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SUI Sling Study - Original

Association between military surgeon volume and complications after sling placement for stress urinary incontinence

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Short title: Surgeon volume versus outcomes in the US military.

Précis.

No significant differences in complication rates after sling surgery, stratified by surgeon volume, are seen in a setting of overall low-volume military surgeons.

Abstract

Objective: To compare 12-month sling post-operative complication rates between high-volume and low-volume surgeons at Military Treatment Facilities (MTFs) in the United States (U.S.).

Methods: This was a retrospective analysis of two military administrative databases. We identified women receiving slings in any U.S. MTF from January 1, 2011 to December 31, 2012. For each surgeon performing a sling during this period, we computed the number of slings they performed in the previous 2 years (January 1, 2009 - December 31, 2010). We identified post-operative complications that occurred in the 12 months following the index sling procedure.

Results: During the study period, 348 gynecologic and urologic surgeons performed 1,632 slings. The average patient age was 47.2 years. Based on our data distribution, we classified surgeons as high-volume ($\geq$12 slings/2yrs) or low-volume ($\leq$4 slings/2yrs). High-volume surgeons operated on patients that were older, more likely to have comorbidities, and receive concomitant prolapse surgery. The overall likelihood of at least one post-operative complication in 12 months for high-volume vs. low-volume surgeons was 48.4% vs. 42.2% (adjusted OR (95% CI) = 1.24, (0.99-1.54), $p=0.06$). Post-operatively, high-volume surgeons were more likely to perform a procedure to manage bladder outlet obstruction (16.1% vs. 10.8%; adjusted OR (95% CI) = 1.58, (1.14-2.19), $p<0.01$). There were no differences between high and low volume surgeons in the rate of other post-operative complications.

Conclusion: No significant differences in complication rates after sling surgery, stratified by surgeon volume, were seen in a setting of overall low-volume military surgeons.

Introduction

In the United States the prevalence of urinary incontinence (UI) has been estimated to be 15.7%[1]. Between 2010 and 2050 the prevalence of urinary incontinence is projected to increase 55% from 18.3 to 28.4 million women as a result of expected demographic changes over time[2]. UI has been shown to cause a deterioration in quality of life, poor care seeking, lifestyle restriction, limitations in social relationships, and higher prevalence of psychological morbidity[3-5].

Across all surgical fields there is a growing interest in the relationship between surgeon and hospital volume and patient outcomes. Only two prior studies have looked at surgeon volume in relation to surgical outcomes specifically for sling surgery for stress urinary incontinence (SUI) in Medicare beneficiaries and had conflicting results.[6,7] These studies both used the 75th percentile as the cut point defining high volume versus low volume but did not suggest a minimum number that may be useful for surgeon privileging and credentialing. These studies also excluded patients younger than age 65 years and the large network of military treatment facilities (MTFs) that collectively provide care to millions of active-duty sevicemembers, retirees and dependents.

The primary aim of this study was to compare 12-month post-operative complication rates after sling placement by high volume surgeons to those of low volume surgeons within MTFs in the United States.

Materials and Methods

This retrospective cohort study was approved by the Naval Medical Center Portsmouth (NMCP) Institutional Review Board. Women, aged 18 and older, with SUI who underwent either an outpatient or inpatient sling placement in any MTF in the United States between January 1, 2011 and December 31, 2012 were included. We excluded women who left the military system after their procedure; women for whom 12-month follow-up data was not available; women who had a procedure for pelvic organ prolapse within 30 days of the sling procedure; women with a diagnosis of pelvic pain within the 12 months prior to the procedure; and women with slings placed laparoscopically as these would not be expected to be performed by a general gynecologist. We did not exclude women with concomitant pelvic reconstruction procedures performed at the same time as the index sling.

