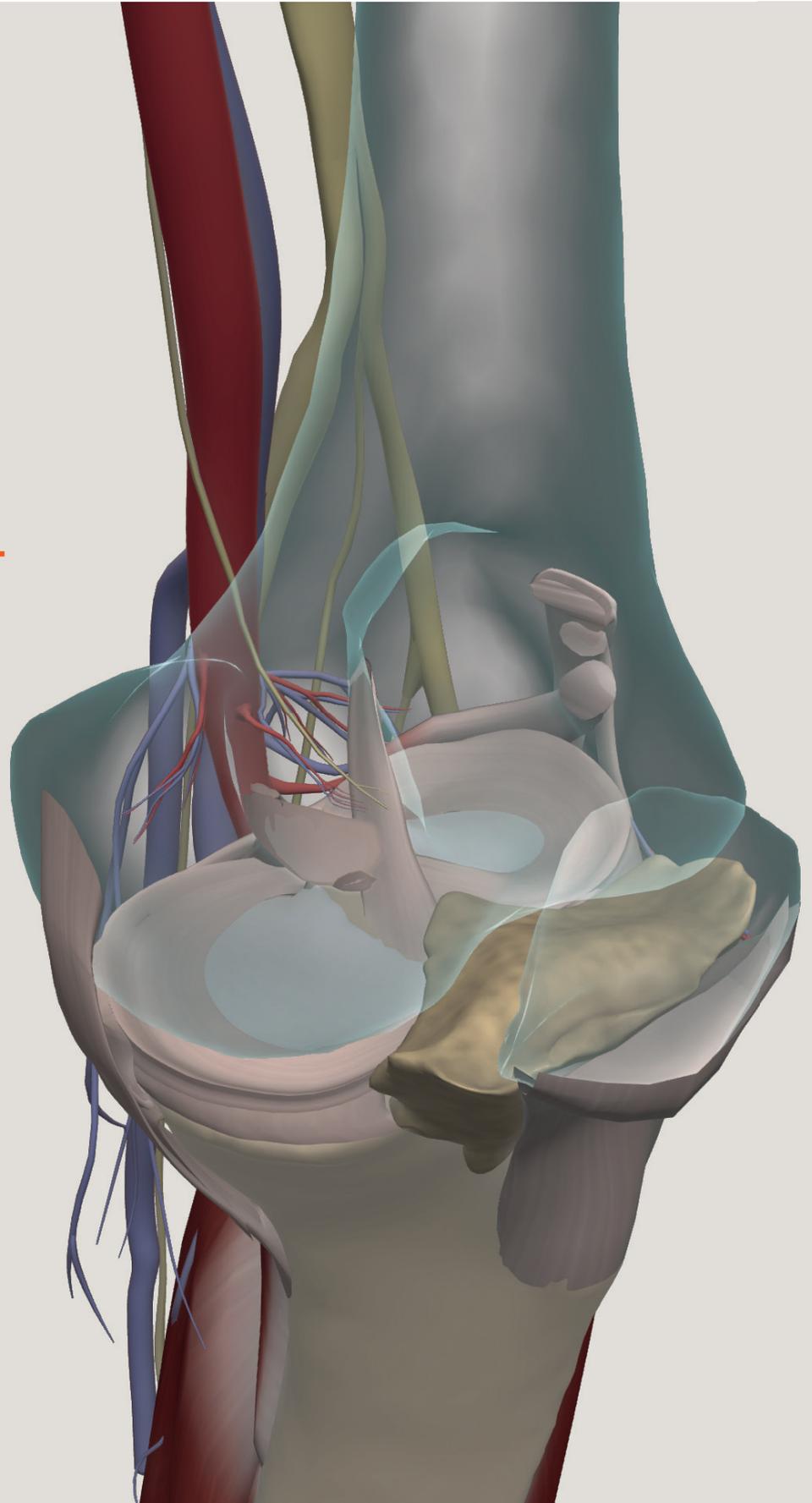
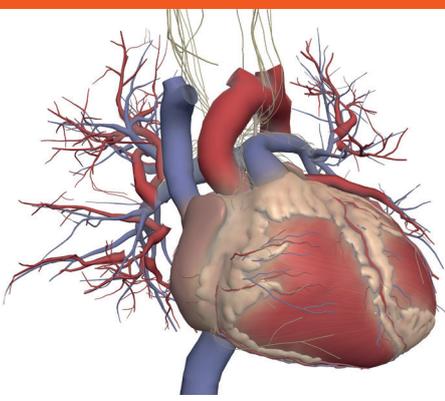


