on models. There are almost 400 different studies encompassing various body systems within the software. There are studies showing pathological conditions, e.g. tumor, aneurysm, bone

deformity. Students in the lecture classes are introduced to *BodyViz* software and its utility but are not required to use the software because of logistical issues.

Classroom Implementation

We have 22 to 24 sections of each of these lab courses in the fall and spring. Students in the undergraduate labs have access to the software in the same building where the labs meet. Time slots are reserved for the Teaching Assistants to take their classes to the facility and explain details of selected studies. Anatomical structures are identified and relationships of different organs in a specific volume discussed. Specific structures are pointed to and students are asked to name those organs during the class period. Students are encouraged to write papers on specific studies by researching the subject further, and highlight the clinical aspects of the pathological condition.

The current paper on embolization is the result of one such project that was undertaken, and serves as a model for students. Outside the class period, students have liberty to sign up for *BodyViz* access and engage in self-study to work on their project. Within the software, images can be manipulated in several different ways, including zoom in/out, color, cut in different planes using a virtual knife, select tissue types based on their density, and annotate. Specific organs and their blood supply can be visualized to identify aneurysm or the blood vessel(s) supplying a tumor. The images are manipulated using an Xbox controller, and students find it fascinating as they explore the depth the software allows. The purpose of acquiring *BodyViz* was to give the students in the undergraduate labs an opportunity to experience firsthand the digital visualization tools that professionals in the biomedical sciences use in real life situations to plan invasive procedures.

Notes for the Instructor

It is much simpler to extract a benign tumor because of its clean-cut borders. Malignant tumors seep into the surrounding organs and their borders are much less evident. For the case study selected for this investigation using the data files available in *BodyViz*, the images of the tumor viewed from different angles and at different magnifications suggest that it is a clear cut lobular tumor (Figs. 2, 3 and 4 in Appendix). However, a closer examination suggests that it has ramifications/extensions and is perhaps not really a solid mass of encapsulated tissue (Fig. 5 in Appendix). This tumor falls right behind the eyes and could possibly be a infratentorial ependymoma due to its centralized intraventricular location within the brain and the trans-sagittal line arterial connection appearing in both the right and left

hemispheres of the brain simultaneously (Fig. 3), which would lead to symptoms of increased cranial pressure. It could be a malignant brain tumor because part of it is hollow, with the right lobe folding inward to its core and creating cave-like structures within itself (Fig. 6 in Appendix). It appears bumpy and fragmented on the smaller right lobe and may be seeping into a portion of the right hemisphere of the brain, suggesting malignancy (the left hemisphere depicts the lobular part of the tumor with a solid and clear cut structure). Without a biopsy and further imaging, it is unlikely that the tumor can be treated accordingly.

Embolization of this tumor, if it is benign, would be beneficial because the surgical strategy would be simplified since it is not located in the deeper regions of the brain like the cerebellum or the brain stem. However, embolization of this tumor, if it is malignant, would not be advantageous because it is built to deceive and spread, making it much harder to distinguish exactly which parts of the internal carotid artery supply its vague borders. Hypothetically, if this was a benign tumor and embolization was to be performed, the micro-catheters would be most likely guided through the blood vessels indicated by the arrows in Figures 5 and 6. These deductions are based on the 3D visualization that the *BodyViz* software allows and the inferences drawn from this study may be extrapolated to a real life situation wherein a neurosurgeon and radiologists must organize the modus operandi for diagnosis and treatment of this type of pathological condition.

Conclusions

The *BodyViz* program is an efficient tool that can be used in planning routes for microcatheter injection of embolic agents into the arteries that supply tumors, thereby leading to their destruction. The *BodyViz* software assists in determining the type of tumor without having to perform a biopsy. Versatility of the software not only assists in diagnosis but also helps plan invasive surgery after the tumor is embolized and remnants need to be removed from the cranium by conventional surgery. From an educational perspective, this exciting tool helps students polish their investigative skills by giving them the opportunity to apply their knowledge, ultimately leading to academic enrichment.

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quality of undergraduate education by providing an excellent instructional and learning environment, including installation of *BodyViz*, the tool that allows dynamic visualization of human anatomy using CT scans, MRIs and other DICOM file formats.

