SURGICALLY DRIVEN DESIGN
FOR ADVANCED JAW RECONSTRUCTION

**PURPOSE**
- Advanced Jaw Reconstruction Rehabilitation (JRR) has emerged over the years to treat head and neck tumors (HNT).
- Surgically Driven Design principles has evolved in the planning and delivery of the Alberta Reconstruction Technique (ART).
- The purpose of this study was to assess the clinical outcomes between the 4.3 mm and 3.5 mm diameter implants in the ART participants.
- The effects of implant diameter and spacing between implants in the fibular bone as well as changes to clinical services to improve clinical outcomes is discussed.

**MATERIALS & METHODS**
- A chart review on adult HNT participants who had undergone an ART between 2011 - 2016 was conducted.
- ART involved a preoperative Surgical Design and Simulation (SDS) using advanced digital technologies (computer aided design and additive manufacturing) for the microvascular fibular free flap reconstruction involving the primary implantation of implants (+/- chemoradiation).
- Background information is presented in Figure 1 and 2 (Walsh et al, 2017) illustrating 4.3 mm diameter implants and 5 mm spacing between implants had the lowest stress on the fibular bone. Figure 3 and 4 illustrate cortical bone loss and implant loss.
- The outcome measures, cortical bone loss occurrence and implant loss between the 4.3 mm and 3.5 mm diameter implants in the ART cohorts are presented in Table 1. These were reported using descriptive statistics.
- The Surgically Driven Design principles implemented to improve the cortical bone vitality in the irradiated ART participants are outlined in Figure 6.

**RESULTS**
- There was a higher occurrence of cortical bone loss and implant loss in the 4.3 mm diameter cohort compared to the 3.5 mm.
- In the non-irradiated ART cases, there were no occurrences of cortical bone loss or implant loss.

**CONCLUSION**
- Implant diameter and spacing between implants may have an impact on the cortical bone vitality and implant success in the irradiated ART cases.
- Follow-up data of the modified protocol in the irradiated ART participants is needed to capture long-term clinical outcome data.

**NEXT STUDY**
- This observational study is a starting point to assess trends in the data to support protocols for the successful completion of advanced Jaw Reconstruction Rehabilitation (JRR).
- Further investigation is needed to study the biological factors that impact the integrity of the osseous and vascular supply of the irradiated fibular bone after advanced JRR.

**Clinical outcomes**

<table>
<thead>
<tr>
<th>Clinical outcomes</th>
<th>4.3 mm</th>
<th>3.5 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>27</td>
<td>15</td>
</tr>
<tr>
<td>Cortical bone loss occurrence</td>
<td>7%</td>
<td>1%</td>
</tr>
<tr>
<td>Implants installed</td>
<td>106</td>
<td>68</td>
</tr>
<tr>
<td>Implant loss</td>
<td>25 (24%)</td>
<td>2 (3%)</td>
</tr>
<tr>
<td>Implant RT dose Gy</td>
<td>(63-67)</td>
<td>(55-67)</td>
</tr>
<tr>
<td>Had RT post-ART</td>
<td></td>
<td></td>
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</tbody>
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**Protocol Modification**

1. Narrow 3.5 mm diameter implant
2. 5 mm spacing between implants
3. Hyperbaric Oxygen Therapy
4. Bone impacted fibular free flap

Figure 1. Finite Element Analysis 1 showing less stress using 5 mm spacing between implants in the fibular bone
Figure 2. Finite Element Analysis 2 showing less stress using the 4.3 mm diameter implant in the fibular bone
Figure 3. CT image of implants in fibula
Figure 4. Outer cortex loss
Figure 5. Radiation therapy back scatter to bone and soft tissue
Figure 6. Protocol Modification for irradiated advanced JRR patients

**Table 1. Clinical outcomes data in ART patients using 4.3 and 3.5 diameter implants**