OPTIMIZING SURGICAL STUDY AND PRACTICE WITH 3D ANATOMICAL RESOURCES



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Introduction

Becoming a licensed surgeon requires years of intensive study, preparation and practice. Aspiring surgeons must meet a set of challenging education requirements, including four years of undergraduate study, four years of medical school, and five to eight years of surgical residency at a hospital or surgical center.

Comprehensive surgical training and surgical practice in their chosen specialty area equips surgeons to deliver the best possible care for patients. But what about when surgery takes them unexpectedly outside their surgical specialty?

In this paper, we will explore how 3D anatomy resources bolster the teaching and learning of anatomy for surgical students. We will discuss the importance of extending knowledge and understanding of anatomy beyond the boundaries of surgical specialty. Finally, we will talk about how having a digital, best-in-class 3D anatomy resource such as Primal Pictures' 3D Real-time Human Anatomy at the ready for surgical procedures can improve surgery, reduce risk, and enhance surgical outcomes.

Operating Outside the Boundaries of Specialty

All surgeons develop core knowledge of anatomy, physiology, metabolism, immunology, pathology, wound healing, shock and resuscitation, intensive care, and others. But the complexities of the human body require more specific study, which is why there are specific surgical specialties to which physicians can devote their careers. The American College of Surgeons recognizes 14 surgical specialties, and the Royal College of Surgeons recognizes 10.

The majority of surgeons operate within their area of specialty and have proficiency within their area.

While a surgeon may review a particular operative technique or other detail before a procedure, it stands to reason that they do not routinely review every structure outside the area of the body on which they will operate, particularly when the procedure is considered routine and they do not

anticipate an anomaly or complication.

But if the unforeseen happens in the operating room – for example, the small tumor in the hard palate has metastasized, wrapping itself around surrounding tissues – the surgeon could suddenly face a situation that challenges them because it goes beyond their area of highest proficiency.

The way to increase anatomical confidence is by providing surgeons with a flexible, accurate and highly detailed anatomy resource they can take from the office to the operating room. Surgery sometimes involves anatomy that is beyond a surgeon's specialty or "safe" area. Having a resource that allows them to drill down and see even the most hidden structures with three-dimensional clarity increases understanding and confidence, ensuring more successful surgical outcomes.