The Military Health System Management and Analysis Reporting Tool and the Military Health System Data Repository database were our primary data sources. From these databases we identified women who underwent sling placement during the study period. These databases house encounter data from MTFs, civilian reimbursement claims data, and pharmacy dispensing events along with demographic, eligibility, and enrollment information. The codes used to identify subjects are listed in detail in Table 1.

The primary exposure of interest was surgeon volume. We determined the number of sling procedures performed by each surgeon in our database over the two years preceding the study period (January 1, 2009 – December 31, 2010) and initially stratified surgeons by quartiles according to the volume of procedures they performed. As Figure 1 shows, however, a large proportion of our surgeons did less than 4 sling procedures in this two-year period. In our initial analyses, the cut point for the 75th percentile for surgeon sling volume was just 4. Conceptually, we could not rationalize treating a surgeon with 4 sling cases over 2 years as a high-volume surgeon. We subsequently divided up the highest quartile into tertiles and used the highest tertile as our high-volume surgeon group. The cut point defining the highest tertile of the highest quartile was 13 sling cases over 2 years. We combined the bottom 3 quartiles into a single group and this was our low volume group. The cut point that defined low volume was 3 or less cases over 2 years. The bottom two tertiles of the top quartile represented our intermediate volume group. By defining our high-volume group as 13 or more cases in 2 years, and our low volume group as 3 or less cases over two years, we clearly separated our high-volume and low-volume groups.

While the datasets contained patient specific data, only aggregate surgeon data was available with limited information on surgeon-specific data regarding complication rates. For each patient there was a variable indicating the number of procedures her surgeon had performed in the two years prior to the study period but there was no variable uniquely identifying that surgeon. Because of dataset limitations, we were not able to adjust for clustering at the level of the surgeon or have each surgeon's individual case volume during the study period.

Our primary outcome was a composite outcome of "any post-operative complication" identical to that used by Suskind and colleagues[8]. We extracted data on post-operative complications, identified by CPT-4 codes and ICD-9 codes (see Table 1), during the 12 months after the sling placement procedure date for all women included in the final sample. Our definitions for the composite outcome of "any postoperative complication" and specific post-operative complications and the ICD-9 codes and CPT codes used to identify these complications were identical to prior studies[8,9].

In addition to our primary exposure and outcome, we obtained data on age, race, surgeon specialty, comorbid diseases, and concomitant pelvic surgery. A priori, we planned to control for these potential confounders: age, race, surgeon specialty, Charlson comorbidity index score[10], and concomitant pelvic organ prolapse surgery. During the process of data abstraction, we realized that race was not reliably recorded so we did not include this variable in our final data set. Age was kept as a continuous variable with the caveat that anyone above the age of 90 had their age recoded to 90 to comply with HIPAA rules. The codes used to classify surgeons by specialty are shown in Table 1. Physician specialty was coded as a binary variable for our analyses (Gynecologist versus non-Gynecologist). The dataset did not permit identification of fellowship-trained gynecologists or urologists. For the Charlson comorbidity index, we extracted data on comorbidities for one year prior to sling placement procedure date for all women included in the final study sample (Appendix A).

We computed 12-month post-operative complication rates for high-volume and low-volume surgeons. We then computed unadjusted and adjusted odds ratios via logistic regression. In our multivariate logistic regression models the initial plan was to adjust for age (continuous), Charlson score (0,1-2, 3 or more), surgeon specialty (Gynecologist vs. non-Gynecologist) and whether or not there was a concomitant procedure for pelvic organ prolapse. When we constructed our logistic regression model (for our composite outcome) with our covariates defined in this manner, there was poor model fit due in large part to age defined as a continuous variable. We subsequently redefined age in several ways and eventually settled on a binary recoding with the cut point at the median age of 46. With age defined this way our multivariate logistic regression model had better fit but age and physician specialty were not statistically significant. For our composite outcome we thus decided to remove age and physician specialty and only adjust for Charlson comorbidity and whether or not there was a concomitant procedure for pelvic organ prolapse. In this iteration there were still a small number of cells with zero frequencies for the outcome and so we further refined our covariates by collapsing the Charlson score into a binary variable (0 versus 1 or more). In this final iteration there were no cells with zero frequencies. For three of our individual post-operative complications, with low frequencies, a model adjusting for Charlson score and concomitant pelvic organ repair produced cells with zero frequencies and overall poor model fit and so we had to adjust our modeling strategy for these outcomes (see footnotes in Table 4).

