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## Travel distance does not affect outcomes after total shoulder arthroplasty



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**Background:** The purpose of this investigation was to determine the effect of travel distance on achieving the minimal clinically important difference (MCID) on all three commonly used patient-reported outcome measures (PROMs) for the shoulder more than 1 year following total shoulder arthroplasty (TSA).

**Methods:** Patients undergoing reverse or anatomic TSA at a high-volume tertiary referral center between September 2016 and August 2018 were retrospectively reviewed. Patients were divided into 2 groups: driving distance of >50 miles from the location of surgery (referral group) and driving distance of <50 miles (local group). Scores on preoperative and postoperative PROMs, including American Shoulder and Elbow Surgeons (ASES) score, Single Assessment Numeric Evaluation (SANE) score, and Constant Score (CS) at minimum 1-year follow-up were assessed. Chi-square analysis was used to analyze the achievement of MCID on any PROM or a combination of PROMs. Logistic regression was performed to determine whether travel distance and other variables of interest had an effect on achieving MCID on all three PROMs.

**Results:** A total of 214 patients with minimum 1-year follow-up were included in the final analysis. Of these, 165 patients (77.1%) traveled <50 miles to their orthopedic provider at the time of surgery. The local group demonstrated significantly inferior preoperative SANE scores ( $P < .001$ ) and significantly higher postoperative ASES scores ( $P = .001$ ). A total of 166 (77%) patients achieved all three MCIDs postoperatively. There was no significant difference between distance groups for achievement of all MCIDs ( $P = .328$ ). On multivariable regression, body mass index  $> 30$  (odds ratio [OR], 5.78; 95% confidence interval [CI], 1.53–30.28), worker's compensation status (OR, 16.78; 95% CI, 2.34–161.39), and higher preoperative ASES score (OR, 1.04; 95% CI, 1.01–1.07) were associated with an increased risk of failure to achieve all MCIDs ( $P < .05$ ). Age, adjusted gross income, private insurance, and travel distance were not significantly associated with failure to achieve all MCIDs.

**Conclusions:** After controlling for age, sex, and adjusted gross income, distance traveled to a high-volume referral center did not have an effect on achieving the MCID on all three commonly used PROMs for the shoulder at least 1 year after undergoing TSA. Elevated body mass index, worker's compensation status, and higher preoperative ASES score were associated with an increased risk of failure to achieve all MCIDs after TSA.

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As healthcare delivery shifts to value-based models, a large proportion of patients are seeking care at high-volume specialty centers. Regional Centers of Excellence (COEs) represent an attractive option for patients due to their potentially lower costs, streamlined clinical pathways, and high-volume providers.<sup>5,22</sup> Gregory et al showed that the increasing volume of total shoulder arthroplasty (TSA) in Texas between 2010 and 2015 reflected a

concentration of care into high-volume inpatient and outpatient centers.<sup>14</sup> Higher-volume shoulder arthroplasty practices have been associated with decreased complications and shorter lengths of stay, which can influence postoperative outcomes and surgical costs.<sup>10,15,28</sup>

Despite the purported benefits of high-volume referral centers, patients may have to travel significant distances to access care at these locations. Patients who live farther from their treating surgeon may not be as closely integrated into the practice's care system or may have more limited access to their care team. A "reverse travel distance bias" has been described in the general surgery literature, whereby patients who travel farther to receive care have a higher risk of complications compared to those who receive care locally.<sup>12</sup> Prior studies have shown no detrimental effect of travel distance on outcomes after various orthopedic procedures including total joint arthroplasty and hip arthroscopy.<sup>3,25</sup> Dubiel et al showed no difference in complication and reoperation rate after reverse TSA between local patients and those traveling from a distance.<sup>10</sup> However, the effect of travel distance on postoperative functional outcomes remains unknown following shoulder arthroplasty.

The rate of TSA is steadily increasing, and is a common procedure at tertiary referral centers.<sup>4</sup> Accordingly, the purpose of this investigation was to determine the effect of increasing travel distances on achieving excellent postoperative functional outcomes (ie, achieving the minimal clinically important difference [MCID] on all three commonly used patient-reported outcome measures [PROMs] for the shoulder) at least 1 year after anatomic or reverse TSA. We hypothesized that a greater travel distance would not affect the achievement of MCID on all PROMs following TSA.