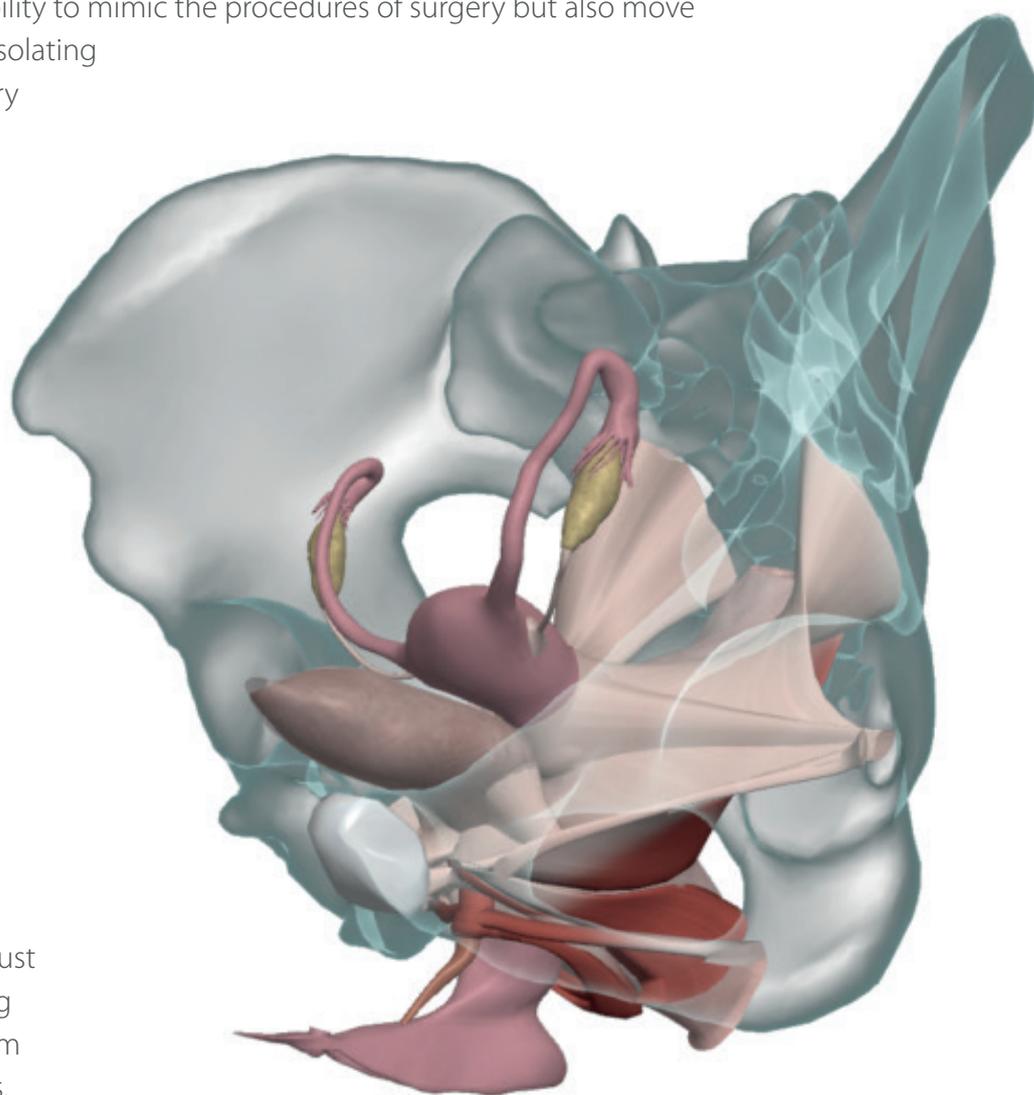
Why Textbook Anatomy is Not Enough

A national survey conducted in the UK has suggested that an important reason why many medical students did not intend to pursue a career in surgery was due to a lack of confidence in their anatomical knowledge. If anatomy proficiency was as easy as studying textbooks, medical students could memorize diagrams of two-dimensional, color-coded structures and expect to find the same orderly anatomy in the operating room. But humans are three-dimensional with physiology that is not easy to understand from studying images in a textbook.

Navigating human structures is learned by going into the lab and learning anatomy first, observing structures and the areas adjacent to them, and by being able to view and isolate each three-dimensional component. But learning in the lab is not without its own set of difficulties. Many medical students struggle with anatomy,¹ especially in areas like the head and neck. When crowded around a specimen in the lab, it can be difficult to see complex structures and there is not always enough time for everyone to examine them up close.

The answer is having a flexible and easy-to-manipulate 3D anatomy resource with which instructors can isolate even the smallest, deepest structures, allowing students to see details they may not otherwise get the opportunity to observe. Using Primal's 3D Real-time Anatomy, instructors have the flexibility to mimic the procedures of surgery but also move from deep to superficial, isolating structures where necessary and highlighting points of interest for students.

Using the Augmented Reality mode in Primal's 3D Real-time Human Anatomy, instructors can also project 3D structures side-by-side with the cadaver, enabling students to relate anatomy to the specimen they are dissecting. Having a 3D anatomy tool, you're not just explaining, you're showing students and helping them learn important principles.