Because there is no consensus as to how to define a high volume surgeon within the specialty of gynecology, we performed our multivariate logistic regression analyses with surgeon volume modeled in several ways: as a binary variable as described above, as an ordinal variable (0-3,4-7,8-12, and 13 or more cases in 2 years), and as a continuous variable (with a range from 0 to 158 cases in 2 years). The results of these models are shown in Table 5.

To ensure our results were not simply due to our choice of cut-points for high and low-volume surgeons we performed a sensitivity analysis and redefined these categories in a more extreme way. We redefined low volume as zero cases in 2 years and high volume as 20 or more cases in 2 years. We then repeated our analyses using this more extreme definition. Additionally, there was one surgeon in our data set who performed 158 sling procedures over 2 years, far more than any other surgeon. We performed our analyses with and without this surgeon and his/her patients to assess whether this individual surgeon was skewing our results.

Sample size calculations: Based on data from Suskind *et al.*[8] we assumed the composite post-sling 12-month complication rate would be 70% for high-volume surgeons and 85% for low volume surgeons. Assuming a power of 80% with a type 1 error rate of 5% we calculated that we would need approximately 95 patients in each group. In the study by Suskind *et al.*, the prevalence of the most uncommon individual post-operative complication was approximately 6% (new diagnosis of pelvic pain). If we assumed that the prevalence of the most uncommon individual complication in our study would also be 6% among high-volume surgeons and 11% among low-volume surgeons, we calculated we would need 384 patients in each group to detect that difference with 80% power and a type 1 error rate of 5%. In the end we had significantly more patients than we calculated we would need during our a-priori sample-size calculations.

Data were analyzed and manipulated through Statistical Analysis Software (SAS), STATA versions 8 and 14(College Station, TX), SPSS version 17(Armonk, NY, IBM Corp), and Microsoft Office Excel.

Results

There were 1,935 women, aged 18 and older, who had a sling procedure for SUI at U.S. MTFs between January 1, 2010 and December 31, 2011. After excluding women for whom 12-month follow up data was not available(n=26), women who had a procedure for pelvic organ prolapse within 30 days of the index sling procedure(n=6), and women with a diagnosis of pelvic pain within 12 months prior to the procedure (=280), our final analysis data set consisted of 1,632 patients.

There were 348 surgeons who performed the sling surgeries during the study period. In our primary analysis, high volume was defined as 13 or more cases in 2 years while low volume was defined as 3 or less cases in 2 years. Of the 348 surgeons, 256 (73%) performed 3 or fewer and 30(8.6%) performed 13 or more slings in the 2 years preceding the study period. During the study period, these 30 high-volume surgeons performed almost as many slings (638) as the 256 low-volume surgeons (664). The surgeon with the highest volume prior to the study period did 158 sling procedures during this time.

The mean age of our study population was 47.2 ± 11.3 years. The characteristics of our study population, stratified by surgeon volume, are shown in Table 2 and the distribution of individual surgeon volume is illustrated in Figure 1. The patients of high-volume surgeons were 5 years older on average and significantly more likely to have a Charlson score of 1 or greater. High-volume surgeons were also significantly more likely to perform concomitant pelvic organ repair at the same time as the index sling procedure.

Overall, 45.5% of subjects had at least one post-operative complication. Of the specific complications, infectious complications were the most frequent, occurring in 25.2% of patients. Less than 1% of patients required a repeat anti-incontinence procedure within 12 months after the index sling procedure. Because the post-operative complications in our study were identical to those examined in 2 other major studies, we present overall unadjusted complication rates for all three studies side by side (Table 3).

