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Introduction of laser technology and procedure use for benign prostatic hyperplasia: data from Florida

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Abstract

Objective—To examine the association of laser technology adoption in a market with surgery rates for benign prostatic hyperplasia (BPH).

Methods—Using the Florida files from the State Ambulatory and Inpatient Surgery Databases (2001 to 2009), we identified all patients who underwent transurethral surgery for BPH. We calculated rates of BPH surgery for all markets within the state (defined by Hospital Service Area) over time. Markets were split into 3 categories: 1) always offering, 2) never offering, or 3) initially not offering but adopting laser prostatectomy after 2001. We used multivariable regression models to estimate surgery rates, adjusted for other market characteristics. Interaction terms were included in the models to examine differences in time trends between market categories.

Results—After adjusting for market characteristics, time trends differed by market category ($p < 0.001$). Surgery rates decreased from 318 to 248 procedures per 100,000 men in markets always offering laser prostatectomy ($p < 0.001$). Markets never offering laser surgery had much lower rates that remained stable (180 to 187 procedures per 100,000 men, $p = 0.805$). In markets adopting laser technology, rates increased from 268 to 296 procedures per 100,000 men after adoption ($p = 0.044$), such that four years after adoption these markets had the highest rates among the three categories.

Conclusions—Adoption of laser technology is associated with rising rates of surgical intervention for BPH. This trend appears to be induced by the introduction of laser surgery.

Keywords

laser prostatectomy; benign prostatic hyperplasia; surgical trends; utilization of health services

Introduction

Approximately one out of eight men age 55 to 64 and three out of four men older than 70 suffer from symptoms of benign prostatic hyperplasia (BPH).^{1,2} Prevalence is likely to rise even further, as the population of the United States is aging.³ This rising prevalence has a significant impact on healthcare and societal costs. Each year \$3.4 billion are spent on BPH

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care and more than 2 million workdays are lost secondary to BPH.¹ Among BPH treatments, surgical treatments are more costly than medical therapy.^{3,4} However, there is significant variation in the utilization of surgical intervention for BPH,⁵ because there is no clear threshold in symptom severity at which to proceed with surgery.

In this context of uncertainty, adoption of a new surgical technology in a market may significantly increase surgery rates.⁶ New surgical technologies such as laser prostatectomy have decreased the morbidity of transurethral resection by reducing length of stay, risk of clot retention, and risk for transurethral resection syndrome.⁷ Thus, the palatability of surgical intervention for BPH has increased. However, the literature is replete with examples of how technology adoption can spur utilization.^{8–12} New technology may increase surgical capacity and enable urologists to satisfy previously unmet demand, but decreasing thresholds for surgical intervention and financial incentives to maximize use of new equipment may also play a role.¹³ In addition, introduction of a new technology in one market but not another may lead to redistribution of surgical treatments among markets, as patients may cross regional borders to gain access to the new technology.¹⁴

New technologies for the management of BPH have recently changed treatment patterns for men with lower urinary tract symptoms. Surgery rates for BPH have been declining among Medicare beneficiaries until the early 2000s. Following the advent of minimally invasive treatments, the surgery rates increased from 900 procedures per 100,000 men in 2000 to more than 1,100 procedures per 100,000 men in 2005.¹⁵ This observed increase in intervention may be driven by secular trends (i.e. more elderly patients are requesting invasive therapy or failing medical therapy over time) or may be associated with the adoption of new technology (i.e. urologists are offering and patients are accepting more surgery after technology adoption). To address this question, we used all payer data from Florida to examine whether introduction of laser prostatectomy in a market triggers increasing surgery rates for BPH.

Methods

Study population

We used the Healthcare Cost and Utilization Project's State Ambulatory Surgery database (SASD) and State Inpatient database (SID) for Florida to identify a cohort of patients who underwent transurethral resection of the prostate [TURP; Current Procedural Terminology (CPT) codes 52601, 52612, 52614, 52620, 52630, International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) code 60.29] or laser prostatectomy (CPT codes 52647, 52648, ICD-9-CM code 60.21) between 2001 and 2009 (n=95,800). These databases capture 100% of the outpatient and inpatient discharges, respectively. We chose Florida for two reasons. First, it is one of the larger and more ethnically diverse states participating in the Healthcare Cost and Utilization Project. Second, it captures discharges from a variety of practice locations, including freestanding ambulatory surgery centers. We excluded patients with a diagnosis of prostate cancer (n=11,743), with a code for both TURP and laser prostatectomy (n=410), as well as those under age 40 (n=99). We linked these data to the Area Resource File to obtain market characteristics (median male population age, median household income, number of urologists per 100,000 population, number of hospital beds per 100,000 population, proportion of urologists 55 years old and older, proportion of the population being Caucasian, having less than a high-school education, and having a urban residence).