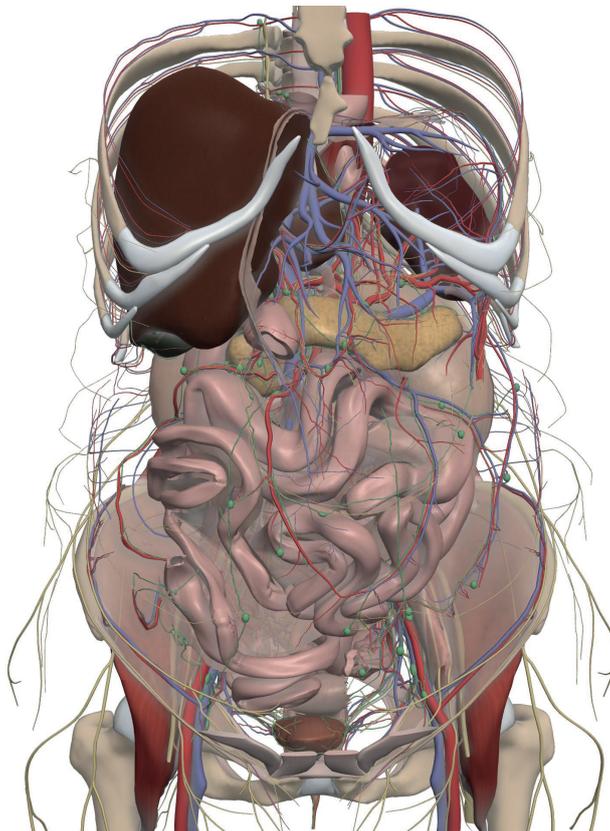
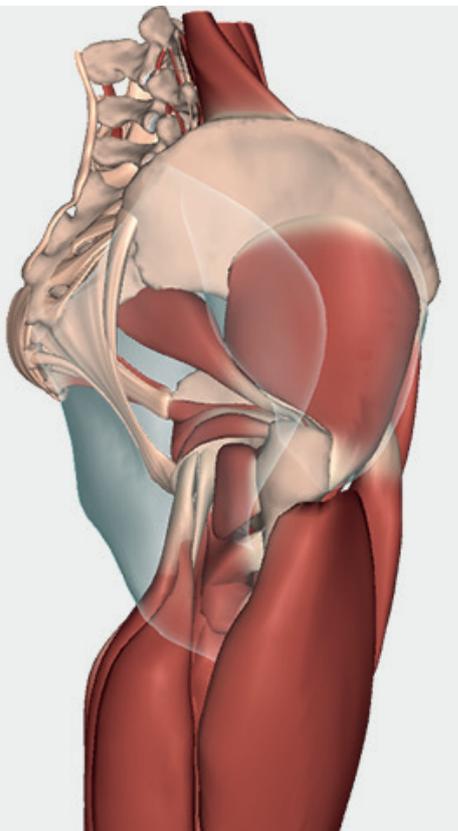