In unadjusted analyses, the overall likelihood of at least one post-operative complication in 12 months for high-volume vs. low-volume surgeons was 48.4% vs. 42.2% (OR (95% CI)=1.29 (1.04-1.60), $p<0.05$). High-volume surgeons were more likely to perform a procedure to manage bladder outlet obstruction in the 12 months after the index sling procedure. There were no statistically significant differences between high and low-volume surgeons in the rate of other post-operative complications (Table 4).

In adjusted analyses, patients of high-volume surgeons had a 24% higher odds of experiencing at least 1 complication in 12 months but this trend did not reach statistical significance (AOR (95% CI) = 1.24, (0.99-1.54), $p=0.06$). High-volume surgeons were still more likely to perform a procedure to manage bladder outlet obstruction in the 12 months after the index sling procedure. There were no statistically significant differences between high and low-volume surgeons in the rate of other post-operative complications in our adjusted analyses (Table 4).

In Table 5, we present the results of our adjusted analyses with surgeon volume modeled in three different ways—as a binary, ordinal, and continuous variable, respectively. Regardless of how surgeon volume was modeled, the odds of at least one post-operative complication in 12 months increased with increasing surgeon volume. With the outlier surgeon included, this trend was only statistically significant when surgeon volume was modeled as an ordinal variable. With the outlier surgeon excluded there was no model where there was a statistically significant association between surgeon volume and the odds of at least one complication.

Discussion

There was no statistically significant association between surgeon sling volume and 12-month post-operative complications within U.S. MTFs when we factored in the presence of an outlier surgeon and we adjusted for clinically relevant confounding factors. We recognize that our surgeon population was a low-volume population and may have contributed to our lack of an association between surgeon volume and post-operative complications rates. However, this is the first large-scale study of surgeon volume versus surgical outcomes within the military health care system in the United States. Within the military beneficiary population, SUI is a common diagnosis and sling surgery is a procedure performed by both general and fellowship-trained gynecologists and urologists.

The study that most closely mirrors our study, by Anger et al[6], looked at the same outcomes in the context of the Medicare population. They defined surgeon volume as being high if greater than or equal to the 75th percentile and low if less than the 75th percentile. Overall their results were similar to ours in that they found no systematic differences in outcomes after sling surgery between high volume versus low volume surgeons.

There are unique aspects to this study that contribute to the literature. Most comparable studies of surgeon volume and surgical outcomes use a single method for defining volume. One approach is a binary approach with the cut-point at the 75th percentile[6,7]. Another approach is to use a predetermined number of surgeries as a cutoff. In a study of outcomes after hysterectomy Vree *et al*. defined low volume as less than 11 hysterectomies annually and high volume as more than 50 cases annually [11]. Finally, other studies have used an ordinal approach[12] categorizing volume into tertiles or quartiles. Recognizing the conceptual problems with defining surgeon volume by a single approach, we intentionally modeled surgeon volume in several ways—binary, ordinal and continuous, respectively. Further, in our binary approach we ensured there was a clear delineation between high and low volume (13 or more versus 0-3 cases over 2 years).

In our study, when all surgeons were included, defining surgeon volume as binary versus ordinal versus continuous did make a difference (see Table 5). We advocate against using a binary approach to defining surgeon volume where everyone above a single cut-point is classified as high volume and then everyone below is classified as low volume as clinically, one extra surgery in a set time period likely makes minimal if any difference in a surgeon's outcomes. We suggest that future studies model surgeon volume in multiple ways and present the results of each approach as the best way to model volume will likely vary for different procedures.

Our overall complication rate, our infection rate and our treatment failure rate compare very favorably with the two studies of Medicare patients (Table 3). We hypothesize that the young age of the military beneficiary population likely contributes to these lower rates.

