

DESIGN, ADDITIVE MANUFACTURE AND CLINICAL APPLICATION OF A PATIENT SPECIFIC TITANIUM IMPLANT TO ANATOMICALLY RECONSTRUCT A LARGE CHEST WALL DEFECT



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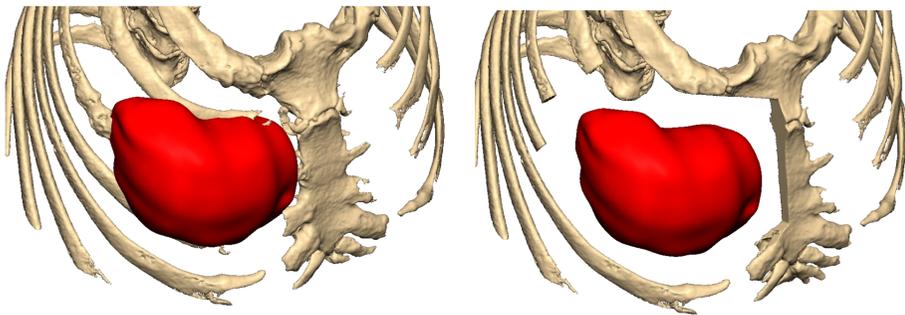
INTRODUCTION

- Chest wall reconstruction of large oncological defects following resection is technically and surgically challenging¹.
- Traditional management involves the use of different materials that surgeons creatively shape intraoperatively to restore anatomy¹.
- This is time consuming and following surgery has the potential for dislocation and paradoxical movement during respiration².
- We present the 3 dimensional (3D) computer aided design (CAD), manufacture and clinical application of a novel custom-made 3D laser sintered titanium alloy implant that provides skeleton reconstruction over a large chest wall resection and maintains the integrity of the thoracic cage.

IMPLANT DEVELOPMENT AND CLINICAL APPLICATION

1: Virtual planning, anatomical models and resection margins

- CT scan processed in Mimics software for the creation of the 3D models.
- 2 cm tumour offset for clear resection margins in Geomagic Freeform software.



2: 3D CAD of the implant and rapid prototyping

- Implant modelled in Freeform software mimicking the anatomy resected.
- Iterative design process with rapid prototyping and 3D printers in house.



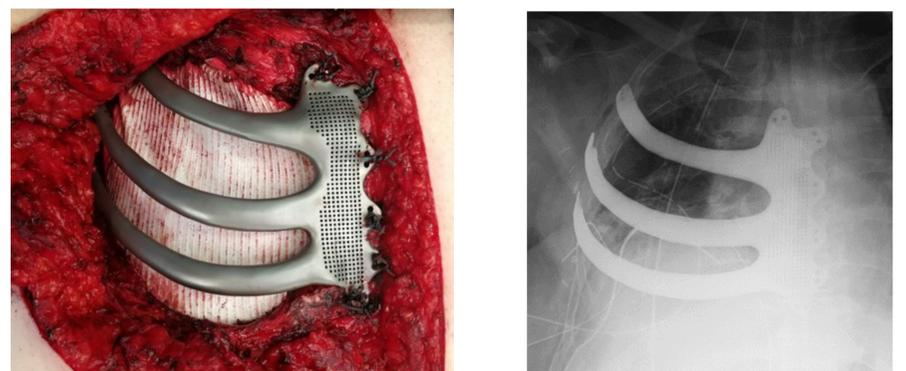
3: Design validation and final manufacture

- Design validated by surgeons after meeting design requirements.
- Manufactured from Ti6Al-4V ELI (Grade 23) by metal powder bed fusion.



4: Clinical implantation and final results

- Surgical resection went to plan. Implant secured with Ethibond sutures.
- Implant successfully restored the integrity of the thoracic cage.



FINDINGS AND CONCLUSIONS

- The implant fitted precisely and anatomically at surgery and provided excellent aesthetical and functional results.
- The implant provided a robust reconstruction while allowing some compliance during breathing movements due to the Ethibond sutures.
- The virtual planning and preoperative production of the implant reduced surgery time and uncertainty and improved safety and accuracy.
- This technique is effective and offers a fast lead-time for implant production (3 weeks) which is crucial for oncological treatment.
- More cases are needed to confirm and quantify the benefits of this procedure and further research is required to design a solution that better mimics the chest wall biomechanics while preventing implant complications.
- This study may offer more prospects for personalised treatments of complex oncological defects with additively manufactured implants.

REFERENCES

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2. Sanna, S., Brandolini, J., Pardolesi, A., Argnani, D., Mengozzi, M., Dell'Amore, A. and Solli, P., 2017. Materials and techniques in chest wall reconstruction: a review. *Journal of visualized surgery*, 3.