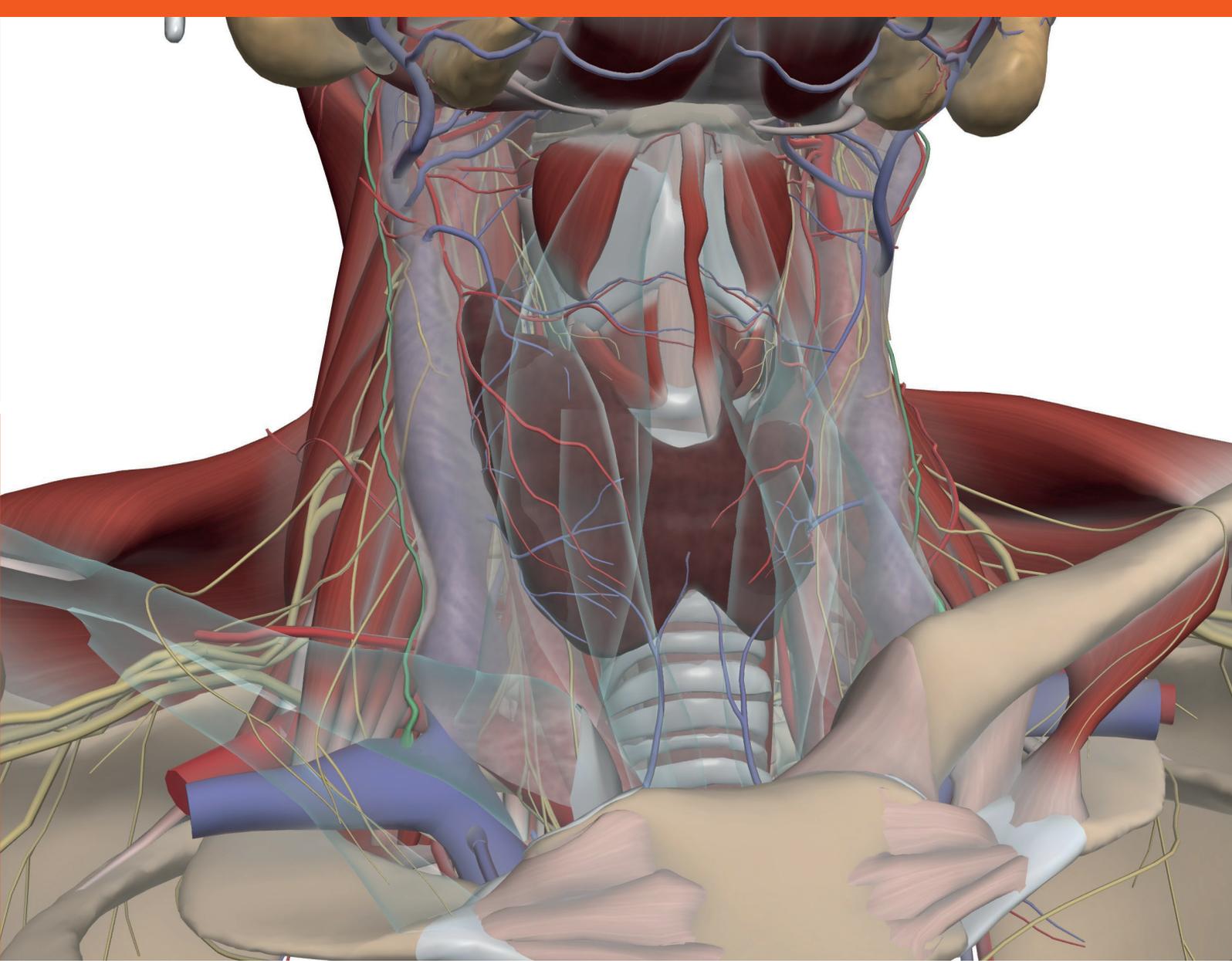
Benefits of an Anatomical Surgical Approach

Now that we've seen how a 3D anatomy resource can be instrumental in the teaching of anatomy in the classroom or lab, let's see how it can be truly transformative in the operating theater.

A recent UCLA-led study² found that using three-dimensional virtual reality models to prepare for kidney tumor surgeries resulted in substantial improvements, including shorter operating times, less blood loss during surgery and a shorter stay in the hospital afterward.

"Surgeons have long since theorized that using 3D models would result in a better understanding of the patient anatomy, which would improve patient outcomes," said Dr. Joseph Shirk, the study's lead author and a clinical instructor in urology at the David Geffen School of Medicine at UCLA and at the UCLA Jonsson Comprehensive Cancer Center. "But actually seeing evidence of this magnitude, generated by very experienced surgeons from leading medical centers, is an entirely different matter. This tells us that using 3D digital models for cancer surgeries is no longer something we should be considering for the future – it's something we should be doing now."¹³





Advancing Technology Requires Advanced Anatomy Resources

Doctors used to operate from the outside in. Today, new technology such as endoscopic surgery and robotic surgery bring new approaches that place the surgeon immediately in the danger zone. Doctors perform many types of procedures in small or difficult to navigate areas such as the head and neck, or for gynecologic and urologic surgeries with more precision – with one small incision the surgeon is in complex anatomy.

Surgery has become more granular and less radical. New technology allows surgeons to operate deeper in the body more quickly, with less invasion of surrounding tissue. To accomplish this, they must know precisely where vital, small structures are. The problem is that with even a highly detailed two-dimensional image of any anatomical area, the surgeon cannot view it from every angle or with extreme magnification they need for performing robotic surgery.