The limitations of the study are similar to any study using a large administrative database[13]. We had no control over the accuracy of the coding of the variables we did use and there were other variables such as race that were not reliably coded. Furthermore, a large proportion of our surgeons were classified as having done zero cases in the 2 years prior to the study period. The database we used only captures cases at U.S. MTFs by attending physicians. We were not able to capture surgeon volume from overseas MTFs, cases done at civilian hospitals during the study period or the previous 2 years, or cases done in residency or fellowship training.

There are now 2 large scale studies (conducted in very different populations) that have failed to show a statistically significant association between surgeon volume and surgical outcomes after sling surgery for SUI. Despite the lack of a significant association between surgeon volume and complications, the overall rate of complications remains high and ranges from 45 to 69%. Future efforts should focus on reducing the high rate of 12-month post-operative complications after sling surgery for SUI.

References

1. Nygaard I, Barber MD, Burgio KL, et al. Prevalence of symptomatic pelvic floor disorders in US women. *Jama.* 2008;300(11):1311-1316.
2. Wu JM, Hundley AF, Fulton RG, Myers ER. Forecasting the prevalence of pelvic floor disorders in U.S. Women: 2010 to 2050. *Obstet Gynecol.* 2009;114(6):1278-1283.
3. de Vries HF, Northington GM, Bogner HR. Urinary incontinence (UI) and new psychological distress among community dwelling older adults. *Archives of gerontology and geriatrics.* 2012;55(1):49-54.
4. Moore CK. The impact of urinary incontinence and its treatment on female sexual function. *Current urology reports.* 2010;11(5):299-303.
5. Nilsson M, Lalos O, Lindkvist H, Lalos A. Impact of female urinary incontinence and urgency on women's and their partners' sexual life. *Neurourology and urodynamics.* 2011;30(7):1276-1280.
6. Anger JT, Rodriguez LV, Wang Q, Pashos CL, Litwin MS. The role of provider volume on outcomes after sling surgery for stress urinary incontinence. *The Journal of urology.* 2007;177(4):1457-1462; discussion 1462.
7. Welk B, Al-Hothi H, Winick-Ng J. Removal or Revision of Vaginal Mesh Used for the Treatment of Stress Urinary Incontinence. *JAMA surgery.* 2015;150(12):1167-1175.
8. Suskind AM, Clemens JQ, Dunn RL, Zhang Y, Stoffel JT, Hollenbeck BK. Effectiveness of mesh compared with nonmesh sling surgery in Medicare beneficiaries. *Obstet Gynecol.* 2013;122(3):546-552.
9. Anger JT, Litwin MS, Wang Q, Pashos CL, Rodriguez LV. Complications of sling surgery among female Medicare beneficiaries. *Obstet Gynecol.* 2007;109(3):707-714.

10. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *Journal of chronic diseases.* 1987;40(5):373-383.

11. Vree FE, Cohen SL, Chavan N, Einarsson JI. The impact of surgeon volume on perioperative outcomes in hysterectomy. *JSLS : Journal of the Society of Laparoendoscopic Surgeons / Society of Laparoendoscopic Surgeons.* 2014;18(2):174-181.

12. Rogo-Gupta LJ, Lewin SN, Kim JH, et al. The effect of surgeon volume on outcomes and resource use for vaginal hysterectomy. *Obstet Gynecol.* 2010;116(6):1341-1347.

13. Kestle JR. Administrative database research. *Journal of neurosurgery.* 2015;122(2):441-442.

Table 1. Procedure and diagnosis codes used.

