Complication Rates Between Local and Referral Patients Undergoing Vaginal Hysterectomy at an Academic Medical Center

CHRISTINE A. HEISLER, MD; L. JOSEPH MELTON III, MD; AMY L. WEAVER, MS;
AND JOHN B. GEBHART, MD, MS

OBJECTIVE: To explore the influence of referral bias on complication rates after vaginal hysterectomy.

PATIENTS AND METHODS: Community-based (local) and referral patients had benign indications and underwent vaginal hysterectomy from January 1, 2004, through December 31, 2005. We retrospectively evaluated patient characteristics, surgical procedures, and complications that occurred within 9 weeks after the index surgery. Complications were defined as admission to the intensive care unit, reoperation, hospital readmission, or medical intervention.

RESULTS: Of 736 patients, 361 (49.0%) were referred from outside the immediate 7-county area. Compared with local patients, referral patients were older (mean age, 54.5 vs 49.3 years; $P < .001$) and had lower body mass index (mean, 27.6 vs 28.7 kg/m²; $P = .02$). More referral patients had cardiovascular disease (4.2% vs 0.5%; $P = .001$) and prior myocardial infarctions (1.9% vs 0%; $P = .007$). Referral patients also had higher American Society of Anesthesiologists scores (score of 3 or 4, 12.6% vs 7.0%; $P = .01$) and longer length of hospitalization (mean, 2.6 vs 2.2 days; $P < .001$), and more underwent pelvic reconstruction (52.1% vs 41.3%; $P = .004$). Fewer referral patients had private insurance (74.5% vs 89.6%; $P < .001$). Despite these differences, overall complication rates were similar for referral and local patients (33.4% vs 29.7%; $P = .28$).

CONCLUSION: Although referral patients had more comorbid conditions than local patients, the groups had similar complication rates after vaginal hysterectomy.

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Accurate information about patient outcomes is critical for establishing standards of care. However, published data may reflect selection or referral bias; outcome reports generally are based on series of patients studied at academic medical centers, and when compared with local patients, patients referred to tertiary academic medical centers often are distinctly different with respect to comorbid conditions and disease status. Consequently, reported outcomes and recommendations may not be applicable to the clinical spectrum of patients seen in the community.² For example, Malkasian and Annegers³ studied referral bias among women undergoing their first treatment for endometrial carcinoma; even after adjusting for age, disease stage, and grade of cancer, referral patients had a lower 5-year survival rate than local patients. Conversely, Warner et al⁴ showed that community residents undergoing surgery had more comorbid conditions, more emergent procedures, and an increased risk of morbidity and death during the first

48 postoperative hours than did referral patients. This is similar to the findings from Whisnant et al,⁵ who reported that 2-day survival of referral patients with subarachnoid hemorrhage was markedly better than that of local patients because the referral group did not include those who died quickly or those who were too unstable to be transferred.

Because of these diverse findings, the actual effect of selection bias on specific outcomes should be quantified. This quantification is critical as we begin the process of outcomes assessment, particularly because it may be naïve and dangerous to assume that the referral group is the higher-risk group or that local and referral patients have equal risk of a given outcome. A thorough analysis of specific patient groups and specific surgical procedures is an integral part of evaluating outcomes and making appropriate risk adjustments if differences between patient groups exist. The objective of this study was to explore the influence of referral bias on complication rates among women undergoing vaginal hysterectomy. We hypothesized that women referred for care would have worse postoperative status and a higher frequency of perioperative complications than local patients.

PATIENTS AND METHODS

As a health care delivery system, Mayo Clinic is unique in that it provides most of the surgical care to residents in the surrounding community and also serves as a major tertiary referral center. Although patients are referred from throughout the United States and the world, approximately 60% of patients reside within a 500-mile radius of the clinic.⁶ Mayo Clinic is located in Olmsted County, which has a

From the Division of Gynecologic Surgery (C.A.H., J.B.G.), Division of Epidemiology and Division of Endocrinology, Diabetes, Metabolism, and Nutrition (L.J.M.), and Division of Biomedical Statistics and Informatics (A.L.W.), Mayo Clinic, Rochester, MN.

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Individual reprints of this article are not available. Address correspondence to John B. Gebhart, MD, MS, Division of Gynecologic Surgery, Mayo Clinic, 200 First St SW, Rochester, MN 55905.