With a 3D anatomy tool, a surgeon can see the anatomy at the magnification they require and rotate it for further inspection. They can understand the boundaries they must stay within during the procedure to ensure surgery will be a success.

When the Unexpected Happens – Anatomy Resources in the Operating Room

No matter how many times a surgeon has performed a procedure or how thoroughly he or she is familiar with each case, at some point they will be confronted with a scenario where their knowledge of anatomy is pushed beyond its limit. When this happens, having a 3D anatomical resource at the ready can make all the difference in the outcome.

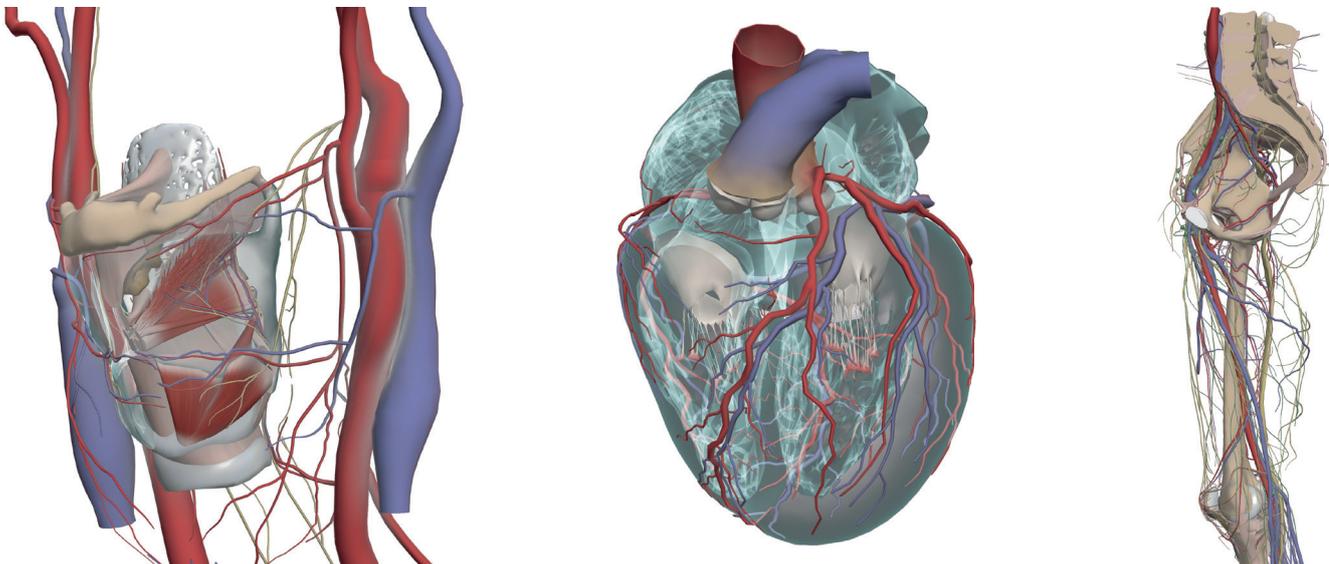
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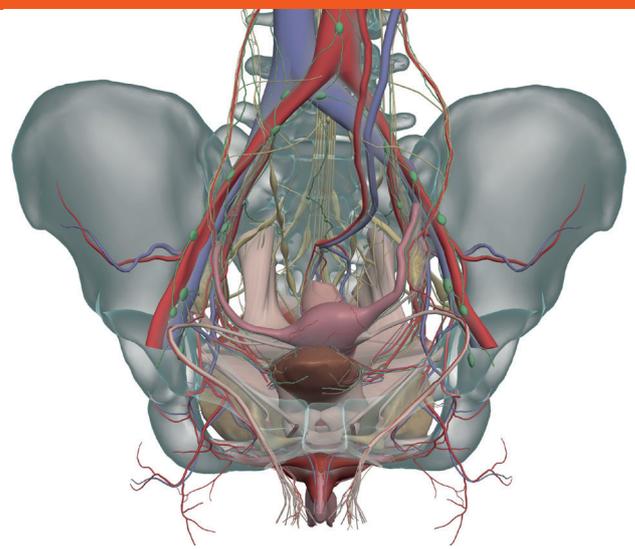
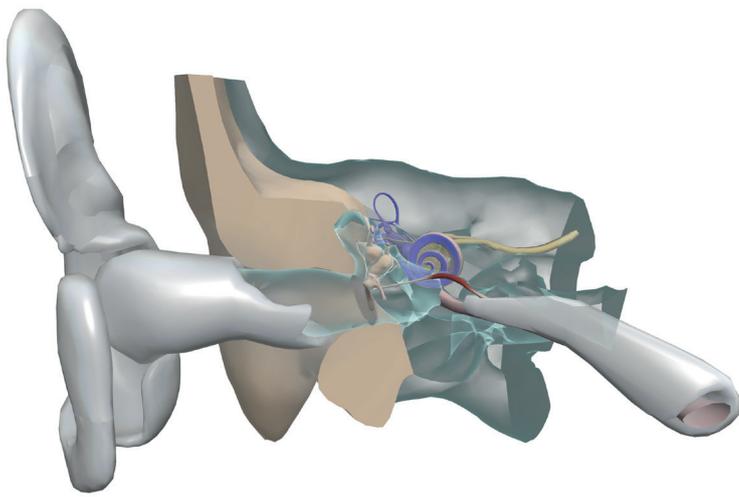
Mr Ajith George FRCS (ORL-HNS) is Consultant Head & Neck Surgeon at University Hospitals of North Midlands. Mr George was performing a surgical procedure on a patient with a sizeable squamous cell carcinoma which had fixed his pinna to the back of his ear.

