

Functional Recovery Trajectories Following Internal Hemipelvectomy: Custom 3D-Printed Reconstruction vs. Non-Reconstruction

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Significance & Hypothesis

Resection of periacetabular tumors involves substantial morbidity. Optimal management after internal hemipelvectomy remains controversial, balancing functional gains against complication risks. While forgoing reconstruction avoids implant-related sequelae, it may limit postoperative mobility. With advancements in custom 3D-printed implants, reconstruction has re-emerged as a viable option, yet longitudinal data on functional recovery trajectories remains sparse. This study compares recovery markers between patients undergoing custom 3D pelvic reconstruction and those managed with non-reconstruction (flail). We hypothesized that reconstruction results in earlier and more robust functional recovery.

Innovation

This study shifts focus from traditional surgical endpoints to patient-centered functional trajectories. By evaluating progression through gait aids and weight-bearing status over a 24-month period, it provides a clinically relevant assessment of the *velocity of recovery* provided by custom 3D reconstruction.

Approach

A retrospective cohort of 35 patients undergoing internal hemipelvectomy for oncologic indications (2007–2025) was analyzed. Inclusion required ≥ 3 months of follow-up; for patients requiring implant removal, data were censored at the time of explant. Weight-bearing status and gait aid use were recorded at defined postoperative intervals. Outcomes were assessed in two contexts: “Activities of Daily Living (ADLs)” (routine mobility) and “Maximum Assist” (highest support required). Patient-reported outcomes (PROs) included TESS, PROMIS Physical Function, and Pain Interference. Fisher’s Exact and Permutation Tests of Differences of Medians were utilized for comparative analysis.

Results

Following exclusions, 14 reconstruction and 10 non-reconstruction patients were analyzed. Functional independence (defined as ≤ 1 -point gait aid use; cane or no aid) was achieved significantly earlier in the reconstruction cohort. By 6 months, 61.1% of reconstruction patients reached functional independence for ADLs compared with 22.2% of non-reconstruction patients ($p=0.103$). At the 12-month interval, the reconstruction group showed a statistically significant advantage in achieving functional independence for maximum assist activities (83.3% vs 25.0%; $p=0.019$).

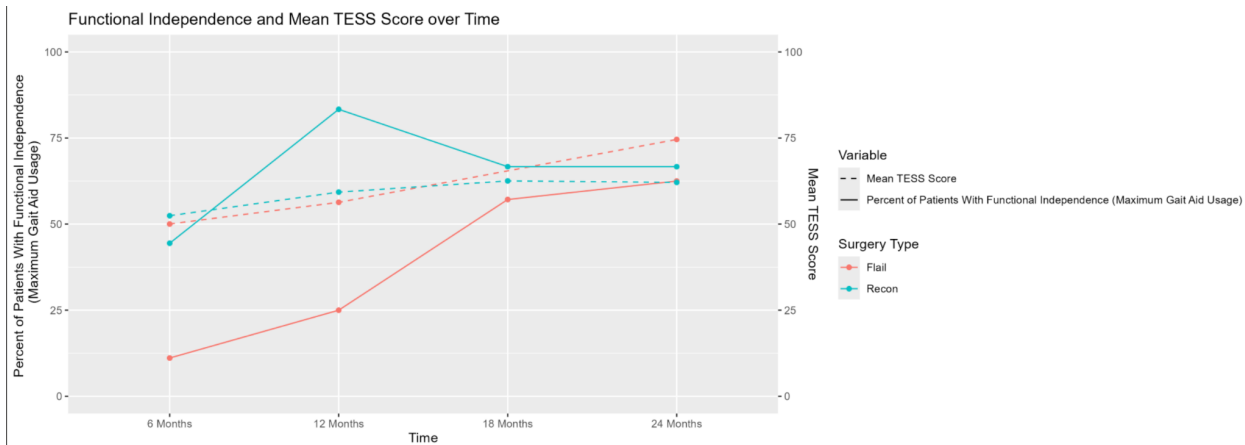
Median time to achieve functional independence was 158 days for reconstruction versus 257.5 days for non-reconstruction ($p=0.454$). While the non-reconstruction group demonstrated a functional “catch up” by 24 months, the reconstruction cohort maintained a higher velocity of recovery throughout the first postoperative year. Patient-reported outcome trajectories (TESS and PROMIS) remained comparable between groups, indicating that while functional milestones were reached sooner with reconstruction, overall quality-of-life improvements followed a similar upward trend across both surgical strategies.

