



Queen Elizabeth Hospital Maxillectomy Using Freeform+ Software

Methodology

VIRTUAL SURGICAL PLANNING

TUMOUR EXCISION

PELVIS BONE EXCISION AND REPOSITIONING

REFINEMENT AND RECONSTRUCTION

3D METAL PRINT FOR ORBITAL FLOOR

Overview

Queen Elizabeth Hospital undertook an innovative surgical procedure utilising **3D reconstruction technology**. This case study highlights the use of virtual surgical planning and **custom-designed** 3D cutting guides in the treatment of a patient who required a maxillectomy. The procedure involved the removal of the maxilla (upper jaw bone) and a tumour, followed by a complex reconstruction using the patient's pelvic bone.

A **maxillectomy** is a surgical procedure that involves the removal of part or all the maxilla, which is the upper jawbone. This surgery is typically performed to excise a tumour located in the maxillary region. The maxilla supports the upper teeth, forms part of the orbit of the eye and contributes to the structure of the nasal cavity and hard palate.



Acquisition of Advanced Technology 🔷 🗸

To facilitate this groundbreaking procedure, Queen Elizabeth Hospital made a strategic investment in advanced medical software and **Haptic Technology**. The hospital acquired **Freeform+** software by Oqton, from OR3D, a leading provider of 3D modelling services and platinum partner to Oqton. This software enabled the **Biomedical Engineer** to create detailed and precise oncology virtual plans for the maxillectomy and reconstruction. In addition to the software, the hospital also purchased a **Haptic Touch X** device. This device provided tactile feedback, allowing the team to feel the virtual objects they were manipulating in the software. This Haptic feedback was crucial for designing accurate cutting guides and for planning the bone reconstruction with high precision.

These guides were meticulously crafted to match the patient's unique anatomy, ensuring that the cuts made during surgery were precise and aligned perfectly with the pre-surgical plan.



www.or3d.co.uk 3 Cedar Court, Brynkinalt Business Centre Estate, Chirk, Wrexham, LL14 5NS





Virtual Surgical Planning

Using the newly acquired Freeform+ software and Haptic Touch X device, a comprehensive virtual plan was devised. The surgical team mapped out the maxillectomy with precise boundaries for tumour excision. The team designed custom 3D cutting guides using the software, ensuring accuracy during the surgical procedure. The Haptic Touch X device allowed surgeons to interact with the virtual models in a tactile manner, enhancing the precision of the surgical planning.

Tumour Excision 🕠

The maxilla was carefully removed following the virtual plan. The custom-designed cutting guides played a crucial role in ensuring precision. A profile was created and extruded from the surface so that the internal skull directly matched the guide. This ensured that the cutting guide fit perfectly onto the skull, aligning the cuts accurately. The removal of the maxilla highlighted the tumour, allowing for clear delineation and complete excision.





Pelvis Bone Excision and Repositioning v

The next phase involved using the patient's pelvic bone to reconstruct the maxillary defect. The pelvis was repositioned in relation to the maxilla as per the virtual plan. The custom guides were used to cut the pelvis bone into the required shape. This precision cutting was crucial for a good fit in the maxillary cavity.

Refinement and Construction 🗸

Post cutting, further refinement was necessary to ensure the bone fitted perfectly. Utilising the custom guides, the pelvis bone was shaped to achieve a more precise fit into the cavity left by the maxilla. This step was critical to ensure that the reconstructed area would function effectively and aesthetically.



"The software provided by OR3D has transformed the service we can provide at the QE hospital. It is a critical part of our everyday use for the virtual surgical planning service from cutting guide design to reconstruction."

EMILIA HARGREAVES Queen Elizabeth Hospital





A significant challenge during the maxillectomy procedure was the reconstruction of the orbital floor, a delicate and vital structure that supports the eye and separates the orbital cavity from the sinus below. The removal of the maxilla and the tumour left a defect in the orbital floor, necessitating a highly precise reconstruction to restore both function and appearance. This task was complicated by the need to ensure that the reconstructed area could support the eye properly and maintain the structural integrity of the orbital cavity.

The process began by digitally recreating the orbital floor using **Freeform+** based on the patient's **CT scan data**. The software enabled the **Biomedical Engineer** to generate an **accurate virtual model** of the patient's orbital cavity and surrounding structures. Once the digital model was complete, a plastic replica of the orbital floor was created in the lab. This plastic model not only helped visualise the patient's unique anatomy but also acts as a template for fabricating the final implant.

Finally, the orbital floor was 3D printed, ensuring a precise fit that perfectly matched the patient's anatomy. This custom metal implant provided strong structural support for the eye and integrated seamlessly with the surrounding bone, restoring both function and stability to the orbital area.





Conclusion

The collaboration between **Queen Elizabeth Hospita**l and **OR3D** showcases the transformative potential of integrating 3D reconstruction in complex surgical procedures. This case highlights how virtual surgical planning and custom 3D cutting guides, facilitated by the **Freeform+** software and **Haptic Touch X** device, can enhance precision, improve patient outcomes, and set new standards in surgical care. The successful maxillectomy and reconstruction using the patient's pelvis bone and a custom created metal plate underscore the efficacy of these advanced techniques.



"The haptic arm adds a next level element to the planning and always gets a great reaction from surgeons and visitors. Finally, the customer service received from OR3D is fantastic and nothing is too much trouble."

BIOMEDICAL ENGINEER - MAXILLOFACIAL PROSTHETICS

Queen Elizabeth Hospital