Project Title: Creation of a 3D Radiology Imaging Analysis Lab (RadIAL)

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Topic Category: Research

Background, Significance of project:
The three-dimensional (3D) visualization of computed tomography (CT) and magnetic resonance imaging (MRI) data can enhance workflow, improve diagnostic ability, and increase understanding of complex anatomy to better prepare for invasive procedures. Key research in these areas will validate and continue to improve integration into clinical practice. 3D imaging data can optimize 3D printing, which is already well integrated in surgical practices, including maxillofacial, cranial, spinal, and orthopedic surgery. Advantages of 3D printed anatomical models include reduced surgical time, improved medical outcomes, decreased radiation exposure, and improved patient understanding of disease and treatment plans.

Purpose/Objectives: To develop a core space for advanced 3D imaging and printing that will support cutting-edge research, improve patient care, enhance trainee education as well as bring increased revenue and grant funding to the institution.

Methods/Approach/Evaluation Strategy: Institutional funding was obtained to create a dedicated lab space and to hire a lab director. A questionnaire was sent to all research and clinical faculty at our institution through department chairs to assess the current and projected uses of 3D imaging and 3D printing. Questions were designed to capture the number of cases in which 3D imaging and 3D printing were used per month (<5, 6-10, >10) and the average cost per case if 3D printing was outsourced (<$500, $500-$999, $1,000-$2,999, $3,000-$4,999, >$5,000). Five-point Likert scale questions regarding the perceived benefits of 3D imaging and 3D printing in clinical practice were used.

Outcomes/Results: The cost to create the 3D imaging lab and hire a 3D lab manager was approximately $300,000. A total of 46 responses were received from 12 specialties. There were 22 responses to the Likert scale questions regarding 3D imaging: 10/22 (46%) strongly agreed that 3D imaging impacts patient care and 8/22 (36%) believed that 3D imaging has changed patient management and improved patient outcomes. 13/46 (28%) respondents reported that they outsourced 3D printing, with the number of cases ranging from 444 to 1,080 per year (mean = 762). The weighted average cost for outsourced cases was $1,444 per case. If in-sourced, assuming 762 cases per year at $500 per case, the net cost savings is estimated to be $719,000 per year.

Discussion/Conclusion with Statement of Impact/Potential Impact:
A dedicated 3D imaging lab will enhance best practices by allowing state-of-the-art post-processing of imaging data for research and optimizing clinical care. Cutting-edge research will be supported using the latest image processing hardware and software. Decreased operation times, decreased complications and improved diagnosis are achievable with using advanced 3D imaging/printing. Consolidated in-sourcing of 3D printing will make it more accessible (quicker turnaround time, ability for personal interaction and improved user satisfaction) and lead to cost savings for the healthcare system.

Creation of a 3D Radiology Imaging Analysis Lab (RadIAL)

Principal Investigator: Judy Yee, MD

Collaborators and Mentors: Nicole Wake, PhD, Philip Ozuah, MD, PhD

Background

Three-dimensional (3D) visualization of computed tomography (CT) and magnetic resonance imaging (MRI) data can enhance workflow, improve diagnostic ability, and increase understanding of complex anatomy to better prepare for invasive procedures. Key research in these areas will validate and continue to improve integration into clinical practice. 3D imaging data can optimize 3D printing, which is already well integrated in surgical practices, including orthopedic, maxillofacial, cranial, and spinal surgery. Advantages of 3D printed anatomical models include reduced surgical time, improved medical outcomes, decreased radiation exposure, and improved patient understanding of disease and treatment plans.

Purpose

To develop a core space for advanced post-processing of imaging data that will support cutting-edge research, improve patient care, enhance trainee education as well as bring increased revenue and grant funding to the institution.

Methods

Institutional funding was obtained to create a dedicated lab space and to hire a lab director. A questionnaire was sent to all department chairs to assess the current and projected uses of 3D imaging and 3D printing. Chairs were asked to forward the questionnaire to their clinical and research faculty. Questions were designed to capture the number of cases in which 3D imaging and 3D printing were used per month and the average cost per case if 3D printing was outsourced. Options for # of cases were: <5, 6-10, >10. Options for cost were: <$500, $500-$999, $1,000-$2,999, $3,000-$4,999, >$5,000. Five-point Likert scale questions regarding the perceived benefits of 3D imaging and 3D printing in clinical practice were used.