Identifying healthcare markets

We divided Florida into 114 healthcare markets based on Hospital Service Areas (HSA) as defined by the Dartmouth Atlas of Healthcare.¹⁶ Patients were assigned to their respective HSA according to their home zip code. We then classified each HSA as either offering or not offering laser prostatectomy in a given year. To increase specificity, offering laser prostatectomy was defined as performing at least five laser prostatectomy procedures per year. Next, we categorized HSAs into 3 mutually exclusive groups: markets that (1) always offered laser prostatectomy, (2) never offered laser prostatectomy, or (3) adopted laser prostatectomy during the study period. For the last group, we defined the year of adoption as the first year in which laser prostatectomy was offered.

Primary outcome

We calculated annual HSA-level rates of BPH surgery. The numerator for this rate calculation was the number of transurethral procedures for bladder outlet obstruction (TURP and laser prostatectomy) performed in a HSA in a specific year. The denominator was the number of men aged 40 years or older residing in a HSA in that year. We determined this number by summing population estimates for the zip code tabulation areas across each HSA's constituent zip codes.¹⁷ All rates were age-adjusted using direct standardization.

Statistical analyses

We compared market and patient characteristics (age, race, payer, socioeconomic status,¹⁸ Charlson comorbidity score¹⁹) across the three groups of HSAs using ANOVA (F-test), the Kruskal-Wallis, and the Chi-squared test. We plotted the age-adjusted population based BPH surgery rates across years according to whether laser prostatectomy was offered, not offered, or adopted during the study period. We used fractional polynomial regression to assess trends visually.²⁰ Using a multiple time series design, we measured the rate of change of surgery use across an HSA after the adoption of laser surgery. This approach reduces bias from the following two potential sources: (1) a difference between HSA types that is stable over time cannot be mistaken for an effect of laser adoption because each HSA is compared with itself, and (2) changes over time that affect all HSAs similarly (i.e. secular trends) cannot be mistaken for an effect of laser adoption.²¹

We used multivariable regression to model surgery rates over time. In these models, the dependent variable was the age-adjusted BPH surgery rate. The main exposures were the type of HSA (adopted laser prostatectomy, always offered, or never offered laser prostatectomy) and the number of years since adoption of laser surgery (set to 0 in the year of adoption or at study mid-point, respectively). For HSAs that adopted laser prostatectomy, we computed the baseline rate as the average across years before adoption. For the other two HSA categories, we defined the baseline rate as the average across years in the first half of the study period. In order to examine whether time trends were different across HSA types, we entered year by HSA category interaction terms into the models. All models were adjusted for market characteristics (median male population age, median household income, number of urologists per 100,000 population, number of hospital beds per 100,000 population, proportion of urologists 55 years old and older, proportion of the population being Caucasian, having less than a high-school education, and having a urban residence). From these models, we calculated adjusted rates of BPH surgery for each year since adoption of laser surgery by HSA type. When calculating these adjusted rates, all market characteristics were held at their mean. We plotted these rates and fit linear trend lines in order to visualize trends by HAS type.

We performed all analyses using Stata version 12SE. All tests were 2-tailed and we set the probability of a Type 1 error at 0.05 or less. The University of Michigan Medical School

Institutional Review Board exempted this study from review in accordance with the Code of Federal Regulations Title 45, subpart A, section 46.101, paragraph b, subparagraph 4.

Results

Over the study period, 63 HSAs adopted laser prostatectomy, while 39 and 12 HSAs always or never offered laser prostatectomy, respectively. Markets adopting or always offering laser prostatectomy had an older population, higher proportion of Caucasians, more and younger urologists, more hospital beds, higher socioeconomic status, and higher baseline surgery rates in 2001 compared to markets never offering laser prostatectomy (Table 1).

Similarly, patients from markets never adopting laser prostatectomy who underwent bladder outlet surgery were younger and of lower socioeconomic status than patients from the other markets (Table 1). In spite of their younger age, these patients were more likely to have comorbidities than patients undergoing surgery in the other markets (Table 1).

Age-adjusted rates of BPH surgery remained relatively stable and low in areas that never offered laser prostatectomy. HSAs that consistently performed laser prostatectomy throughout the study period had high but slightly declining rates (Figure 1), due to a stable number of procedures in the setting of a rising population (Table 2). However, rates in markets adopting laser prostatectomy were increasing (Figure 1).