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TABLE 1. Patient Characteristics^a

Characteristic	Local patients (n=375)	Referral patients (n=361)	P value ^b
Distance from Mayo Clinic, median (IQR) (miles)	9 (2-20)	134 (68-275)	<.001
Age (y) at surgery, mean $\pm$ SD	49.3 $\pm$ 12.1	54.5 $\pm$ 14.2	<.001
Race			.049
White	322 (85.9)	302 (83.7)	
Black	6 (1.6)	2 (0.6)	
Other	2 (0.5)	10 (2.8)	
Did not indicate	45 (12.0)	47 (13.0)	
Insurance status			<.001
Private	336 (89.6)	269 (74.5)	
Public	32 (8.5)	85 (23.5)	
None	3 (0.8)	6 (1.7)	
Unknown	4 (1.1)	1 (0.3)	
Body mass index (kg/m ²), mean $\pm$ SD	28.7 $\pm$ 6.1	27.6 $\pm$ 5.9	.02
Tobacco use	62 (16.5)	26 (7.2)	<.001
Alcohol use	6 (1.6)	1 (0.3)	.12
Indication for surgery ^c			<.001
Prolapse	158 (42.1)	193 (53.5)	
Bleeding	186 (49.6)	128 (35.5)	
Other	31 (8.3)	40 (11.1)	
Preoperative evaluation of prolapse ^d			
Anterior defect	90/249 (36.2)	138/196 (70.4)	<.001
Posterior defect	59/247 (23.9)	87/195 (44.6)	<.001
Uterine	89/244 (36.5)	124/196 (63.3)	<.001

^a Data are presented as number (percentage) for categorical data. IQR = interquartile range.

^b Comparisons between the local and referral groups were evaluated with the χ^2 or Fisher exact test for nominal or categorical variables and the 2-sample *t* test or Wilcoxon rank sum test for continuous variables.

^c Any patient with prolapse as an indication for surgery, regardless of other indications, was classified as prolapse.

^d Stage 3 or 4. Percentages were calculated using the number of patients with documented or quantified examinations as the denominator.

relatively stable population of 100,000 (most residents are of northern European descent).²

The study was approved by the Mayo Clinic Institutional Review Board. We identified all women (≥ 18 years) who underwent a vaginal hysterectomy for a benign indication from January 1, 2004, through December 31, 2005. Patients were included regardless of concurrent salpingectomy, oophorectomy, pubovaginal sling, or reconstructive pelvic surgery. However, patients who underwent any additional nonvaginal surgery, including laparoscopy, were excluded.

Residency status was determined by home address zip code. Patients were stratified into 2 cohorts: those residing in Olmsted County or the surrounding 6 Minnesota counties (local patients) and those from outside this 7-county area (referral patients).

Mayo Clinic and its affiliated hospitals have an integrated electronic medical records linkage system, which includes all details of medical, surgical, radiologic, laboratory, and follow-up care. A complete (inpatient and outpatient) record review was performed for each patient. Patient

characteristics were collected, including age, race, insurance status, and home address. The distance between the home address and Mayo Clinic also was calculated. Pertinent medical history and surgical history were abstracted from records of the initial consultation or a previous health maintenance examination. Operative notes, anesthesia records, and postoperative progress notes were used to collect perioperative data, including dismissal dates and diagnoses. All postoperative correspondence was evaluated through dictated telephone conversations, scanned records from other institutions, and postoperative examinations.

Main outcome measures were complications that occurred within 9 weeks after the index surgery. Complications were defined as any medical problem requiring intervention (eg, blood transfusion for postoperative anemia, antibiotics for urinary tract infection), unplanned admission to the intensive care unit, reoperation, or hospital readmission.

STATISTICAL ANALYSES

Comparisons between local and referral patients were evaluated with the χ^2 or Fisher exact test for nominal variables and the 2-sample *t* test or Wilcoxon rank sum test for continuous variables. Data were analyzed using the SAS software package (version 9.0; SAS Institute, Cary, NC). All calculated *P* values were 2-sided, and *P* < .05 was considered statistically significant.

