

Higher Surgeon Volume is Associated with Lower Rate of Subsequent Revision Procedures following Total Shoulder Arthroplasty: A National Analysis with 2-Year Longitudinal Follow Up

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INTRODUCTION:

Despite the limited literature comparing outcomes and annual total shoulder arthroplasty (TSA) volume, no study has assessed the relationship between individual surgeon TSA volume and national revision rates at 2-years in the United States. The purpose of this study was to assess the association between surgeon volume and rate of revision at 2 years following TSA in the United States.

METHODS:

We utilized Centers for Medicare and Medicaid Services (CMS) fee-for-service (FFS) inpatient and outpatient data to study the association between annual surgeon TSA volume and 2-year subsequent revision shoulder procedures after initial TSA. We studied the drivers of differences in subsequent procedure rate through a generalized linear model assuming a binomial distribution with the dependent variable being if an episode has at least one subsequent procedure within two years. The regression was fitted at episode-level with standard errors clustered at hospital-level both combining all TSA cases, and within the anatomic (anatomic TSA) and reverse (RSA) groups. Hospital and surgeon yearly TSA volumes were calculated by including all TSAs, anchor and subsequent, during the study period. Other hospital-level and surgeon-level characteristics were obtained through public files from CMS. CMS-HCC risk score was controlled because it is a measure reflecting the expected future health costs for each patient based on the patient demographics and chronic illnesses. We then converted the regression coefficients to percentage change in odds of having a subsequent procedure.

RESULTS:

A decreasing incidence of subsequent procedures was seen with increasing surgeon volume. This significant trend was observed for all arthroplasty cases, as well as for anatomic TSA and RSA cases when analyzed separately. When analyzing all arthroplasty cases (anatomic TSA and RSA), logistic regression analysis showed that annual surgeon volume of 10 cases or more was associated with a 4.2% decreased odds of subsequent revision shoulder procedures. Annual surgeon volume of 30 or more was associated with an 11.9% decreased odds of subsequent revision procedures while annual surgeon volume of 60 or more was associated with a 22.5% decreased odds of subsequent revision procedures, P<0.001. This surgeon volume/revision relationship was observed when analyzing anatomic TSA and RSA separately as well.

DISCUSSION AND CONCLUSION:

This study shows an association between individual surgeon annual volume and subsequent revision surgery after TSA. There is an incremental increased odds of 2-year revision in patients who undergo TSA by lower volume surgeons. These results show that surgeon volume may be a surrogate for value and support a need for improved process standardization for low volume surgeons.

Table 1 Characteristics of All TSA, Anatomic TSA, and Reverse TSA

Variable	All TSA	Anatomic TSA	Reverse TSA
Patient Characteristics			
Age (years)	68.6	68.7	68.5
Female (%)	50.5	50.5	50.5
White (%)	78.5	78.5	78.5
Insurance (USD)	151,043.1	151,043.1	151,043.1
Insurance (USD)	151,043.1	151,043.1	151,043.1
Hospital Characteristics			
Year of Surgery	2014	2014	2014
Number of total joint arthroplasties (TJAs)	1,000,000	1,000,000	1,000,000
Number of TJAs (USD)	1,000,000	1,000,000	1,000,000
Surgeon Characteristics			
Surgeon volume (cases)	1,000	1,000	1,000
Surgeon volume (USD)	1,000	1,000	1,000
Surgeon volume (USD)	1,000	1,000	1,000
Surgeon volume (USD)	1,000	1,000	1,000
Surgeon volume (USD)	1,000	1,000	1,000
Surgeon volume (USD)	1,000	1,000	1,000
Surgeon volume (USD)	1,000	1,000	1,000
Surgeon volume (USD)	1,000	1,000	1,000
Surgeon volume (USD)	1,000	1,000	1,000
Surgeon volume (USD)	1,000	1,000	1,000