At one point during the procedure, George encountered the emissary vein of the sigmoid sinus and the occipital artery that was running just under it. As he puts it, “we push the boundaries all the time in surgery, we operate on tumors larger and larger so we may come across anatomy that we’ve never seen before and so that [the vessels] surprised me.”

After the surgery had been completed, George sought clarification. “I took out my phone and opened my augmented reality software. I went hunting for that vessel because I had no idea what it was. And then, sure enough, when you use the software you realize that THERE it is. There is this emissary vein of the sigmoid sinus.”

“And then you can start planning for your next case. I’ve started learning about new muscle associations, longissimus and obviously the splenius, which I knew about. But in that dissection, I had to take the gentleman’s splenius to get his cancer clear. So, you’re going deeper and deeper.”





“This is where detail for us is key. Finding this kind of level of detail on other platforms is just not possible. And when you put the temporal bone back in, you can just see this little inconspicuous vein there. So now what you can do is use the augmented reality. You superimpose that onto the camera image I’ve got from surgery and that actually gives you an idea now of where you’re going to expect to find that vein and the occipital artery.”

Mr. George relies on Primal’s 3D Real-time to map out muscles, vessels and his technique for the next similar case he encounters, so that he knows with confidence where structures are located. “That is only possible by using Primal’s Augmented Reality software on top of imaging from the case at hand.”

Having a highly detailed and exhaustively researched 3D anatomy resource makes it possible for anyone involved in the education and practice of medicine – from instructors and students to residents and even the most practiced of surgeons – to learn, explore, and refresh specific areas of anatomy in vivid detail. By understanding each muscle, nerve, and artery, and its relation to others surrounding it, even experienced surgeons like Mr. George can learn new information and detail, so they can go far beyond the familiar and plan for the next surgery with confidence.