RESULTS

Local patients lived a median distance of 9 miles from Mayo Clinic (interquartile range, 2-20 miles), whereas referral patients resided a median of 134 miles away (interquartile range, 68-275 miles). Patient characteristics of the local and referral groups are summarized in Table 1. Referral patients were older and had a lower mean body mass index, and fewer had private insurance. Furthermore, referral patients reported less tobacco use than local patients. The indication for hysterectomy was uterine prolapse for most referral patients, whereas more local patients underwent hysterectomy for bleeding indications (eg, menorrhagia). Among the patients undergoing vaginal reconstructive surgery, more referral patients had a higher stage of prolapse (stage 3 or 4).

The comorbid medical conditions of local and referral patients are summarized in Table 2. Referral patients had more cardiovascular disease, including a greater number of myocardial infarctions, and less asthma than local patients. The American Society of Anesthesiologists score was also higher for referral patients than for local patients.

Surgical experiences for local and referral patients are summarized in Table 3. A greater proportion of referral

TABLE 2. Preoperative Comorbid Conditions^a

Comorbid condition	Local patients (n=375)	Referral patients (n=361)	P value ^b
Cardiovascular			
Hypertension	94 (25.1)	111 (30.7)	.09
Cardiovascular disease	2 (0.5)	15 (4.2)	.001
Peripheral vascular disease	1 (0.3)	0 (0)	>.99
Congestive heart failure	1 (0.3)	3 (0.8)	.36
Prior myocardial infarction	0 (0)	7 (1.9)	.007
Respiratory			
Asthma	40 (10.7)	23 (6.4)	.04
Obstructive pulmonary disease	4 (1.1)	2 (0.6)	.69
Emphysema	2 (0.5)	1 (0.3)	>.99
Gastrointestinal			
Reflux disease	42 (11.2)	30 (8.3)	.19
Gastric bypass surgery	5 (1.3)	2 (0.6)	.45
Bowel disorder	24 (6.4)	28 (7.8)	.47
Liver disorder	7 (1.9)	9 (2.5)	.56
Genitourinary			
Anomaly	1 (0.3)	4 (1.1)	.21
Endocrine			
Diabetes mellitus	19 (5.1)	18 (5.0)	.96
Thyroid disorder	62 (16.5)	45 (12.5)	.12
Neurologic			
Cerebrovascular accident	4 (1.1)	6 (1.7)	.54
Neuropathy	2 (0.5)	1 (0.3)	>.99
Dementia	1 (0.3)	1 (0.3)	>.99
Hematologic			
Anemia (hemoglobin, <12.0 g/dL)	52 (13.9)	46 (12.7)	.68
Prior thrombosis	8 (2.1)	15 (4.2)	.12
Corticosteroid use within previous year	10 (2.7)	8 (2.2)	.69
ASA score ^c			.01
1 or 2	346/372 (93.0)	313/358 (87.4)	
3 or 4	26/372 (7.0)	45/358 (12.6)	

^a Data are presented as number (percentage) for categorical data. ASA = American Society of Anesthesiologists.

^b Comparisons between the local and referral groups were evaluated with the χ^2 or Fisher exact test.

^c Unknown for 6 patients (3 from each group).

patients underwent pelvic reconstructive surgery, which likely contributed to the longer duration of hospitalization. Additionally, more referral patients underwent intraoperative cystoscopy, but the groups showed no difference in initial bilateral ureteral patency. Although local patients had a higher mean uterine weight, no difference between groups was observed in the proportion of patients with uterine weight exceeding 250 g. The groups also had no differences in the frequency of concurrent oophorectomy or midurethral sling procedures; however, the frequency of concurrent salpingectomy was slightly higher for referral patients.

The postoperative complication rates for local and referral groups are summarized in Table 4. We had no follow-up information for 24 women; all but 1 of the patients lost to follow-up were in the referral group. Exclusion of those lost to follow-up from the analysis did not affect the results

TABLE 3. Surgical Experience^a

	Local patients (n=375)	Referral patients (n=361)	P value ^b
Oophorectomy	251 (66.9)	264 (74.0)	.07
Salpingectomy	260 (69.3)	274 (75.9)	.047
Midurethral sling	57 (15.2)	64 (17.7)	.36
Pelvic reconstruction	155 (41.3)	188 (52.1)	.004
Cystoscopy	162 (43.2)	194 (53.7)	.004
Initial bilateral ureteral patency ^c	153/162 (94.4)	179/194 (92.3)	.66
Transfusion	5 (1.3)	26 (7.2)	<.001
Length of hospital stay (d), mean $\pm$ SD	2.2 $\pm$ 0.9	2.6 $\pm$ 1.2	<.001
Uterine weight (g), mean $\pm$ SD	149.5 $\pm$ 110.0	132.3 $\pm$ 107.2	.03
Uterine weight >250 g	42 (12)	39 (10.8)	.61

^a Data are presented as number (percentage) for categorical data.