Variable	ICD-9/CPT codes used
Stress urinary incontinence	625.6, 599.81, 599.82
Sling procedure for SUI	57288 (CPT) 59.4, 59.71, 59.79 (ICD-9 Procedure)
Infectious Complications	590.10, 590.80, 590.9, 595.0, 595.3, 595.89, 595.9, 599.0, 599.7x, 996.31, 996.64, 996.65, 998.5x
Urologic Complications	565.1, 568.81, 593.3, 596.x, 597.0, 608.83, 619.x, 665.7x, 996.3x, 997.5, 998.1x, 998.2, 998.4, 998.6, 998.7
New Diagnosis of	596.51, 788.31

Urgency	
New Diagnosis of Pelvic Pain	625.8, 625.9, 788.9x, 789.9
New Diagnosis of Bladder Outlet Obstruction	596.0, 599.6x, 788.2x, 788.38, 788.62
Management of Bladder Outlet Obstruction	51010, 51040, 51701, 52270, 52281, 52285, 53500, 53620, 53660, 57287 (CPT)
Cytoscopy	52000, 52204, 52281 (CPT)
Urodynamics	51725, 51726, 51795 (CPT)
Repeat Incontinence Procedure	57288 (CPT) 59.4, 59.71, 59.79 (ICD-9 Procedure)
Provider specialty	207V00000X (Gynecologist); 207VG0400X (Gynecologist);

	207VX0201X (Gynecologist); 208800000X (Urologist)

Table 2. Summary of Demographic and comorbidity characteristics of women undergoing a pubovaginal sling * within Military Treatment Facilities in the US, Jan 1 2011 to Dec 31 2012.

	Surgeon volume		p-value
	Low volume (0-3 slings in 2 years) N=664	High volume (13 or more slings in 2 years) N=638	
Patient age†	44.64±0.42	50.12±0.45	0.001‡
Concomitant pelvic organ prolapse procedure at time of index sling§	128(19.3)	166 (26.0)	0.004‖
Provider specialty§			0.001‖
Gynecologist	473(71.2)	450(70.5)	
Urogynecologist	146(22)	186(29.2)	
Other	45(6.8)	2(0.3)	
Charlson Score §			0.001‖
0	507(76.4)	442(69.3)	
1-2	140 (21.1)	155(24.3)	

3 or more	17(2.6)	41(6.4)

*Defined by the combination of CPT code 57288 and ICD-9 procedure codes 59.4(suprapubic sling operation); 59.71(levator muscle operation for urethrovesical suspension) and 59.79 (other repair of stress urinary incontinence) in conjunction with ICD-9 diagnosis codes 625.6(stress incontinence female); 599.81(urethral hypermobility) and 599.82(Intrinsic sphincter deficiency). This captured both inpatients and outpatients.

† Data presented is mean ± Standard error

‡ P-value computed by Student's t-test

§ Data presented is N (%)

||P-value computed by chi-square test

Table 3. Twelve-month post-operative complications after sling surgery within Military treatment facilities (MTF) in the US.

	Howard et al.	Anger et al (2007)	Suskind et al (2013)
Total number of sling procedures	1,632	1,356	6,698
Population	Military beneficiaries at MTFs	Medicare	Medicare
Age(y) *	47.2±11.3	Not reported	70.1±10.6
Charlson Comorbidity index score 3 or greater†	3.9	2.7	6.9
Concomitant pelvic organ prolapse repair†	22.6	34.4	Not reported
Time period of index sling procedure	Jan 1, 2011-Dec 31, 2012	Jan 1, 1999-Jul 31, 2000	2006 to 2008

Complications†§			
Any complication	45.5	Not reported	69.8
Descriptors of specific urologic complications			
Diagnosis of urologic complication	11.5	21.6	16.7
Infectious complication	25.2	49.7	45.4
Treatment failure	0.9	8.3	6.8
(Repeat incontinence procedure)			
New diagnosis of bladder outlet obstruction	7.4	6.9	10.6
Management of bladder outlet obstruction	12.8	8.0	13.9
New diagnosis of pelvic pain	8.7	9.4	6.4
Intermediate indicators of urologic complications			
New diagnosis of urgency	5.5	15.2	19.6
Cystoscopy	6.4	32.4	17.7
Urodynamics	1.7	30.5	7.5

*Data presented is mean ± standard deviation

†Data presented are percentages

§ Because a patient can have more than one complication the percentages in this part of the table do not add to 100%.