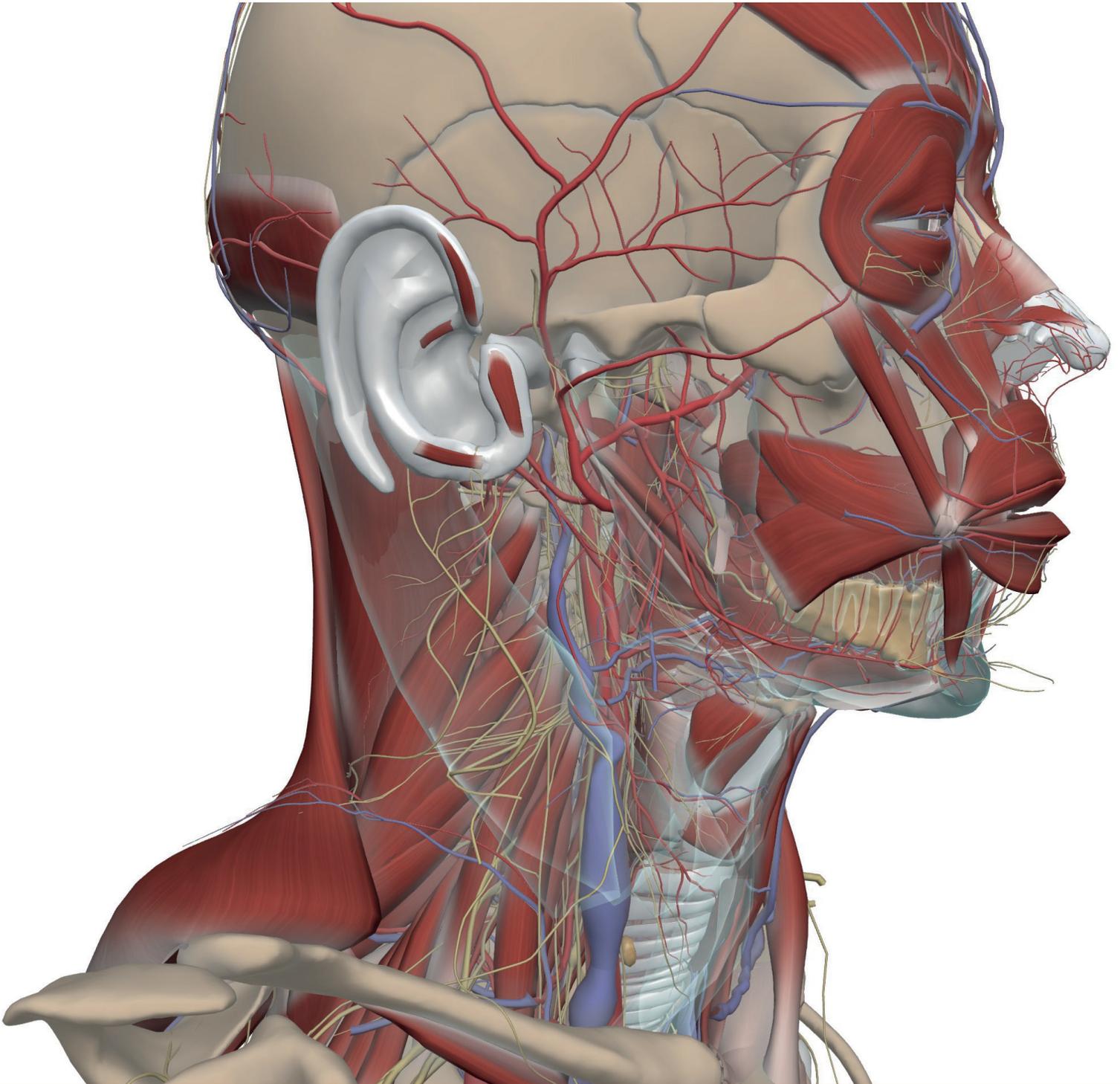
“Fortunately, we’ve got products like Primal which have got the accuracy that I can use to give me the information I need, to help me with complex cases.”

Sources

- 1 <https://www.sciencedaily.com/releases/2019/09/190918131457.htm>
- 2 Joseph D. Shirk, David D. Thiel, Eric M. Wallen, Jennifer M. Linehan, Wesley M. White, Ketan K. Badani, James R. Porter. Effect of 3-Dimensional Virtual Reality Models for Surgical Planning of Robotic-Assisted Partial Nephrectomy on Surgical Outcomes. JAMA Network Open, 2019; 2 (9): e1911598 DOI: 10.1001/jamanetworkopen.2019.11598
- 3 Hall, S., Stephens, J., Parton, W. et al. Identifying Medical Student Perceptions on the Difficulty of Learning Different Topics of the Undergraduate Anatomy Curriculum. Med.Sci.Educ. 28, 469–472 (2018).

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