We next examined trends in BPH surgery rates after adjusting for market factors. Trends in BPH surgery rates differed significantly by market type ($p < 0.001$ for interaction). In adjusted models, we again identified low and fairly stable rates in HSAs never offering laser prostatectomy (p for linear trend 0.805, Figure 2) and high but decreasing rates in HSAs always offering laser prostatectomy (p for linear trend 0.001, Figure 2). In HSAs adopting laser prostatectomy, we observed a significant increase in rates after adoption ($p = 0.044$, Figure 2).

Comments

BPH surgery rates decreased in areas that consistently offered laser surgery over the period of observation. However, HSAs that adopted laser prostatectomy started out with lower rates that increased following adoption. Areas without laser surgery had more stable rates of surgery and no significant trend could be identified over the study period (Figure 2).

Both adoption of laser surgery and secular trends may affect surgery rates for BPH. Possible drivers for secular trends would be the ever growing elderly population or increases in seasonal migration of elderly men to Florida, leading to greater and greater demand for these procedures. However, if these secular trends were the primary driver of changing surgery rates, one would expect continuously rising rates across all three categories of HSAs,³ which we did not observe.

Rather, time trends in surgery rates differed significantly across markets. Several factors may have contributed to this association. First, introduction of laser prostatectomy may have increased the surgical capacity in a market and therefore enabled urologists to satisfy previously unmet demand. Conversely, capacity remained stable in markets consistently offering laser prostatectomy throughout the entire study period. In these markets, the number of procedures remained stable in the setting of a rising population (Table 2), thus leading to a decrease in surgery rates over time. Second, one may speculate that physicians perceived laser prostatectomy as less invasive and may therefore have lowered their thresholds for surgical intervention. Similarly, patients may be more willing to undergo a procedure that is seen as having less risk for complications and having “laser surgery” may

have an additional appeal to patients. This then leads to increasing rates of surgery after the adoption of laser prostatectomy, but no significant changes in trend in areas that constantly did or did not offer laser prostatectomy. Such increasing rates of surgical intervention after the introduction of a new technology have previously been observed for laparoscopic cholecystectomy, endovascular intervention for peripheral vascular disease, laparoscopic antireflux surgery, and robotic prostatectomy.^{8–12} For example, hospitals acquiring a surgical robot increased their prostatectomy volume by 30 cases, while the prostatectomy volume decreased in hospitals not acquiring a surgical robot.¹¹ Third, financial considerations may have played a role. Physicians and hospitals may have implicit incentives to maximize use of new equipment in order to more quickly amortize upfront investment costs after the introduction of a new technology.¹³ It is therefore conceivable that a combination of all three factors – changes in capacity, decreasing thresholds for intervention, and financial considerations – have contributed to increasing surgery rates after the introduction of laser prostatectomy.

In addition, HSAs always offering or adopting laser prostatectomy had significantly more urologists than HSAs not offering laser prostatectomy (Table 1). One may speculate that increased competition among urologists contributed to the adoption of laser technology in these markets.

It appears that surgery rates are more prone to be affected by innovation if decisions about treatment depend on patients' personal values and preferences, i.e. if they are preference sensitive care.²² For example, rates for stone surgery, colonoscopy, and cataract surgery all increased after opening of ambulatory surgery centers, while rates of cancer directed breast surgery, which parallel the incidence of breast cancer, remained stable.^{23,24} Surgical intervention for BPH is a prime example of preference sensitive care, because BPH mainly affects quality of life and a decision of whether to proceed or not proceed with surgical intervention mainly depends on a patient's personal values and preferences.^{5,22}

Understanding the impact of new technology on surgical therapy of BPH is important for addressing the rising disease burden of BPH. Our analysis revealed that markets that consistently offered laser prostatectomy throughout the study period had decreasing surgery rates, because they performed a stable number of procedures while their population increased. However, markets that adopted laser prostatectomy experienced increasing surgery rates, i.e. the increase in the number of procedures after introduction of laser surgery surpassed population growth. New laser technology apparently encourages patients to accept and physicians to perform more surgical procedures for the therapy of BPH. Laser technology offers several advantages for the patient, such as shorter catheterization times, shorter length of stay, lower risk of clot retention, and the ability to perform surgery in anticoagulated patients,^{7,25,26} so it may be worthwhile to encourage its dissemination. However, stakeholders should be aware that further dissemination of laser technology may increase costs for treatment of BPH due to increased utilization of surgical procedures.

