available at www.sciencedirect.com
journal homepage: www.europeanurology.com

European Association of Urology

Bladder Cancer

Propensity-Matched Comparison of Morbidity and Costs of Open and Robot-Assisted Radical Cystectomies: A Contemporary Population-Based Analysis in the United States

Jeffrey J. Leow [a,b], *Stephen W. Reese* [a,b], *Wei Jiang* [a], *Stuart R. Lipsitz* [a], *Joaquim Bellmunt* [c], *Quoc-Dien Trinh* [a,b,c], *Benjamin I. Chung* [d], *Adam S. Kibel* [b,c], *Steven L. Chang* [a,b,c,*]

[a] *Center for Surgery and Public Health, Brigham and Women's Hospital, Harvard Medical School, Boston, MA, USA;* [b] *Division of Urology, Brigham and Women's Hospital, Harvard Medical School, Boston, MA, USA;* [c] *Dana-Farber/Brigham and Women's Hospital Cancer Center, Harvard Medical School, Boston, MA, USA;* [d] *Department of Urology, Stanford University Medical Center, Stanford, CA, USA*

Article info

Article history:
Accepted January 19, 2014
Published online ahead of print on January 28, 2014

Keywords:
Radical cystectomy
Bladder cancer
Complications
Costs
Robot-assisted
Comparative effectiveness research

Abstract

Background: Radical cystectomy (RC) is a morbid procedure associated with high costs. Limited population-based data exist on the complication profile and costs of robot-assisted RC (RARC) compared with open RC (ORC).
Objective: To evaluate morbidity and cost differences between ORC and RARC.
Design, setting, and participants: We conducted a population-based, retrospective cohort study of patients who underwent RC at 279 hospitals across the United States between 2004 and 2010.
Outcome measurements and statistical analysis: Multivariable logistic and median regression was performed to evaluate 90-d mortality, postoperative complications (Clavien classification), readmission rates, length of stay (LOS), and direct costs. To reduce selection bias, we used propensity weighting with survey weighting to obtain nationally representative estimates.
Results and limitations: The final weighted cohort included 34 672 ORC and 2101 RARC patients. RARC use increased from 0.6% in 2004 to 12.8% in 2010. Major complication rates (Clavien grade $\geq$3; 17.0% vs 19.8%, $p = 0.2$) were similar between ORC and RARC (odds ratio [OR]: 1.32; $p = 0.42$). RARC had 46% decreased odds of minor complications (Clavien grade 1–2; OR: 0.54; $p = 0.03$). RARC had $4326 higher adjusted 90-d median direct costs ($p = 0.004$). Although RARC had a significantly shorter LOS (11.8 d vs 10.2 d; $p = 0.008$), no significant differences in room and board costs existed ($p = 0.20$). Supply costs for RARC were significantly higher ($6041 vs $3638; $p < 0.0001$). Morbidity and cost differences were not present among the highest-volume surgeons ($\geq$7 cases per year) and hospitals ($\geq$19 cases per year). Limitations include use of an administrative database and lack of oncologic characteristics.
Conclusions: The use of RARC has increased between 2004 and 2010. Compared with ORC, RARC was associated with decreased odds of minor but not major complications and with increased expenditures attributed primarily to higher supply costs. Centralization of ORC and RARC to high-volume providers may minimize these morbidity and cost differences.
Patient summary: Using a US population–based cohort, we found that robotic surgery for bladder cancer decreased minor complications, had no impact on major complications and was more costly than open surgery.

* Corresponding author. Brigham and Women's Hospital, Division of Urology, 45 Francis Street, Boston, MA 02115, USA. Tel. +1 617 525 3117; Fax: +1 617 566 3475.
E-mail address: slchang@bics.bwh.harvard.edu (S.L. Chang).

0302-2838/$ – see back matter
http://dx.doi.org/10.1016/j.eururo.2014.01.029

Please cite this article in press as: Leow JJ, et al. Propensity-Matched Comparison of Morbidity and Costs of Open and Robot-Assisted Radical Cystectomies: A Contemporary Population-Based Analysis in the United States. Eur Urol (2014), http://dx.doi.org/10.1016/j.eururo.2014.01.029

1. Introduction

Bladder cancer (BCa) imposes a significant burden on the health care system, with approximately $3 billion in annual expenditures in the United States [1]. Patients who have muscle-invasive BCa contribute substantially to this economic burden, because the gold-standard therapy—radical cystectomy (RC)—is a complex surgical procedure with a high surgical complication rate [2,3]. These postoperative complications frequently increase hospital length of stay (LOS) and use of hospital resources, thereby raising medical expenditures.

Since the 1990s, minimally invasive surgery (MIS) has gained popularity because of its potential to reduce surgical morbidity and shorten LOS. Laparoscopic RC was first described in 1993 [4] but was not widely adopted, likely because of the demand for advanced laparoscopic skills [5]. Since robot-assisted RC (RARC) was first reported in 2003 [6], there has been renewed optimism for reducing the morbidity of RC with MIS.