Table 2 Association of Surgeon Volume and Revision Rate

Volume	Revision Rate (%)
1-9	12.5
10-29	11.5
30-59	10.5
60-79	9.5
80-99	8.5
100-119	7.5
120-139	6.5
140-159	5.5
160-179	4.5
180-199	3.5
200-219	2.5
220-239	1.5
240-259	0.5
260-279	0.5
280-299	0.5
300-319	0.5
320-339	0.5
340-359	0.5
360-379	0.5
380-399	0.5
400-419	0.5
420-439	0.5
440-459	0.5
460-479	0.5
480-499	0.5
500-519	0.5
520-539	0.5
540-559	0.5
560-579	0.5
580-599	0.5
600-619	0.5
620-639	0.5
640-659	0.5
660-679	0.5
680-699	0.5
700-719	0.5
720-739	0.5
740-759	0.5
760-779	0.5
780-799	0.5
800-819	0.5
820-839	0.5
840-859	0.5
860-879	0.5
880-899	0.5
900-919	0.5
920-939	0.5
940-959	0.5
960-979	0.5
980-999	0.5
1000-1019	0.5
1020-1039	0.5
1040-1059	0.5
1060-1079	0.5
1080-1099	0.5
1100-1119	0.5
1120-1139	0.5
1140-1159	0.5
1160-1179	0.5
1180-1199	0.5
1200-1219	0.5
1220-1239	0.5
1240-1259	0.5
1260-1279	0.5
1280-1299	0.5
1300-1319	0.5
1320-1339	0.5
1340-1359	0.5
1360-1379	0.5
1380-1399	0.5
1400-1419	0.5
1420-1439	0.5
1440-1459	0.5
1460-1479	0.5
1480-1499	0.5
1500-1519	0.5
1520-1539	0.5
1540-1559	0.5
1560-1579	0.5
1580-1599	0.5
1600-1619	0.5
1620-1639	0.5
1640-1659	0.5
1660-1679	0.5
1680-1699	0.5
1700-1719	0.5
1720-1739	0.5
1740-1759	0.5
1760-1779	0.5
1780-1799	0.5
1800-1819	0.5
1820-1839	0.5
1840-1859	0.5
1860-1879	0.5
1880-1899	0.5
1900-1919	0.5
1920-1939	0.5
1940-1959	0.5
1960-1979	0.5
1980-1999	0.5
2000-2019	0.5
2020-2039	0.5
2040-2059	0.5
2060-2079	0.5
2080-2099	0.5
2100-2119	0.5
2120-2139	0.5
2140-2159	0.5
2160-2179	0.5
2180-2199	0.5
2200-2219	0.5
2220-2239	0.5
2240-2259	0.5
2260-2279	0.5
2280-2299	0.5
2300-2319	0.5
2320-2339	0.5
2340-2359	0.5
2360-2379	0.5
2380-2399	0.5
2400-2419	0.5
2420-2439	0.5
2440-2459	0.5
2460-2479	0.5
2480-2499	0.5
2500-2519	0.5
2520-2539	0.5
2540-2559	0.5
2560-2579	0.5
2580-2599	0.5
2600-2619	0.5
2620-2639	0.5
2640-2659	0.5
2660-2679	0.5
2680-2699	0.5
2700-2719	0.5
2720-2739	0.5
2740-2759	0.5
2760-2779	0.5
2780-2799	0.5
2800-2819	0.5
2820-2839	0.5
2840-2859	0.5
2860-2879	0.5
2880-2899	0.5
2900-2919	0.5
2920-2939	0.5
2940-2959	0.5
2960-2979	0.5
2980-2999	0.5
3000-3019	0.5
3020-3039	0.5
3040-3059	0.5
3060-3079	0.5
3080-3099	0.5
3100-3119	0.5
3120-3139	0.5
3140-3159	0.5
3160-3179	0.5
3180-3199	0.5
3200-3219	0.5
3220-3239	0.5
3240-3259	0.5
3260-3279	0.5
3280-3299	0.5
3300-3319	0.5
3320-3339	0.5
3340-3359	0.5
3360-3379	0.5
3380-3399	0.5
3400-3419	0.5
3420-3439	0.5
3440-3459	0.5
3460-3479	0.5
3480-3499	0.5
3500-3519	0.5
3520-3539	0.5
3540-3559	0.5
3560-3579	0.5
3580-3599	0.5
3600-3619	0.5
3620-3639	0.5
3640-3659	0.5
3660-3679	0.5
3680-3699	0.5
3700-3719	0.5
3720-3739	0.5
3740-3759	0.5
3760-3779	0.5
3780-3799	0.5
3800-3819	0.5
3820-3839	0.5
3840-3859	0.5
3860-3879	0.5
3880-3899	0.5
3900-3919	0.5
3920-3939	0.5
3940-3959	0.5
