3D-Printed Hemipelvic Endoprostheses Improve Long-term Function and Sacroiliac Stability after Enneking Type II/II+III Periacetabular Tumor Resection: A Matched Cohort Study

Haijie Liang[1], Jichuan Wang[1], Xingyu Liu[1], Boyang Wang[1], Feiyang Qi[1], Huayi Qu[1], Dasen Li[1], Shun Tang[1], Wei Guo[1], and Yi Yang[1]

1 Musculoskeletal Tumor Center, Beijing Key Laboratory for Musculoskeletal Tumors, Peking University People's Hospital, Beijing, China

Significance & Hypothesis/Techniques

Hemipelvic reconstruction after Enneking type II or II+III periacetabular tumor resection remains mechanically demanding and complication-prone. A frequently overlooked mechanism of late instability is progressive operative-side sacroiliac (SI) joint diastasis and pelvic obliquity during long-term weight-bearing. We hypothesized that a 3D-printed hemipelvic prosthesis (Figure 1) designed for optimized load transfer and porous bone–implant integration would reduce long-term SI diastasis, improve gait and function, and lower prosthesis-related complications compared with conventional modular prostheses.

Innovation

This study represents one of the largest matched cohort comparisons of 3D-printed versus conventional hemipelvic endoprostheses with long-term follow-up exceeding 10 years. It is the first to systematically evaluate operative-side SI joint stability using serial CT-based SI gap ratio analysis, providing quantitative evidence linking prosthesis design to long-term pelvic biomechanical outcomes.

Approach (Materials & Methods)

A retrospective, single-center matched cohort study was performed on consecutive patients undergoing en bloc type II or II+III resection followed by hemipelvic reconstruction (3D-printed group, n=101; conventional modular group, n=102; total n=203). The 3D-printed implant was a porous titanium hemipelvic prosthesis with an anatomically contoured iliac foundation and preplanned screw trajectories; the porous interface was intended to facilitate biological fixation. Primary outcomes were long-term SI stability (radiographic SI diastasis/pelvic obliquity), functional outcome (MSTS-93), and gait performance. Secondary outcomes included prosthesis-related complications (infection, dislocation, mechanical failure/loosening) and implant survival. Serial postoperative CT was used for time-course assessment of operative/contralateral SI gap ratios.

Results

Over a mean 11.5-year follow-up, the 3D-printed cohort showed a significantly lower incidence of progressive SI diastasis and clinically relevant pelvic obliquity than the conventional cohort. Long-term functional outcomes were superior in the 3D-printed cohort (MSTS-93: 22.1±2.2 vs 16.9±4.6), accompanied by better gait performance and reduced reliance on walking aids. Prosthesis-related complications were less frequent in the 3D-printed cohort (5 vs 19), and implant survival favored 3D-printed reconstruction ($p<0.05$). In CT-based time-course analyses, operative/contralateral SI gap ratios remained near symmetric in the 3D-printed group (median 1.05; range 0.76–1.18) (Figure 2), whereas ratios were consistently higher in conventional recipients (range 1.26–1.66; all $p<0.05$). Notably, despite the overall advantage, late SI diastasis and pelvic tilt were not eliminated and occurred in a subset of long-term survivors.

Discussion

In a 200-case single-center matched cohort with more than 10-year follow-up, 3D-printed hemipelvic prostheses provided durable reconstruction with improved long-term SI stability, gait and function, and fewer prosthesis-related complications. These findings support the concept that optimized load transfer and porous osseointegrative interfaces improve mid-to-long-term performance, while emphasizing the need for further strategies to minimize residual late pelvic obliquity and SI diastasis.