The investigations directly comparing the outcomes of RARC with open RC (ORC) are primarily single-institution studies [7–9] or without a standardized 90-d measure for complications [2], as recommended by the European Association of Urology (EAU) [10,11]. Herein, we performed a contemporary population-based analysis to examine utilization rates, associated morbidity with the Clavien classification system, and costs of RARC compared with ORC.

2. Methods

2.1. Data source

Premier Perspective Database (Premier, Inc., Charlotte, NC, USA) is an all-payer hospital discharge database developed for quality and utilization benchmarking in the United States [12]. It includes more than 45 million inpatient discharges (about 20% of total discharges) from approximately 600 hospitals, capturing all hospital costs and charges. Each patient has a unique identifier, permitting longitudinal analysis. All data are de-identified, and we received institutional review board exemption for this study.

2.2. Study cohort and covariates

Using International Classification of Diseases, ninth revision (ICD-9) codes, we captured all adult patients who underwent RC (57.71) between 2004 and 2010 from 279 hospitals. We classified procedures as RARC through a review of the chargemaster description for each patient, identifying supplies unique to robotic procedures [12]. To establish a direct comparison of ORC and RARC only, we excluded patients undergoing nonrobotic, laparoscopic RC, which represented <0.5% of all procedures.

We examined relevant patient, hospital, and surgical characteristics. Patient characteristics include age (<55, 55–64, 65–74, ≥75 yr of age), gender, race (white, black, Hispanic, other/unknown), marital status (single, married, unknown), insurance status (Medicare, Medicaid, private, other/unknown), and Charlson Comorbidity Index (0, 1, ≥2) [13]. Hospital characteristics include teaching status, hospital size (<400, 400–600, or >600 beds), location (urban or rural), and geographical region (Northeast, Midwest, West, or South). Surgical characteristics include year of procedure, type of urinary diversion (continent neobladder [57.87] versus ileal/colonic conduit [56.51,56.61,56.71]), and receipt of pelvic lymphadenectomy (40.0, 40.3, 40.50, 40.53, 40.59, 40.0).

Annual surgical volume was calculated based on the number of RC cases, irrespective of surgical approach, by surgeons and hospitals in the year the procedure was performed on a given patient. We divided annual surgical volume into approximately equal quintiles, as previous researchers have done [14], and performed subgroup analysis of the highest-volume providers to specifically assess the impact of surgical volume.

2.3. Outcomes

We used ICD-9 codes to identify events defined by the Clavien classification system (Supplemental Table 1). We included events not present at the time of admission for RC but occurring during the index hospital stay or on readmission to the hospital within 90 d of the procedure. Patients who had events that were managed in the outpatient setting were not captured for this analysis. Complications were classified as minor (Clavien grade 1–2) or major (Clavien grade 3–5). Clavien grade 5 denotes mortality and was identified through disposition codes. According to EAU guidelines [11], we assessed that our methodology meets 7 of the 10 Martin criteria. We also examined 90-d readmission rates and LOS.

We calculated 90-d direct hospital costs, distinct from charges, for each patient to estimate the total expenditure associated with ORC and RARC. These costs were further divided into categories to better analyze differences in specific resource utilization between cohorts. The capital costs and annual maintenance fees associated with the robotic platform were not included; these fixed costs per case depend on the specific type of robotic unit as well as the amortization of these costs based on the frequency and duration of use [15], none of which is reliably available in the current database. To facilitate comparison, all costs were adjusted to 2012 US dollars using the medical component of the Consumer Price Index.

2.4. Statistical analyses

We summarized patient, hospital, and surgical characteristics with descriptive statistics. Categoric variables were compared using χ^2 tests; continuous variables were compared using Mann-Whitney tests. Costs, LOS, and operating room time remained skewed after logarithmic transformation. For costs and operating room time, we performed median regression analyses. For LOS, we used generalized estimating equations to perform regression analyses, conforming to a gamma distribution. Multivariable logistic regression was used to determine the association of surgical approach and outcomes. To minimize selection bias, we used inverse probability of treatment weight (IPTW) with propensity scores based on the patient, hospital, and surgical characteristics noted above [16]. The Premier database contains projection weights derived from the 1998 American Hospital Association Annual Survey, validated by the 1998 National Hospital Discharge Survey. Using these weights, we were able to obtain nationally representative estimates for discharge data. Survey weighting, adjusting for hospital clustering, was then combined with propensity weighting using IPTW [17] to achieve estimates generalizable to the US population. All statistical analyses were performed using SAS 9.3 (SAS Institute, Cary, NC, USA). All tests were two-sided, and a p value <0.05 was considered statistically significant.

2.5. Threshold analysis

Because prior studies report that surgical volume is inversely related to operative time and complications for robotic procedures [18], we

Please cite this article in press as: Leow JJ, et al. Propensity-Matched Comparison of Morbidity and Costs of Open and Robot-Assisted Radical Cystectomies: A Contemporary Population-Based Analysis in the United States. Eur Urol (2014), http://dx.doi.org/10.1016/j.eururo.2014.01.029