^b Comparisons between the local and referral groups were evaluated with the χ^2 test for nominal variables and the 2-sample t test for continuous variables.

^c Determined for women who underwent cystoscopy.

presented in Tables 1 through 3 (data not shown). Overall, the frequency of any postoperative complication within 9 weeks after surgery did not differ between the groups. More referral patients had unplanned admissions to the intensive care unit, but the difference was not statistically significant ($P=.06$). However, local patients had a lower rate of any infections (14.2% vs 20.1%; $P=.04$) and urinary tract infections (12.6% vs 18.0%; $P=.04$). Postoperative complication rates for local and referral groups, stratified by type

TABLE 4. Intraoperative and Postoperative Complications Within 9 Weeks After Surgery^a

Outcome	Local patients (n=374) ^b	Referral patients (n=338) ^b	P value ^c
Any complication	111 (29.7)	113 (33.4)	.28
Non-UTI complication	71 (19.0)	68 (20.1)	.70
Type of complication ^d			
Cardiopulmonary	10 (2.7)	9 (2.7)	.99
Thromboembolic	7 (1.9)	8 (2.4)	.65
Any infection	53 (14.2)	68 (20.1)	.04
UTI	47 (12.6)	61 (18.0)	.04
Genitourinary	20 (5.4)	17 (5.0)	.85
Bleeding	18 (4.8)	16 (4.7)	.96
Neurologic	6 (1.6)	8 (2.4)	.46
Unplanned ICU admission	1 (0.3)	6 (1.8)	.06
Hospital readmission	13 (3.5)	11 (3.3)	.87
Reoperation	10 (2.7)	6 (1.8)	.42
Medical intervention	87 (23.3)	83 (24.6)	.69

^a Data are presented as number (percentage) for categorical data. ICU = intensive care unit; UTI = urinary tract infection.

^b Follow-up data were not available for 1 local patient and 23 referral patients.

^c Comparisons between the local and referral groups were evaluated with the χ^2 test or Fisher exact test.

^d No complications from anesthesia were reported for either group ($P>.99$).

TABLE 5. Intraoperative and Postoperative Complications Within 9 Weeks After Surgery^a

Outcome	Pelvic reconstruction surgery			No pelvic reconstruction surgery		
	Local patients ^b (n=155)	Referral patients ^b (n=181)	P value ^c	Local patients ^b (n=219)	Referral patients ^b (n=157)	P value ^c
Any complication	68 (43.9)	79 (43.6)	.97	43 (19.6)	34 (21.7)	.63
Non-UTI complication	37 (23.9)	40 (22.1)	.70	34 (15.5)	28 (17.8)	.55
Type of complication ^d						
Cardiopulmonary	7 (4.5)	7 (3.9)	.77	3 (1.4)	2 (1.3)	>.99
Thromboembolic	3 (1.9)	6 (3.3)	.51	4 (1.8)	2 (1.3)	>.99
Any infection	36 (23.2)	57 (31.5)	.09	17 (7.8)	11 (7.0)	.78
UTI	35 (22.6)	54 (29.8)	.13	12 (5.5)	7 (4.5)	.66
Genitourinary	10 (6.5)	11 (6.1)	.89	10 (4.6)	6 (3.8)	.72
Bleeding	9 (5.8)	10 (5.5)	.91	9 (4.1)	6 (3.8)	.89
Neurologic	4 (2.6)	6 (3.3)	.76	2 (0.9)	2 (1.3)	>.99
Unplanned ICU admission	1 (0.6)	6 (3.3)	.13	0 (0.0)	0 (0.0)	>.99
Hospital readmission	6 (3.9)	6 (3.3)	.78	7 (3.2)	5 (3.2)	>.99
Reoperation	4 (2.6)	6 (3.3)	.76	6 (2.7)	0 (0.0)	.04
Medical intervention	54 (34.8)	64 (35.4)	.92	33 (15.1)	19 (12.1)	.41

^a Data are presented as number (percentage) for categorical data. ICU = intensive care unit; UTI = urinary tract infection.