## Methods

### *Study approval and patient inclusion criteria*

This study was approved by the institutional review board, and no funding was received. Data were prospectively gathered on all patients undergoing anatomic or reverse TSA from September 2016 to August 2018 by 4 fellowship-trained surgeons (GG, GN, NV, BF) at a high-volume tertiary referral center in a large metropolitan area. Inclusion criteria were patients who underwent anatomic or reverse TSA for treatment of primary glenohumeral osteoarthritis, rotator cuff tear arthropathy, or arthropathy secondary to chronic inflammatory conditions (ie, gout or rheumatoid arthritis) with a minimum of 12 months postoperative follow-up. Patients undergoing reverse shoulder arthroplasty for proximal humerus fracture or malignancy were excluded. Additional exclusion criteria were revision arthroplasty, unavailable PROMs at a minimum of 1 year postoperatively, unavailable geographic demographic information (postal code at the time of surgery), or patients with residences further than the bordering states of the institution of study (Illinois, Indiana, Michigan, Iowa, and Wisconsin) who would have likely required transportation other than ground transport.

### *Surgical technique*

The anatomic or reverse TSA was performed by one of the four senior authors (GG, GN, NV, BF) via a standard deltopectoral approach with combined interscalene regional and general anesthesia. All surgeons were fellowship-trained in sports medicine or shoulder and elbow surgery practicing at a high-volume orthopedic surgery practice, all perform a high volume of TSA procedures, and all are within the top 1% of work relative value units by Medical Group Management Association data.

### *Postoperative rehabilitation program*

All patients underwent a postoperative rehabilitation protocol prescribed by their treating surgeon, all of which were similar and followed the same principles and guidelines.

For anatomic TSA, Phase I consists of passive motion for the first 6 weeks postoperatively. A sling is worn at all times for the first 2 weeks, after which it is weaned until week 6 when it is discontinued entirely. Supine well-arm assisted passive range of motion is emphasized in all planes as allowed per the safe zone specified by the surgeon based on intraoperative findings. Phase II (6–12 weeks postoperatively) consists of active range of motion with the goal to achieve full range of motion by the end of week 10. Resisted internal rotation is begun at 10 weeks postoperatively. Light resistance and aquatic therapy may be initiated in this phase. After 10 weeks, the patient enters Phase III which consists of final strengthening and increasing functional activities, given the achievement of acceptable motion.

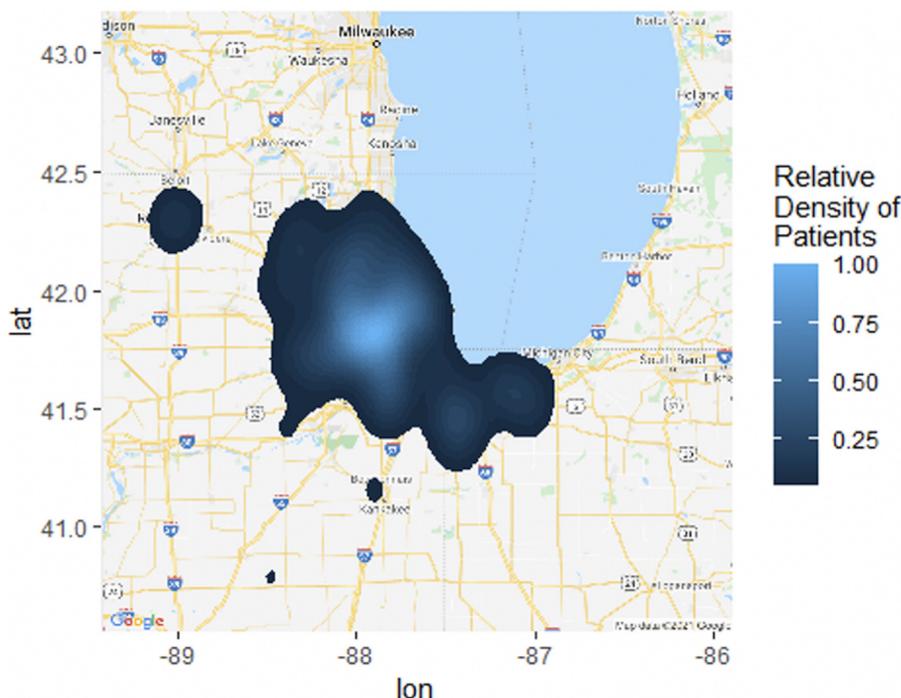
For reverse TSA, a sling is worn at all times during the first 2 weeks postoperatively. During this phase, the goal is to increase passive range of motion for elevation to 120° and external rotation to 30°. During Phase II (2–6 weeks postoperatively), the sling may be removed and the arm may be used for activities of daily living. Weight bearing is protected and dislocation precautions are maintained. Submaximal isometrics for the deltoid are initiated and full passive range of motion is achieved. During phase III (6 weeks–3 months postoperatively), the sling is discontinued completely and passive external rotation is allowed to advance beyond 30°. Active range of motion is initiated and optimized. After 3 months postoperatively, rehabilitation consists of optimizing functional use of the extremity and increasing strength/resistance training to meet the demands of the patient's work tasks, hobbies, and activities of daily living.

