

Distance Weighted Matching in the Quantification of Excess Morbidity in External Hemipelvectomy and Hip Disarticulation

Kole Joachim BA, Amanda Perrotta MS, Adrian Lin MS, Sumin Jeong BSN, Brandon Gettleman MD, Christopher Hamad MD, Michael Fice MD, Lauren E. Wessel MD, Nicholas Bernthal MD, Alexander B. Christ, MD

¹David Geffen School of Medicine at UCLA, Department of Orthopaedic Surgery, Los Angeles, CA

kjoachim@mednet.ucla.edu

Disclosures: Nicholas M. Bernthal (3B-Biomet; 3B-Daiichi Sankyo; 3B-Deciphera; 3B-Onkos; 3B-Zimmer; 5-Trellis; 9-Musculoskeletal Tumor Society; 9-Orthopaedic Research and Education Foundation), Alexander B. Christ (3B-Onkos Surgical, Inc.; 3B-Smith & Nephew, Inc.; 3B-Zimmer Biomet Holdings, Inc.; 3B-Stryker; 3B-Daiichi Sankyo; 3B-Globus Medical, Inc.; 9-AAOS Hip & Knee Evaluation Committee; 9-MSTS Fellowship Committee; 9-ORS Implant Section President; 8-Arthroplasty Editorial Board)

INTRODUCTION: External hemipelvectomy represents one of the most complex oncologic procedures; however, the actual excess morbidity compared to matched controls remains poorly quantified. We aimed to quantify the excess risk and resource utilization associated with external hemipelvectomy and hip disarticulation using a distance-weighted composite patient methodology constructed from alternative pelvic oncologic procedures.

METHODS: We conducted a retrospective cohort study using National Surgical Quality Improvement Program (NSQIP) data from 2019-2023. Patients undergoing external hemipelvectomy (CPT 27290, n=25; CPT 27295, n=54) were compared to composite controls created from patients undergoing other pelvic oncologic procedures. Control procedures included pelvic tumor resection (CPT 27045, n=89) and radical pelvic resection (CPT 27049, n=63), totaling 152 patients. These control procedures were selected as appropriate comparisons because they represent oncologic pelvic operations that share anatomical location and oncologic indication with hemipelvectomy but lack the extensive bone and soft tissue resection that defines hemipelvectomy procedures. This design isolates the excess morbidity specifically attributable to the hemipelvectomy procedure itself rather than confounding from oncologic indication or pelvic anatomical location. Composite controls were generated using distance-weighted matching on 16 comprehensive variables across four domains: patient demographics (age, sex, BMI), preoperative risk factors (ASA classification, functional status, diabetes, smoking, COPD, hypertension, steroid use), preoperative laboratory values (albumin, hematocrit, white blood cell count, creatinine), and procedure complexity (operative time, work relative value units). Each hemipelvectomy patient was matched to 5-10 control patients with inverse distance weighting to create composite controls. Primary outcomes included length of stay, textbook outcome (defined as absence of major complications, readmissions, reoperations, mortality, and length of stay \leq 75th percentile), and massive transfusion (\geq 4 units). Statistical analysis employed Wilcoxon signed-rank tests for skewed continuous data and paired t-tests for normally distributed outcomes, with bootstrap confidence intervals for non-parametric comparisons.

RESULTS SECTION: Using distance-weighted matching, 79 hemipelvectomy patients were matched to 79 composite controls with significant covariate balance across 12 of 16 matching variables (Figure 1). The hemipelvectomy cohort included 41.8% females compared to 52.6% in the unmatched control population (p=0.153). Hemipelvectomy demonstrated significant excess morbidity compared to composite controls with 4.9 days longer median length of stay (9.0 vs 4.1 days, 95% CI: 3.5-7.9, p<0.001), representing a 120% increase in hospitalization duration. Textbook outcome achievement was substantially reduced by 48.3% (32.9% vs 81.2%, 95% CI: -58.5% to -38.1%, p<0.001), with fewer than one-third of hemipelvectomy patients experiencing uncomplicated recovery. Massive transfusion risk (\geq 4 units) was markedly elevated at 25.3% versus 0.0% in controls (95% CI: 15.5%-35.1%, p<0.001), with this bleeding complication completely absent in the matched control population. Major morbidity composite occurred in 7.6% vs 0.0% of controls (95% CI: 1.6%-13.6%, p=0.013), while any major complication developed in 25.3% vs 8.9% (95% CI: 6.4%-26.5%, p=0.002) (Figure 2).

DISCUSSION: Distance-weighted matching effectively isolated the true morbidity burden of external hemipelvectomy and hip disarticulation by creating well-balanced composite controls, providing the first controlled comparison for these rare, high-complexity procedures. The 25.3% massive transfusion risk stems from the procedure's inherent technical demands, including extensive bone resection, major vascular exposure, and loss of anatomical tamponade, which create bleeding challenges absent even in similar pelvic oncologic operations. This hemorrhagic risk appears to trigger a cascade of complications, explaining the 48.3% reduction in optimal outcomes as initial bleeding leads to hemodynamic instability, prolonged operative times, and downstream morbidity. The methodology successfully balanced 12 of 16 matching variables while preserving the entire treatment cohort, demonstrating its value for comparative research in rare procedures where traditional matching approaches are inadequate. These evidence-based benchmarks replace vague institutional estimates with quantified risk data, directly informing patient counseling and enabling standardized perioperative protocols including blood bank preparation, multidisciplinary team coordination, and consideration for prophylactic intensive care monitoring.

SIGNIFICANCE/CLINICAL RELEVANCE: This study provides surgeons with specific, quantified complication rates for hemipelvectomy procedures while demonstrating a scalable methodology for generating robust comparative data in other rare, complex surgical procedures where adequate control groups are traditionally unavailable.