Discussion & Impact

Reconstruction following internal hemipelvectomy is associated with a consistent trend toward accelerated functional recovery. Defining functional independence as the use of a cane or no gait aid, our data demonstrates that reconstruction allows a larger proportion of patients to reach this milestone as

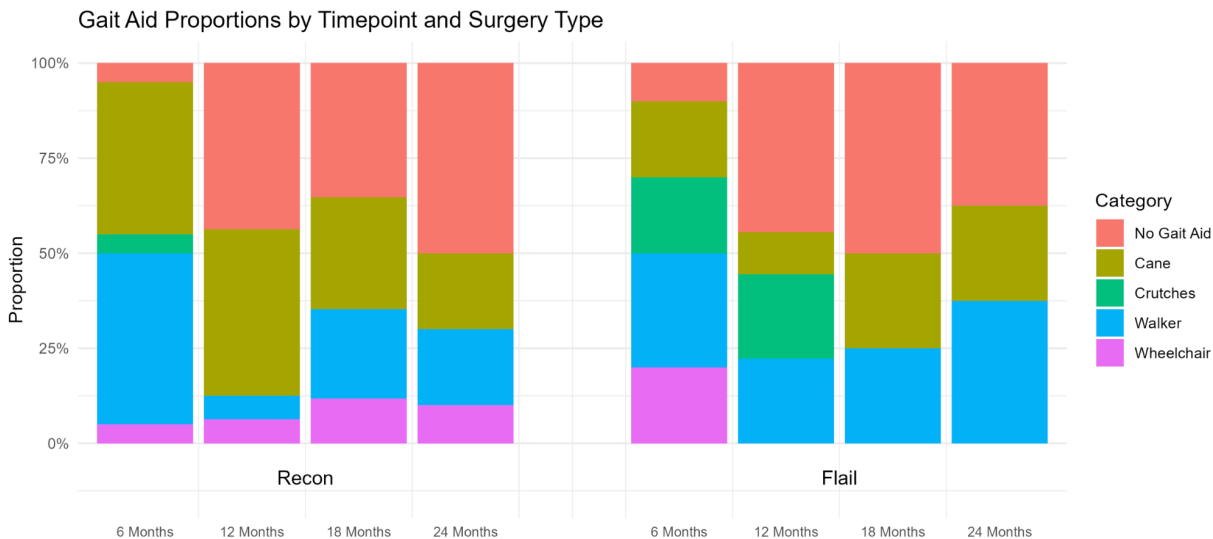
early as 6 to 12 months postoperatively. This "velocity of recovery" is clinically significant, as it minimizes the duration of high-stability aid reliance (walkers/crutches) and lessens the immediate postoperative disability period. These findings suggest that custom 3D-printed pelvic reconstruction effectively restores early mobility, providing a compelling rationale for its use in periacetabular tumor resection.

Figure 1. Longitudinal Functional Independence Trajectories



Line graph demonstrating the percentage of patients achieving functional independence (defined as $\leq$ 1-point gait aid use: cane or no aid) and mean TESS scores. The reconstruction group (teal) demonstrates a significantly faster trajectory toward independence in the first year compared to the non-reconstruction group (coral).