### *Functional outcome evaluation*

All patients in the study completed at least one of three postoperative shoulder specific PROMs, including the American Shoulder and Elbow Surgeons (ASES) score, the Single Assessment Numerical Evaluation (SANE) score, and/or the Constant Murley Score (CS) at a minimum of 1 year or up to 2 years after surgery. The MCID is the minimum improvement in outcomes most patients will require to perceive a noticeable difference in symptoms.<sup>7</sup> Thus, the clinical significance of improvements on PROMs was based on whether or not patients achieved MCID on the ASES, SANE, and CS instruments. Patients that reached or surpassed these previously established targets were considered to have attained the MCID either on individual questionnaires or a combination thereof.

### *Assessment of geographical location*

The institution where this study was conducted is located in a large metropolitan area with approximately a 50-mile cutoff between urban and suburban areas. Thus, patients within 50 miles of the institution were considered to have sufficient accessible transportation options for travel to postoperative follow-up visits as well as access to adequate physical therapy as required by current standards of postoperative rehabilitation. The Google Maps application programming interface was utilized to systematically fetch travel distances between patient's home postal codes and the specific institution's surgery center locations. Patients with home residences less than 50 miles from the institution were labeled as the local group, whereas those with home residences 50 miles or greater from the institution were labeled as the referral group.



**Figure 1** Geospatial representation of the relative density of patients included in this study relative to the center where the study took place.

Average adjusted gross income (AGI) for each of the zip codes included in the study was collected from public US Internal Revenue Service statistics. AGI was used to assess if estimated income was an effect modifier on the association between geographic location and achieving the MCID. The tax return data for the year 2017 were utilized for all patients as it was the most recently published data.

*Statistical analysis*

The relative density of patients in relation to the institution of study was summarized as a heatmap distribution. The geographical distribution of patients attaining MCID for each PROM (ASES, CS, and SANE) was summarized as geographical scatterplots with marker size corresponding to the number of patients within each geographical area. One size marker was used to denote areas with fewer than 10 patients to protect patient anonymity. Descriptive statistics for all continuous variables were reported as means and standard deviations, while categorical variables were reported as frequency and percentages. Differences between local and referral groups were assessed using independent t-tests or Mann-Whitney U test for continuous data and chi-square tests of independence for categorical data. Postoperative differences in PROMs were assessed via paired sample t-tests. A logistic regression was performed to predict risk of not achieving all three MCIDs (ASES, SANE, and CS). Features included in the model included sex, age, body mass index (BMI), Charleston Comorbidity Index (CCI), AGI, primary insurance (including worker’s compensation status), preoperative PROMs, and travel distance. Covariables in regression models were carefully selected to reflect clinically relevant characteristics while maintaining appropriate regression power.<sup>16</sup> Continuous variables were recoded into categorical variables for ease of interpretation and easier translation to clinical applications. Pearson chi-square and Hosmer-Lemeshow goodness of fit statistics were assessed for each regression with low *P*-values indicating a poor model fit. All

analyses were performed in R (Version 3.6.2; R Foundation, Vienna, Austria), and  $\alpha$  was set to 0.05.

**Results**

A total of 2701 total patients underwent primary TSA during the study period and were eligible for inclusion in the study. Of these, 1776 registered for PROMs linked to their TSA procedure, and 311 had an address available to calculate travel distance and met the inclusion criteria regarding geography and were performed at the correct surgical facility. A total of 214 of these patients (69%) had complete 1-year follow-up PROMs and were included in the final analysis. The overall mean age was 65.88 (standard deviation, 8.79) years with a mean BMI of 30.43 (standard deviation, 6.48) and 127 (40.7%) females. A total of 165 patients (77.1%) traveled fewer than 50 miles at the time of surgery, illustrated on the geospatial density distribution map (Fig. 1). The median driving distance to the facility where the surgery took place was 23.14 (interquartile range, 13.05–34.20) miles for the local cohort and 84.63 (interquartile range, 61.15–130.21) miles for the referral cohort. There were no statistically significant differences in sex, age, BMI, CCI, smoking status, activity level, or primary payor between local and referral cohorts (Table I).

