PREOPERATIVE PLANNING UTILIZING 3D PRINTING

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IMPORTANCE OF PREOPERATIVE PLANNING

- Creating a plan can limit the amount of incisions needed
- Complex surgeries require individualistic plans
- Some surgeries require an implant to be picked based on the patient’s situation
- Planning allows surgeons to minimize the length of surgery
  - Limiting time in surgery limits postsurgical complications
IMPORTANCE OF 3D PRINTING

- Allows for a complete view of the area for operation using CT, MRI, and Ultrasound scans
- Test implants before the operation
- Used in very complex surgeries
- Joint replacement, deformity correction, excision of tumors, repair of irregular bone fractures
- Shows complete anatomy of individual
- Allows surgeons to visualize area in three dimensions whereas CAT scans and X-rays only show 2 dimensions
3D PRINTING PROCESS

- Scan desired area and denoise
- Segmentation: use image slices of about 1mm
- Use an image processing software to create 3D model
- Print 3D image
  - Average time for printing: 12 hours for 6 inch model
SURGEON USE OF 3D PRINTING

- Use 3D printed template to visualize the surgical area
- Select incision placement
- Instrumentation
- Placement of implants
  - Implants can be tested prior to surgery
  - Best placement and type of implant can be decided on prior to surgery
- Virtual surgeries may be available to virtually practice the surgery to allow for more complete planning
CASE STUDY

• 63-year old male with osteolytic lesion in C-2 vertebral body and C-1 anterior arch
• Without intervention tumor progression creates a poor quality of life and eventual death
• Semitransparent 3D bio model used for planning
• Bio model used to plan and test implants
• Bio model used to chose surgical incision site
EXPERIENCE OF FIRST 50 SURGERIES DONE USING 3D-PRINTED BIOMODELS

- 5 surgeons involved with 50 cases being documented
- Using CT scans bio models were produced to allow surgeons to develop mental image of the patients anatomy
  - CT taken using Medical Rapid-prototyping Computed-tomography Protocol in 76% of cases
- 3D models also used intraoperatively for referencing
- Cases generally involved injuries that were complex to fully visualize in 2D
# RESULTS

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Average score (out of 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accurate representation</td>
<td>8.1</td>
</tr>
<tr>
<td>Turn around time</td>
<td>4.6</td>
</tr>
<tr>
<td>Helpful in preoperative planning</td>
<td>8.3</td>
</tr>
<tr>
<td>Altered the surgical plan</td>
<td>5.7</td>
</tr>
<tr>
<td>Reduced surgical time</td>
<td>7.8</td>
</tr>
<tr>
<td>Improved inventory management</td>
<td>8.2</td>
</tr>
<tr>
<td>Avoiding unforeseen complications</td>
<td>6.8</td>
</tr>
<tr>
<td>Postoperative Xray assessment</td>
<td>7.6</td>
</tr>
<tr>
<td>New information compared to preoperative CT</td>
<td>6.2</td>
</tr>
<tr>
<td>Would recommend its use to other surgeons</td>
<td>8.9</td>
</tr>
</tbody>
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PROS

• Complete view
• Complex anatomy can be documented
• Test implants before operation
• Provide surgeons with a better basis for their preoperative plan

CONS

• Design engineer without medical terminology
• Resistance of surgeons to this change
• Resistance of health care providers to pay for bio models
• Expensive
  • Printing equipment
  • Biomedical engineer salary
  • Design engineer
DISCUSSION

• 3D printing is a valuable tool in preoperative planning
  • Mainly in respect to complex surgeries
  • Though valuable it is very expensive
  • As it becomes more popular, the cost will be reduced
  • As more design technicians work with these models the wall between surgical language and design language may be broken


QUESTIONS