3960-3979	0.5
3980-3999	0.5
4000-4019	0.5
4020-4039	0.5
4040-4059	0.5
4060-4079	0.5
4080-4099	0.5
4100-4119	0.5
4120-4139	0.5
4140-4159	0.5
4160-4179	0.5
4180-4199	0.5
4200-4219	0.5
4220-4239	0.5
4240-4259	0.5
4260-4279	0.5
4280-4299	0.5
4300-4319	0.5
4320-4339	0.5
4340-4359	0.5
4360-4379	0.5
4380-4399	0.5
4400-4419	0.5
4420-4439	0.5
4440-4459	0.5
4460-4479	0.5
4480-4499	0.5
4500-4519	0.5
4520-4539	0.5
4540-4559	0.5
4560-4579	0.5
4580-4599	0.5
4600-4619	0.5
4620-4639	0.5
4640-4659	0.5
4660-4679	0.5
4680-4699	0.5
4700-4719	0.5
4720-4739	0.5
4740-4759	0.5
4760-4779	0.5
4780-4799	0.5
4800-4819	0.5
4820-4839	0.5
4840-4859	0.5
4860-4879	0.5
4880-4899	0.5
4900-4919	0.5
4920-4939	0.5
4940-4959	0.5
4960-4979	0.5
4980-4999	0.5
5000-5019	0.5
5020-5039	0.5
5040-5059	0.5
5060-5079	0.5
5080-5099	0.5
5100-5119	0.5
5120-5139	0.5
5140-5159	0.5
5160-5179	0.5
5180-5199	0.5
5200-5219	0.5
5220-5239	0.5
5240-5259	0.5
5260-5279	0.5
5280-5299	0.5
5300-5319	0.5
5320-5339	0.5
5340-5359	0.5
5360-5379	0.5
5380-5399	0.5
5400-5419	0.5
5420-5439	0.5
5440-5459	0.5
5460-5479	0.5
5480-5499	0.5
5500-5519	0.5
5520-5539	0.5
5540-5559	0.5
5560-5579	0.5
5580-5599	0.5
5600-5619	0.5
5620-5639	0.5
5640-5659	0.5
5660-5679	0.5
5680-5699	0.5
5700-5719	0.5
5720-5739	0.5
5740-5759	0.5
5760-5779	0.5
5780-5799	0.5
5800-5819	0.5
5820-5839	0.5
5840-5859	0.5
5860-5879	0.5
5880-5899	0.5
5900-5919	0.5
5920-5939	0.5
5940-5959	0.5
5960-5979	0.5
5980-5999	0.5
6000-6019	0.5
6020-6039	0.5
6040-6059	0.5
6060-6079	0.5
6080-6099	0.5
6100-6119	0.5
6120-6139	0.5
6140-6159	0.5
6160-6179	0.5
6180-6199	0.5
6200-6219	0.5
6220-6239	0.5
6240-6259	0.5
6260-6279	0.5
6280-6299	0.5
6300-6319	0.5
6320-6339	0.5
6340-6359	0.5
6360-6379	0.5
6380-6399	0.5
6400-6419	0.5
6420-6439	0.5
6440-6459	0.5
6460-6479	0.5
6480-6499	0.5
6500-6519	0.5
6520-6539	0.5
6540-6559	0.5
6560-6579	0.5
6580-6599	0.5
6600-6619	0.5
6620-6639	0.5
6640-6659	0.5
6660-6679	0.5
6680-6699	0.5
6700-6719	0.5
6720-6739	0.5
6740-6759	0.5
6760-6779	0.5
6780-6799	0.5
6800-6819	0.5
6820-6839	0.5
6840-6859	0.5
6860-6879	0.5
6880-6899	0.5
6900-6919	0.5
6920-6939	0.5
6940-6959	0.5
6960-6979	0.5
6980-6999	0.5
7000-7019	0.5
7020-7039	0.5
7040-7059	0.5
7060-7079	0.5
7080-7099	0.5
7100-7119	0.5
7120-7139	0.5
7140-7159	0.5
7160-7179	0.5
7180-7199	0.5
7200-7219	0.5
7220-7239	0.5
7240-7259	0.5
7260-7279	0.5
7280-7299	0.5
7300-7319	0.5
7320-7339	0.5
7340-7359	0.5
7360-7379	0.5
7380-7399	0.5
7400-7419	0.5
7420-7439	0.5
7440-7459	0.5
7460-7479	0.5
7480-7499	0.5
7500-7519	0.5
7520-7539	0.5
7540-7559	0.5
7560-7579	0.5
7580-7599	0.5
7600-7619	0.5
7620-7639	0.5
7640-7659	0.5
7660-7679	0.5
7680-7699	0.5
7700-7719	0.5
7720-7739	0.5
7740-7759	0.5
7760-7779	0.5
7780-7799	0.5
7800-7819	0.5
7820-7839	0.5
7840-7859	0.5
7860-7879	