^b Follow-up data were not available for 1 local patient and 23 referral patients.

^c Comparisons between the local and referral groups were evaluated with the χ^2 test or Fisher exact test.

^d No complications from anesthesia were reported for any group ($P>.99$).

of surgery, are listed in Table 5. Overall, the complication rates tended to be lower among those who did not undergo pelvic reconstruction surgery. We observed no significant difference in the complication rates between the local and referral groups when patients were stratified by pelvic reconstruction surgery status. Nevertheless, within the group that did not undergo pelvic reconstruction surgery, more local patients than referral patients had a reoperation within 9 weeks after surgery.

DISCUSSION

Referral bias can complicate the generalization of findings from tertiary care centers because of inherent differences between referral and local patients. Patients referred to a tertiary care center commonly present with a greater number of clinically important comorbid conditions or worse disease processes than those in the local community. For example, Kennedy et al⁷ showed that patients referred to a tertiary care center for cataract surgery more often had ophthalmic disorders or surgical procedures before cataract extraction, had a higher frequency of combined surgical approaches, and were significantly younger than community-based patients. Similarly, patients referred for idiopathic dilated cardiomyopathy had a worse prognosis compared with patients from the local community.⁸ However, Roger et al⁹ observed a lower 30-day mortality rate and better long-term survival of referral patients undergoing elective abdominal aortic aneurysm repair. As these studies illustrate, quantification of referral bias is imperative when postoperative complications and other outcomes are being addressed.

One of the main strengths of the current study is the ability to quantify referral bias as it applies to vaginal surgery. To our knowledge, this is the first article that describes the magnitude of referral bias within a group of women undergoing vaginal hysterectomy. Our study was a planned secondary analysis of an initial study that was sufficiently powered to detect small differences between groups (vaginal hysterectomy with and without additional reconstructive surgery). This is important for the identification of serious but infrequent complications. Moreover, the distribution of patients between referral and local groups was fairly similar (neither group was underrepresented). Two urogynecologists and 7 gynecologic oncologists performed the surgical procedures during the 2-year study period, which improves generalizability of the study findings.

Our study has several limitations. First, it was inherently limited by its retrospective nature. Not all potentially relevant variables could be assessed from the medical records, and some important measures may have been excluded. Second, all surgeons were fellowship trained and performed operations multiple times per week. Their skill level may not be representative of that of gynecologic surgeons at other institutions. Third, we examined follow-up data only through the first 9 postoperative weeks, and complications may have occurred after that period. However, complications due to surgery should diminish with time. Fourth, the complication rate could be underestimated if a referral patient's regular health care provider did not contact our institution about a specific complication. Nevertheless, we had 96% ascertainment

for the study patients through 9 weeks and think that this concern is minimal.

Outcome-based quality improvement studies are becoming mainstream within surgical specialties since the advent of the National Surgical Quality Improvement Program. Outcome assessment allows a direct comparison of perioperative complications, although the residence status of patients receiving care at tertiary medical centers is rarely reported. In the current study, referral patients and local patients had differences in age, comorbid conditions, and American Society of Anesthesiologists score, but the overall rate of perioperative complications did not differ. The benefit of an academic center in treating higher-risk (referral) patients could have been underestimated without investigating the influence of selection bias. Of note, our referral patients had more medical comorbid conditions, longer hospitalizations, and lower rates of private health insurance. These differences have profound implications on reimbursements for referral centers.

Further studies are needed to examine the role of referral bias in medical and surgical intervention. Do academic medical centers or tertiary care centers treat different types of patients than do local community hospitals? If they do, how can comparisons of patient outcomes be accurate if inherent differences exist between local and referral patients? Characterization of these differences and risk-adjusted outcomes of various medical and surgical procedures are needed to provide meaningful assessment of outcome-based quality improvement initiatives.

CONCLUSION

Patients referred for vaginal hysterectomy were older and had more comorbid conditions, longer hospitalizations, and lower rates of private health insurance than local patients. However, both groups had similar complication rates. Referral bias should be routinely assessed in any quality improvement program.

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