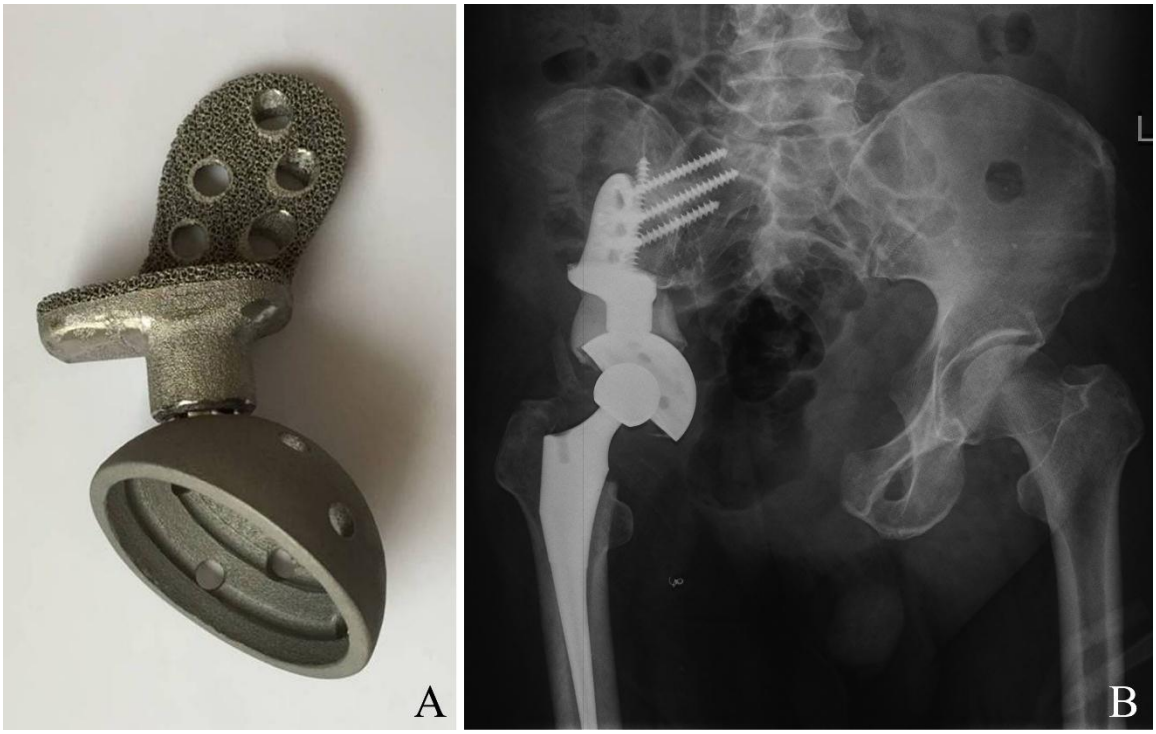

Figure 1 A 3D-printed standard hemipelvic endoprosthesis designed for reconstruction after pelvic type II resection **A**: A photograph of the 3D-printed hemipelvic prosthesis showed porous structure on the bone-metal interface and preserved holes for screw fixation. The acetabular ring and iliac foundation were separate and could be assembled intraoperatively; **B**: Post-operative X-ray photography after pelvic type II + III resection and reconstruction with a 3D-printed hemipelvic endoprosthesis, which showed that the fixation screws at the foundation could pass through sacroiliac joint into upper sacral vertebra.

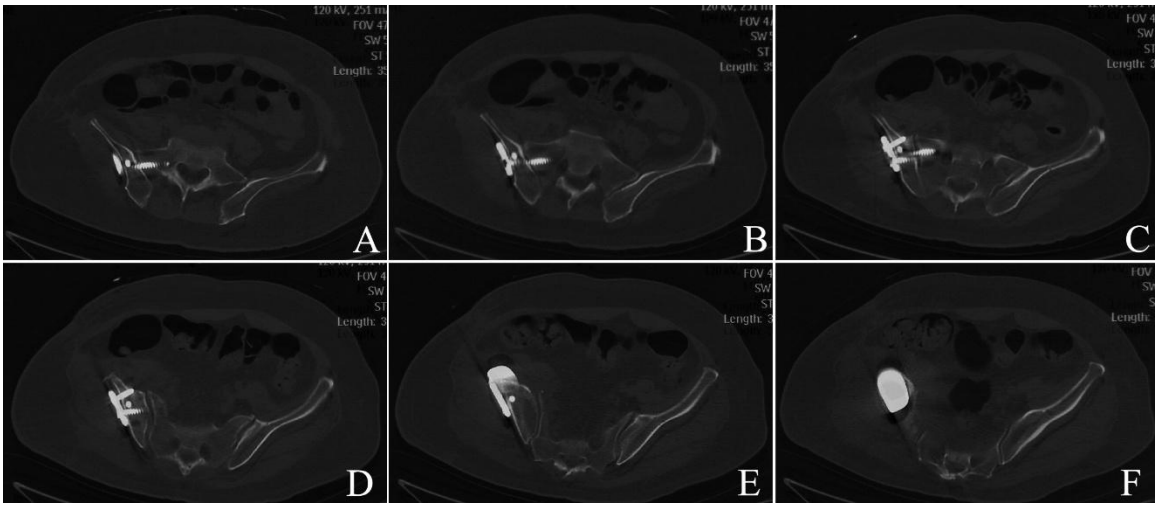

Figure 2 A-F Results of CT scan at 6-month follow-up from a 59-year-old male receiving type II + III resection of a pelvic chondrosarcoma and reconstruction with 3D-printed hemipelvic endoprosthesis. Axial CT films showed that there was no recurrence, and that the fixation screws precisely went through the sacroiliac joint into the sacral vertebra, and that the widths of both sacroiliac gaps were generally equal.