

Minimally Invasive Pelvic Fixation of Pelvic Metastases Using CT-Assisted Surgical Navigation is Associated with Predictable Pain Relief and Durable Restoration of Skeletal Stability and Function

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Significance & Hypothesis: Pelvic metastatic disease frequently produces severe mechanical pain, impaired ambulation, and poor quality of life. Radiotherapy remains a key component of treatment but may provide incomplete palliation when structural instability or pathologic fracture is present. Open reconstructive procedures can restore stability but carry substantial morbidity in patients with advanced cancer. Minimally invasive percutaneous fixation may provide rapid stabilization with lower surgical risk. The objective of this study was to evaluate outcomes of CT-navigated percutaneous pelvic fixation for painful pelvic metastases. We hypothesized that minimally invasive fixation would provide reliable pain relief, reduced narcotic use, and improved functional status.

Innovation: This study examines CT-assisted navigation to perform percutaneous fixation of metastatic pelvic lesions in patients with limited residual bone stock and severe mechanical pain. Navigation enables accurate screw placement in complex pelvic anatomy while maintaining a minimally invasive approach. In selected patients, thermal ablation was combined with fixation to address concerns regarding local tumor progression.

Approach (Materials & Methods): A retrospective review was performed of prospectively collected data from 36 patients treated between 2017 and 2025 for locally advanced pelvic metastatic disease. All patients presented with severe functional pain requiring high-dose narcotics and limited ambulatory capacity; 26 had pathologic fractures. Surgery aimed to restore pelvic stability through CT-navigated percutaneous fixation. Pain outcomes were assessed using the Visual Analog Scale (VAS) and opioid consumption measured as morphine milligram equivalents (MME). Functional outcomes were evaluated using Eastern Cooperative Oncology Group (ECOG) performance status and ambulatory capacity. Outcomes were recorded at baseline, 1 month, and at 3-month intervals. Differences between baseline, 1-month, and 12-month measurements were evaluated using ANOVA and chi-square testing.

Results: No hardware malposition or intraoperative complications occurred. All 36 patients were alive at 3 months and 30 remained alive at 12 months. Stable fixation was maintained in all cases. Mean VAS pain scores and opioid requirements improved significantly at 1 month ($p = 0.001$ and $p = 0.04$, respectively). At 3 months, VAS scores remained significantly improved ($p = 0.006$), while opioid consumption remained reduced but did not reach statistical significance ($p = 0.4$). Functional outcomes improved substantially: ECOG performance status improved by at least one level in all patients at 1 month and by two levels in 29 patients at 3 months. Among the 30 patients alive at 12 months, improvements in pain, analgesic requirements, and ambulatory function remained stable compared with the 3-month evaluation.

Discussion & Impact: CT-navigated percutaneous fixation provided consistent pain relief, reduced opioid use, and improved functional status in patients with pelvic metastatic disease. The technique achieved durable skeletal stabilization without perioperative complications in this cohort. These findings support minimally invasive fixation as a treatment option for metastatic pelvic instability in patients who may not tolerate extensive reconstruction. Further research should refine patient selection, evaluate the role of adjunctive ablation, and assess longer-term outcomes.

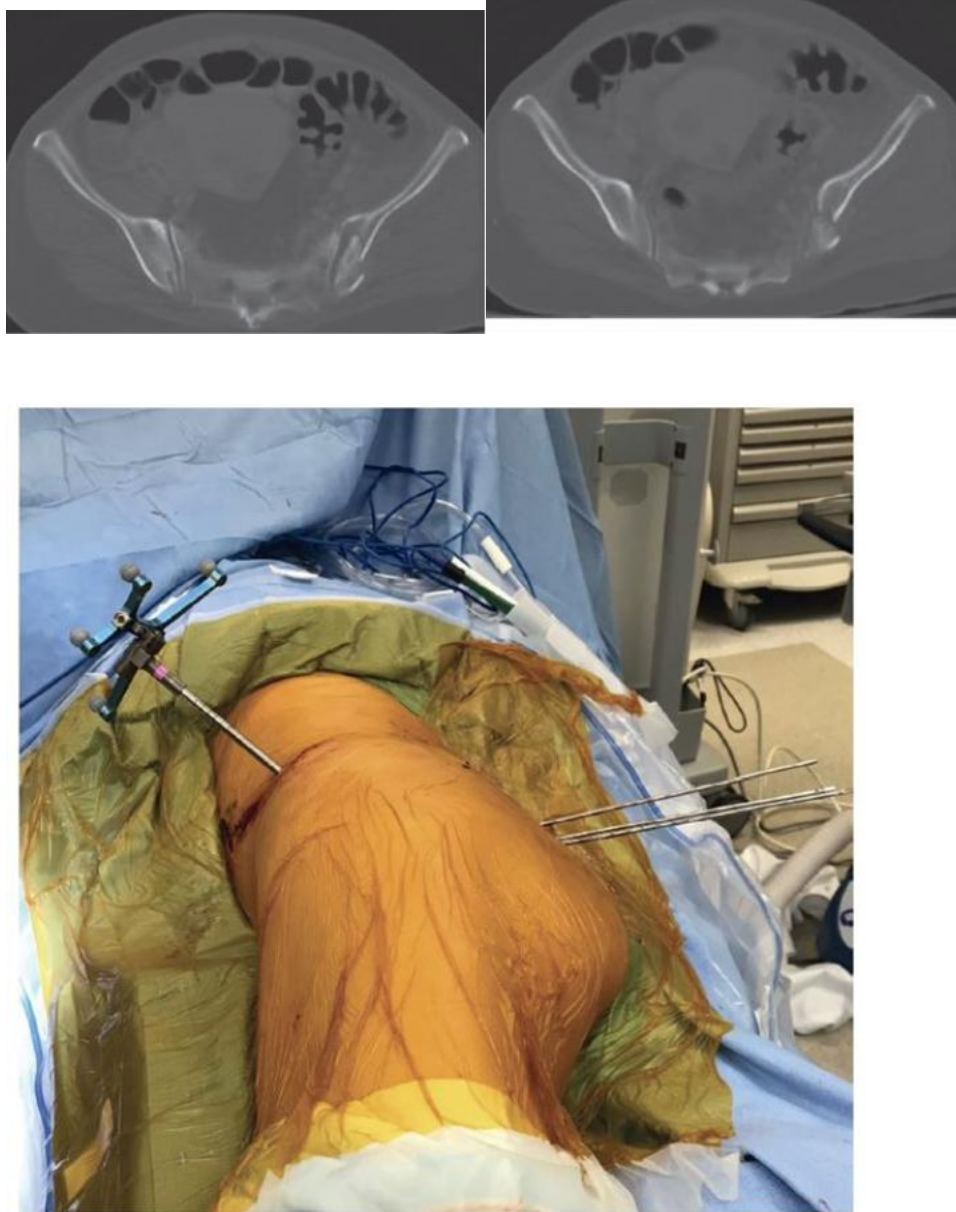


Figure 1. Example of CT-navigated percutaneous pelvic fixation with navigation-guided guidewire placement. 47yo female with metastatic EGFR mutant lung cancer and mildly displaced fracture through the left posterior ilium occurred 10 days after radiation (35Gy), leading to acute onset of disabling pain and inability to weight bear. Patient positioned in full right lateral position to facilitate screw insertion in the posterior left ilium. After placement of the reference frame on the anterior portion of the ipsilateral iliac crest, multiple navigated 3.2-mm guidewires have been inserted along the trajectory selected on preoperative plan.