Figure 2. Gait Aid Proportions by Timepoint and Surgery Type



Stacked bar chart illustrating the transition through gait aid categories. Functional independence is represented by the combined "Cane" and "No Gait Aid" segments. Reconstruction patients show an earlier and more robust shift into these independent categories by the 6-month mark.

Table 1 & 2. Quantitative Functional and Patient-Reported Milestones

	Reconstruction	Flail	p-value	Activities of Daily Living (ADLs)			
Average (SD) time to WBAT	121.625 (SD = 94.146) (n = 16)	98.375 (SD = 82.799) (n = 8)	0.370	Number of Patients	14	10	
Average PROMIS Physical Function Score (6 months)	30.167 (SD = 2.317) (n = 6)	32 (SD = N/A) (n = 1)	0.714	Percent of patients achieving cane or no gait aid for ADLs by 6 months	61.1%	22.2%	0.103
Average PROMIS Physical Function Score (12 months)	36.857 (SD = 5.871) (n = 7)	38.5 (SD = 3.536) (n = 2)	0.639	Percent of patients achieving cane or no gait aid for ADLs by 12 months	83.3%	62.5%	0.347
Average PROMIS Physical Function Score (18 months)	38.286 (SD = 7.782) (n = 7)	38 (SD = N/A) (n = 1)	1	Percent of patients achieving cane or no gait aid for ADLs by 18 months	66.7%	71.4%	1
Average PROMIS Physical Function Score (24 months)	37.714 (SD = 4.192) (n = 7)	33 (SD = N/A) (n = 1)	0.375	Percent of patients achieving cane or no gait aid for ADLs by 24 months	55.6%	62.5%	1
Average PROMIS Pain Interference Score (6 months)	55.833 (SD = 10.685) (n = 6)	54 (SD = N/A) (n = 1)	0.714	Median Time to No Gait Aid for ADLs (days)	356	450	0.515
Average PROMIS Pain Interference Score (12 months)	60.286 (SD = 5.407) (n = 7)	55.5 (SD = 3.536) (n = 2)	0.306	Median Time to Single Point Assist for ADLs (days)	158	257.5	0.454
Average PROMIS Pain Interference Score (18 months)	60.375 (SD = 5.902) (n = 1)	62 (SD = N/A) (n = 1)	0.889	Median Time to Return to Pre-Op Gait Aid Usage for ADLs (days)	337	450	0.139
Average PROMIS Pain Interference Score (24 months)	56.5 (SD = 1.732) (n = 4)	61 (SD = N/A) (n = 1)	0.2	Maximum Assist			
Average TESS Score (6 months)	52.427 (SD = 8.240) (n = 3)	50.025 (SD = 1.138) (n = 2)	0.8	Percent of patients achieving cane or no gait aid for maximum assist by 6 months	44.4%	11.1%	0.193
Average TESS Score (12 months)	59.294 (SD = 11.674) (n = 5)	56.330 (SD = 5.416) (n = 2)	0.810	Percent of patients achieving cane or no gait aid for maximum assist by 12 months	83.3%	25%	0.019
Average TESS Score (18 months)	62.54 (SD = 14.257) (n = 4)	N/A (SD = N/A) (n = 0)	N/A	Percent of patients achieving cane or no gait aid for maximum assist by 18 months	66.7%	57.1%	1
Average TESS Score (24 months)	62.113 (SD = 7.371) (n = 3)	74.585 (SD = 35.942) (n = 2)	0.7	Percent of patients achieving cane or no gait aid for maximum assist by 24 months	66.7%	62.5%	1
				Median time to no gait aid (days)	530.5	639	0.802
				Median time to single point assist (days)	195	257.5	0.602
				Median time to return to Maximum Pre-Op Gait Aid Usage (days)	132	257.5	0.507

Consolidated analysis of weight-bearing and gait milestones. A statistically significant difference in the proportion of patients reaching functional independence was observed at 12 months for maximum assist activities (p=0.019), favoring the reconstruction cohort