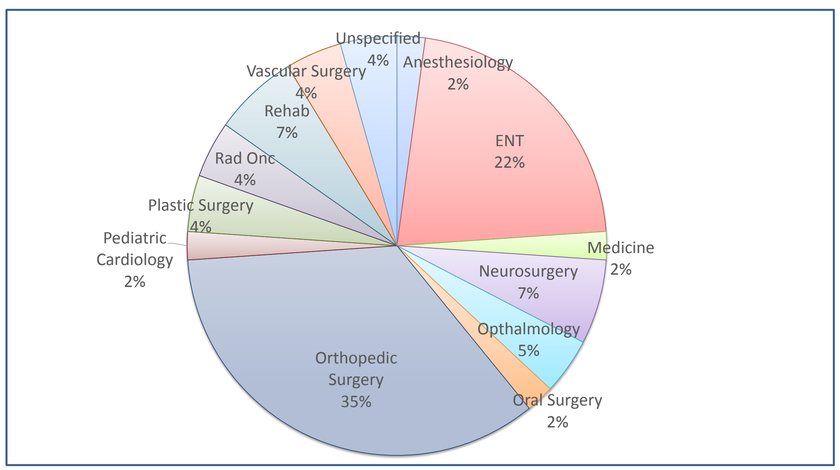


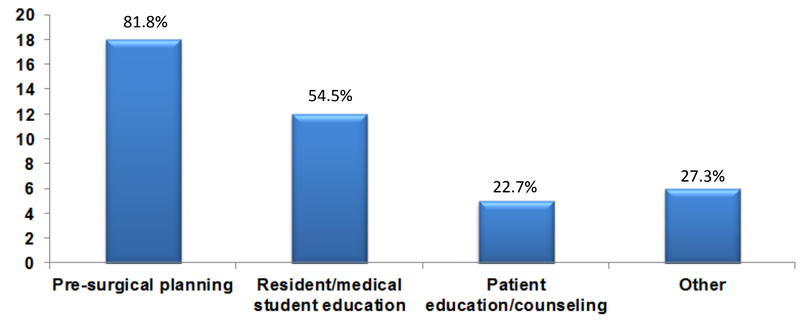
Figure 1: Questionnaire responses by medical specialty.

This work was presented at the 2019 ELAM® Leaders Forum.

Results

There were a total of 46 survey responses from 12 specialties **(Figure 1)**. There were 22 responses indicating current use of 3D imaging with the breakdown of uses shown in **Figure 2**. For the Likert Scale questions, 10/22 (46%) strongly agreed that 3D imaging impacts patient care and 8/22 (36%) believed that 3D imaging has changed patient management and improved patient outcomes.

2A. What do you use 3D imaging for? (Check all that apply)



2B. How many cases do you do per month?

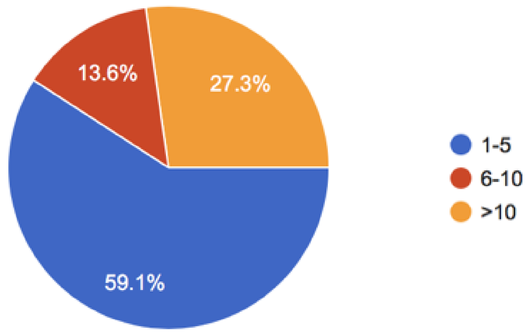


Figure 2: A. Current uses of 3D imaging (Note that more than one answer could be selected). **B.** Number of cases per month.

3D printing was utilized by 16/46 (35%) of respondents: 13/46 (28%) outsourced 3D printing and 3/46 (7%) used their own desktop fused deposition modeling (FDM) 3D printer. Types of cases included the following:

- Skull base surgery
- Complex endoscopic sinus surgery
- Head and neck cancer resection
- Craniofacial craniopagus
- Creating prosthetics and orthotics
- Foot deformities
- Fracture malunion deformity correction
- Arterial repair and reconstruction
- Vascular lesions in the neck
- Aneurysm treatment and AVM treatment
- Planning for radiation therapy (cancers– skin, prostate, cervical, lung)

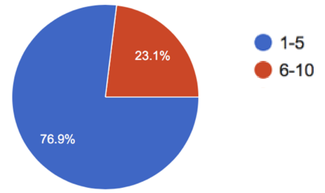
For outsourced models, a variety of companies were utilized including 3D Systems (Stryker), Materialise (DePuy Synthes), Zimmer Biomet, Mighty Oak Medical, KLS Martin, Medtronic, Globus, and Restor 3D. The majority of case types were:

- Anatomic models (46.2%)
- Templates/guides (30.8%)
- Implantable devices (7.7%)
- Anatomic models and templates/guides (7.7%)
- Anatomic models and implantable devices (7.7%).

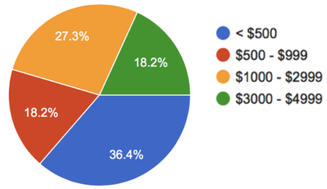
The number of outsourced cases ranged from 444 to 1,080 per year (mean = 762) and the weighted average cost for outsourced cases was $1,444 per case. **Figure 3** shows the breakdown regarding number of cases per month, price estimates, as well as how physicians are currently paying for models.

4/14 (28.6%) of respondents strongly believed that 3D printing impacts patient care more than imaging, 39/44 (88.6%) said that they would order MR/CT studies to include 3D imaging if it was available in house and 43/44 (97.7%) said they would order 3D printed anatomic models in house if it was available. **If in-sourced, assuming 762 cases per year at $500 per case, the net cost savings is estimated to be $719,000 per year**.

3A. How many cases do you outsource per month?



3B. Approximately how much do you pay per case?



3C. How do you currently pay for printed models?

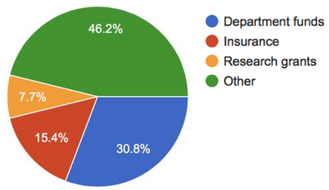


Figure 3: A. Number of cases per months that are outsourced. **B.** Estimated cost per case (US$). **C.** Breakdown of how models are paid for.

Conclusions

A dedicated 3D imaging lab will enhance best practices by allowing state-of-the-art post-processing of imaging data for research and optimizing clinical care. Cutting-edge research will be supported using the latest image processing hardware and software. Decreased operation times, decreased complications and improved diagnosis are achievable with using advanced 3D imaging/printing. Consolidated in-sourcing of 3D printing will make it more accessible (quicker turnaround time, ability for personal interaction and improved user satisfaction) and lead to cost savings for the healthcare system.

Future work will be performed to evaluate which case types are created in house, to quantitatively measure how these models can positively impact patient care, and to determine the actual cost savings.