Ms. Alexandra Ulmet was an undergraduate in the Department of Biology and Biochemistry. Currently, she is pursuing her research interests at the Texas Medical Center in Houston.

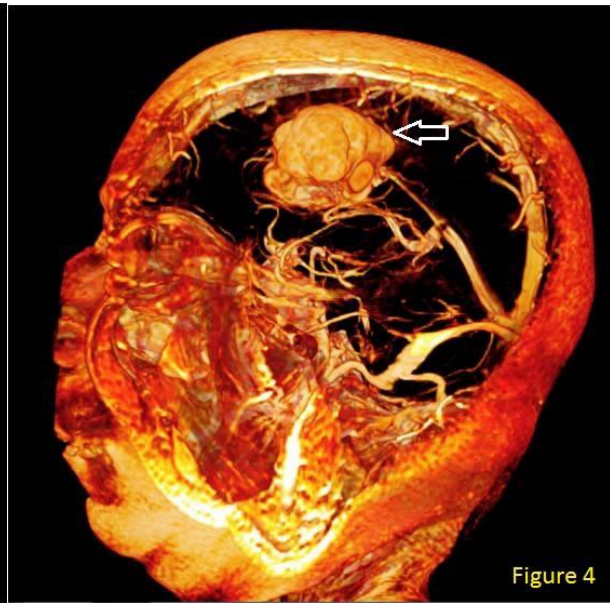
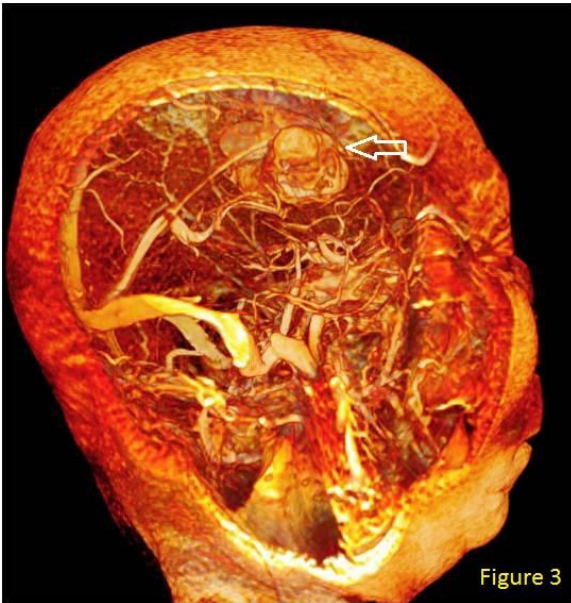
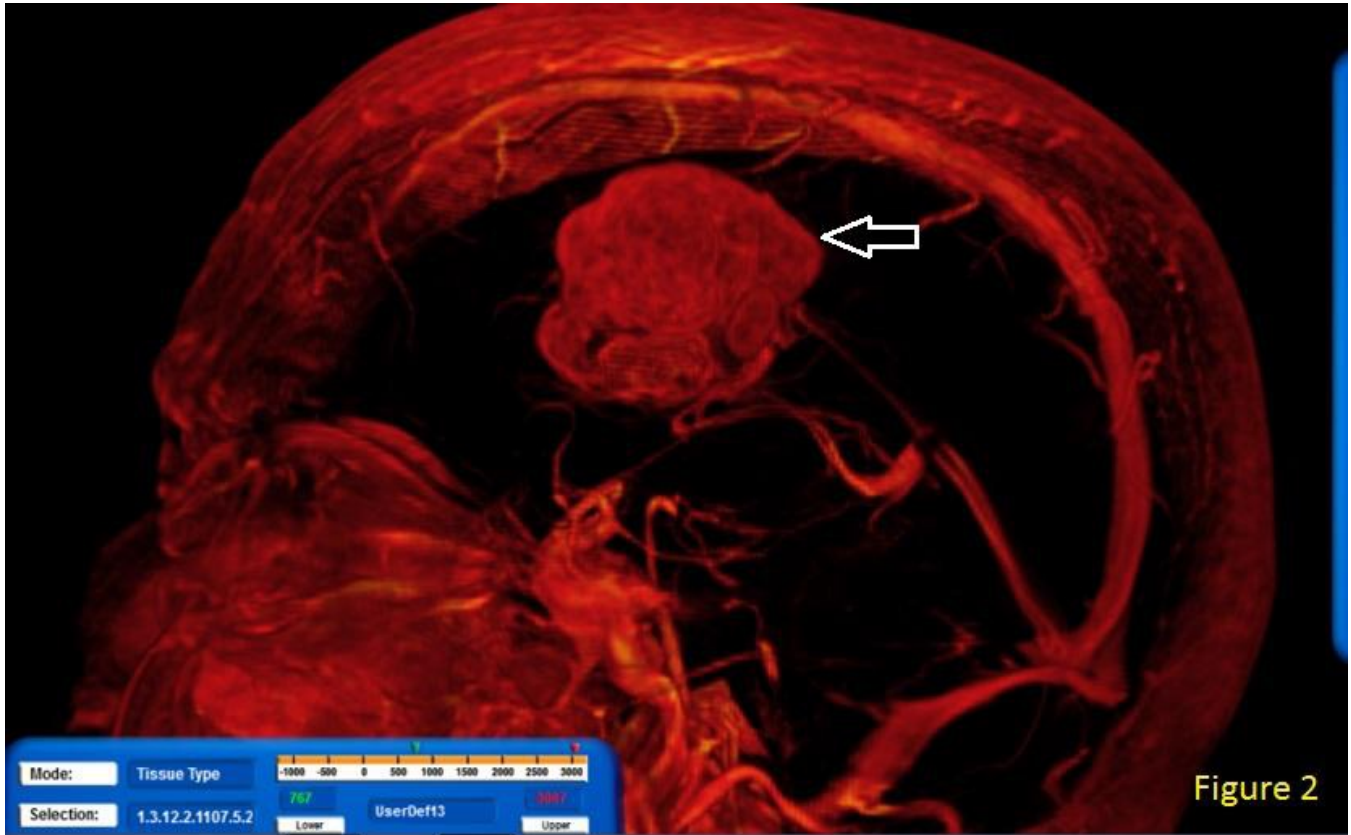
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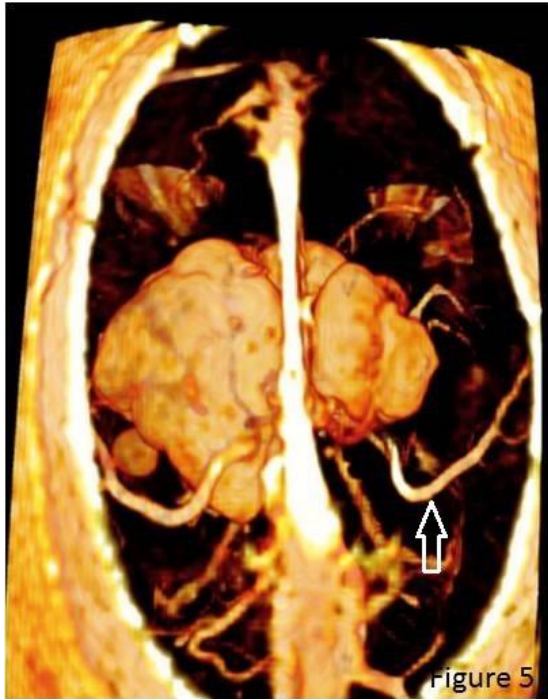
About the Authors

Dr. Tejendra Gill came to the US in 1985 as a Fulbright Fellow to work on the catecholamines in the American eel, *Anguilla rostrata*, in the Department of Anatomy, Jefferson Medical College, Thomas Jefferson University, Philadelphia, PA. After moving to Houston, he has been working at the University of Houston for the last 16 years. Currently, he is Instructional Professor and Director of Laboratory Instruction, Department of Biology and Biochemistry, UH Central Campus, Houston, TX. He teaches undergraduate courses in Human Anatomy & Physiology I and II, Endocrinology etc. He oversees Human A&P and Human Physiology Labs, and is a member of the University of Houston - Health Professions Advisory Committee (HPAC), which reviews academic credentials of students applying to medical and dental schools. He has received several grants for curriculum development leading to improvements in the

Appendix A *BodyViz* Figures



Figures 2, 3 and 4. Images of brain tumor visualized using 3D stereoscopic *BodyViz* software.



Figures 5 and 6. Showing exactness of the tumor and blood vessels.

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