Our study has several limitations. A possible explanation for increasing surgery rates after adoption of laser prostatectomy is redistribution of surgical treatments from one area to another, as patients may increasingly cross regional borders to gain access to new technology.¹⁴ However, border crossing is unlikely to affect our results, because we assigned procedures to markets based on a patient's residence and not based on the performing provider's location. While we were able to adjust for the measured differences between the HSA categories in multivariable analyses, unmeasured confounding may still have affected our results. Although the use of administrative data allowed us to obtain a 100% sample of all inpatient and outpatient procedures performed in Florida over the study period, we were unable to elicit which type of laser was used for a specific procedure.

Nevertheless, laser procedures are clearly coded distinctly from TURPs in both the SASD and SID databases. Office based procedures such as transurethral needle ablation and transurethral microwave thermotherapy¹⁵ were not included in this analysis. However, given our focus to study how introduction of a new surgical technology influences use of operative – and not office – procedures for BPH, our data accurately reflect the impact of new surgical technology on use of outpatient and inpatient surgery for treatment of BPH.

Conclusion

Adoption of laser technology for BPH was associated with subsequently rising rates of surgical intervention. This trend appears to be induced by the introduction of laser surgery. Although there may be a role for encouraging adoption of new laser technology due to its apparent advantages, stakeholders should be aware that this will likely increase costs because of increased utilization of surgical interventions.

Acknowledgments

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Figure 1.
Yearly population-based rates of BPH surgery in Florida by Hospital Service Area category.

Figure 2.

Adjusted population-based rates of BPH surgery after the adoption of laser prostatectomy or study midpoint. Rates were adjusted for market characteristics (median male population age, median household income, number of urologists per 100,000 population, number of hospital beds per 100,000 population, proportion of urologists 55 years old and older, proportion of the population being Caucasian, having less than a high-school education, and having a urban residence). Baseline rate in year 0 corresponds to the average across years during the study period before the adoption of laser prostatectomy for HSAs that adopted laser prostatectomy and to the average across years in the first half of the study period for the other 2 categories of HSAs.

Table 1

Summary statistics for the study population and the patients who underwent surgery by HSA type.

	HSA with laser prostatectomy			
Market characteristics	always offered	adopted during study period	never offered	p value
HSAs, No. (%)	39 (34)	63 (55)	12 (11)	-
Age, median of male population (IQR), y	40.6 (36.7–43.5)	39.3 (35.1–42.3)	36.1 (34.3–39.2)	0.026 [*]
Race, proportion Caucasian population, mean (SD), %	81.8 (8.3)	82.1 (8.2)	74.5 (10.0)	0.016 [†]
Education, individuals with less than high school diploma, mean (SD), %	19.5 (5.5)	19.1 (5.3)	28.7 (9.1)	<0.001 [‡]
Income, median for household (IQR), \$	40669 (39114–46618)	43403 (39114–46618)	33773 (30495–42074)	0.017 [*]
Urban residence, mean (SD), %	90.2 (11.3)	82.7 (19.3)	50.0 (33.9)	<0.001 [‡]
No. of urologists per 100 000 population, mean (SD)	4.2 (1.6)	3.5 (1.5)	1.5 (2.2)	<0.001 [‡]
Urologists 55 years old and older, mean (SD), %	46.7 (11.2)	53.4 (19.9)	67.8 (29.4)	0.023 [‡]
No. of hospital beds per 100 000 population, mean (SD)	341 (94)	288 (97)	215 (112)	<0.001 [‡]
Age adjusted BPH surgery rate per 100 000 population in 2001, mean (SD)	346 (210)	279 (186)	177 (128)	0.023 [‡]
Patient characteristics				
All patients, No.	49808	33360	380	-
Age, mean (SD), y	72.6 (9.5)	73.0 (9.1)	69.9 (9.2)	<0.001 [‡]
Race, Caucasian, %	76.7	90.6	72.8	<0.001 [‡]
Medicare coverage, %	75.5	77.7	72.9	<0.001 [‡]
Lowest socioeconomic tercile, %	33.8	30.1	90.0	<0.001 [‡]
Charlson score of 0, %	61.6	59.6	55.3	<0.001 [‡]

^{*} Kruskal-Wallis test;[†] ANOVA (F-test);[‡] Chi-squared test; HSA = Hospital Service Area

Table 2

Mean number of transurethral procedures for BPH and population estimates by HSA category.

HSA with laser prostatectomy	2001		2003		2005		2007		2009	
	n	pop	n	pop	n	pop	n	pop	n	pop
always offered	147	57	134	61	145	64	141	67	145	70
adopted during the study period	53	20	52	22	55	23	66	24	71	26
never offered	5	2.7	5	2.8	3	3.0	3	3.1	4	3.2

Abbreviations: HSA, hospital service area; n = mean number of transurethral procedures for BPH per year; pop = mean population estimate (in 1,000) for men aged 40 years or older