Table 4. Twelve-month post-operative complications, by surgeon volume, after sling surgery within Military treatment facilities (MTFs) in the US.

Complications	Surgeon volume			
	Low volume (0-3 slings in 2 years) N=664 N(%)	High volume (13 or more slings in 2 years) N=638 N(%)	Unadjusted Odds Ratio OR(95% CI)	Adjusted Odds ratio OR (95% CI)
Any complication	280(42.2)	309(48.4)	1.29(1.04-1.60)*	1.24(0.99-1.54) †
Infectious complication	154(23.2)	177(27.7)	1.27(0.99-1.63)	1.22(0.95-4.57) †
Urologic complication	74(11.1)	72(11.3)	1.01(.72-1.43)	0.92(0.65-1.31) †
New diagnosis of urgency	36(5.4)	35(5.5)	1.01(.62-1.63)	0.96(0.59-1.56)

				†
New diagnosis of pelvic pain	67(10.1)	48(7.5)	0.73(0.49-1.07)	0.69(.46-130) †
New diagnosis of bladder outlet obstruction	55(8.3)	40(6.3)	0.74(0.49-1.13)	0.72(0.47-1.10) †
Management of bladder outlet obstruction	72(10.8)	703(16.1)	1.58(1.15-2.19) ‡	1.58(1.14-2.19) †‡
Cystoscopy	49(7.4)	43(6.7)	0.91(0.59-1.39)	0.77(0.30-1.96)§
Urodynamics	11(1.7)	8(1.3)	0.75(.30-1.89)	0.76(0.30-1.90)‖
Repeat incontinence procedure	6(.9)	7(1.1)	1.22(0.41-3.64)	1.17(0.39-3.51)¶

Because patients can have more than one complication the percentages in the column do not add to 100%

*$P<0.05$

†Adjusted for Charlson comorbidity score (0 vs. 1 or more) and concomitant pelvic organ prolapse repair

‡ $P<0.01$

§Adjusted for age (greater than or equal to median [46] vs less than median) and concomitant pelvic organ prolapse repair

||Adjusted for concomitant pelvic organ prolapse repair

¶Adjusted for Charlson comorbidity score (0 vs. 1 or more)

Table 5. Results of logistic regression modeling for surgeon sling volume versus odds of any complication in 12 months using three different methods to model surgeon volume.*

	Model 1a N=1,302	Model 1b N=1,272	Model 2a N=889	Model 2b N=859	Model 2 N=1,632	Model 2b N=1,602	Model 3a N=1,632	Model 3b N=1,602
	Outlier surgeon included	Outlier surgeon excluded	Outlier surgeon included	Outlier surgeon excluded	Outlier surgeon included	Outlier surgeon excluded	Outlier surgeon included	Outlier surgeon excluded
Surgeon sling volume (dichotomous)								
High volume (13 or more/2yrs)	1.24 (0.99-1.54)†	1.20 (0.96-1.50)						
Low volume (0-3/2yrs)	reference	reference						

Surgeon sling volume(dichotomous)						
High volume (20 or more/2yrs)	1.23 (0.93-1.61)	1.19 (0.90-1.57)				
Low volume (0 /2yrs)	reference	reference				
Surgeon sling volume (ordinal: 0-3, 4-7,8-12, 13 or more slings/2yrs)			1.08 (1.00-1.16)[‡]	1.07 (0.99-1.15)[†]		
Surgeon sling volume (continuous)					1.00 (1.00-1.01)[†]	1.00 (0.99-1.01)

*Models adjusted for Charlson score (1 or more vs. 0) and concomitant pelvic organ procedure.

†P>0.05<0.10

‡P<0.05

Figure Legend

Figure 1. Number of Sling Procedures Performed by Military Surgeons within the United States (January 1, 2009-December 31,2010)