Title: **The PEEK of Innovation: Custom 3D-Printed Polyetheretherketone (PEEK) Rib Implants for Chest Wall Reconstruction in a Locally Advanced Breast Cancer Patient**

Authors: Rudolph John R. de Juras, MD[1]; Racel Ireneo Luis C. Querol, MD, FPCS, FPATACSI[1]; Gisel T. Catalan, MD, FPCS, FPATACSI[1]; Rentor Y. Cafino, MD, FPSO-HNS[2]

[1]Division of Thoracic, Cardiac & Vascular Surgery, Department of Surgery, College of Medicine and Philippine General Hospital, University of the Philippines Manila

[2]Department of Otorhinolaryngology – Head and Neck Surgery, Zamboanga City Medical Center

Corresponding Author: Rudolph John R. de Juras, MD

Mobile Number: +63 917 5431407

Telephone: N/A

E-mail: rrdejuras@up.edu.ph

Introduction

Chest wall invasion by locally advanced breast cancer is uncommon but poses significant therapeutic and reconstructive challenges. En bloc resection remains the cornerstone for oncologic control, yet restoration of thoracic integrity demands durable, anatomically conforming reconstruction. Conventional materials such as polymethylmethacrylate, titanium plates, and polypropylene mesh, while effective in restoring rigidity, often fail to replicate the complex biomechanics of the chest wall or allow optimal postoperative imaging. Polyetheretherketone (PEEK), a biocompatible thermoplastic with favorable mechanical properties and radiolucency, offers a promising alternative. The advent of three-dimensional (3D) printing enables the creation of patient-specific implants that accurately replicate native anatomy, potentially improving surgical precision, functional outcomes, and cosmesis. We present the case of a 59-year-old female with locally advanced breast cancer and rib invasion, managed through radical resection and chest wall reconstruction using custom 3D-printed PEEK neoribs in a resource-limited setting.

Methods

A 59-year-old hypertensive female presented with a five-year history of a progressively enlarging left breast mass, ultimately staged as cT4N0M0 invasive carcinoma. Following neoadjuvant chemotherapy (AC×4, T×4), computed tomography demonstrated tumor adherence to the left 2nd and 3rd ribs, with a predicted 6.0 × 5.7 cm chest wall defect. Imaging datasets were converted into 3D models using Materialise Mimics Innovation Suite to delineate tumor extent, design osteotomy guides, and fabricate anatomically precise PEEK rib implants. Both cutting guides and implants were sterilized preoperatively. Surgery involved radical mastectomy, en bloc resection of the 2nd and 3rd ribs, and implantation of custom PEEK neoribs secured with titanium screws and sternal wires. A prolene mesh overlay reinforced the repair, while plastic surgery provided soft-tissue coverage with a pedicled latissimus dorsi flap and split-thickness skin graft.

Results

The procedure produced a 7 × 10 cm chest wall and 14 × 13 cm skin defect, which were successfully reconstructed. Intraoperative placement of cutting guides ensured accurate osteotomy, and the pre-fabricated implants matched the native thoracic curvature, minimizing intraoperative adjustments. Postoperative chest radiographs were unremarkable, and the patient was extubated without respiratory compromise. She reported minimal pain and demonstrated early mobilization. Graft take was satisfactory at two weeks, with no infection or dehiscence noted at one and six months follow-up. At six months, the wound was fully healed, grafts were intact, and the patient resumed activities of daily living with preserved respiratory function and favorable cosmetic results. Histopathology confirmed invasive carcinoma with rib involvement, and margins were negative.

Conclusion

This case underscores the feasibility and clinical utility of 3D-printed PEEK rib implants for chest wall reconstruction following oncologic resection. The material's strength, radiolucency, and biocompatibility, combined with patient-specific customization, provide a superior alternative to traditional reconstruction methods, balancing structural integrity with cosmetic and functional outcomes. Importantly, the success of this approach in a resource-limited environment demonstrates that advanced precision technologies can be adapted locally to expand access to cutting-edge care. This report highlights the potential of PEEK implants to redefine thoracic reconstruction paradigms, aligning with global trends toward personalized, regenerative, and technology-driven surgical oncology.