*Comparison of preoperative and postoperative outcome scores*

Overall, patients reported statistically significant postoperative improvements in the ASES, SANE, and CS instruments (Table II). Notably, all mean postoperative scores exceeded patient acceptable symptomatic states ( $P < .001$ ).<sup>13</sup> On subgroup analysis by distance group, the local group demonstrated significantly inferior preoperative SANE scores ( $P < .001$ ) (Table III). There were no significant differences between referral groups on ASES or Constant instruments preoperatively. Postoperatively, the local group demonstrated significantly higher ASES scores ( $90.2 \pm 11.7$  vs.  $84.7 \pm 15.9$ ;  $P = .001$ ). There was no significant difference between

**Table I**  
Cohort demographics.

	Local group (n = 165)	Referral group (n = 49)	P values
Gender			
Male	95 (57.6)	32 (65.3)	.423
Female	70 (42.4)	17 (34.7)	.423
Age			
<56	24 (14.5)	7 (14.3)	1.000
56-70	86 (52.1)	28 (57.1)	.649
>70	55 (33.3)	14 (28.6)	.651
BMI			
<25	27 (16.4)	6 (12.2)	.634
26-30	53 (32.1)	13 (26.5)	.57
>30	85 (51.5)	30 (61.2)	.301
Charleston Comorbidity Index			
0-3	127 (77)	39 (79.6)	.848
>3	38 (23)	10 (20.4)	.848
Smoking status			
Never	83 (50.3)	18 (36.7)	.132
Former	47 (28.5)	20 (40.8)	.145
Active	8 (4.8)	3 (6.1)	1.000
Unknown	27 (4.8)	8 (6.1)	1.000
Activity level (kilometers walked per day)			
0-0.4	26 (15.8)	6 (12.2)	.706
0.41-0.8	28 (17)	14 (28.6)	.112
0.81-1.6	25 (15.2)	0 (0)	<b>.008</b>
1.61-3.2	17 (10.3)	5 (10.2)	1.000
>3.2	21 (12.7)	7 (14.3)	.966
Unknown	48 (29.1)	17 (34.7)	.567
AGI			
<60k	118 (71.5)	40 (81.6)	.219
\$60k-100k	33 (20)	7 (14.3)	.489
>\$100k	14 (8.5)	2 (4.1)	.472
Payor			
Private	86 (52.1)	28 (57.1)	.649
Medicare	75 (45.5)	19 (38.8)	.507
Work Comp	4 (2.4)	2 (4.1)	.901
Driving distance >49 miles	23.9 ± 13.4	104.4 ± 58.2	<b>&lt;.001</b>

BMI, body mass index; AGI, adjusted gross income.

Bold indicates statistical significance value ( $P < .05$ ).

Categorical variables displayed as n (%). Continuous variables displayed as mean ± standard deviation.

**Table II**  
Preoperative and 1-year postoperative functional scores for the entire cohort.

	Preoperative	Postoperative	P values
ASES	41.7 ± 16.2	86 ± 15.2	<b>&lt;.001</b>
Constant	11.8 ± 5.2	26.7 ± 7	<b>&lt;.001</b>
SANE	32.9 ± 22.5	82.3 ± 18.7	<b>&lt;.001</b>

ASES, American Shoulder and Elbow Surgeons; SANE, Single Assessment Numeric Evaluation.

Bold indicates statistical significance value ( $P < .05$ ).

Displayed as mean ± standard deviation.

referral groups for SANE or Constant instruments postoperatively. Similarly, there were no statistically significant differences between distance groups for MCID achievement of ASES ( $P = 1.00$ ), Constant ( $P = .241$ ), or SANE ( $P = .256$ ) instruments (Fig. 2, A-C).

A total of 166 (77%) patients achieved all three MCID (ASES, Constant, and SANE) postoperatively (Table IV). There was no significant difference between distance groups for the achievement of MCID on all three PROMs ( $P = .328$ ) (Table IV). Of patients not achieving all three MCIDs, 24 patients (11%) achieved two of three MCID, 17 patients (8%) achieved only one of three MCIDs, and 7 (3%) patients did not achieve any MCID (Table IV).

*Multivariable regression for risk of not achieving all of ASES, SANE, and CS MCID*

Both goodness of fit statistics (Pearson and Hosmer-Lemeshow) rejected the null hypothesis due to inadequate model fit. Patient

**Table III**  
Preoperative and 1-year postoperative functional scores by distance group.

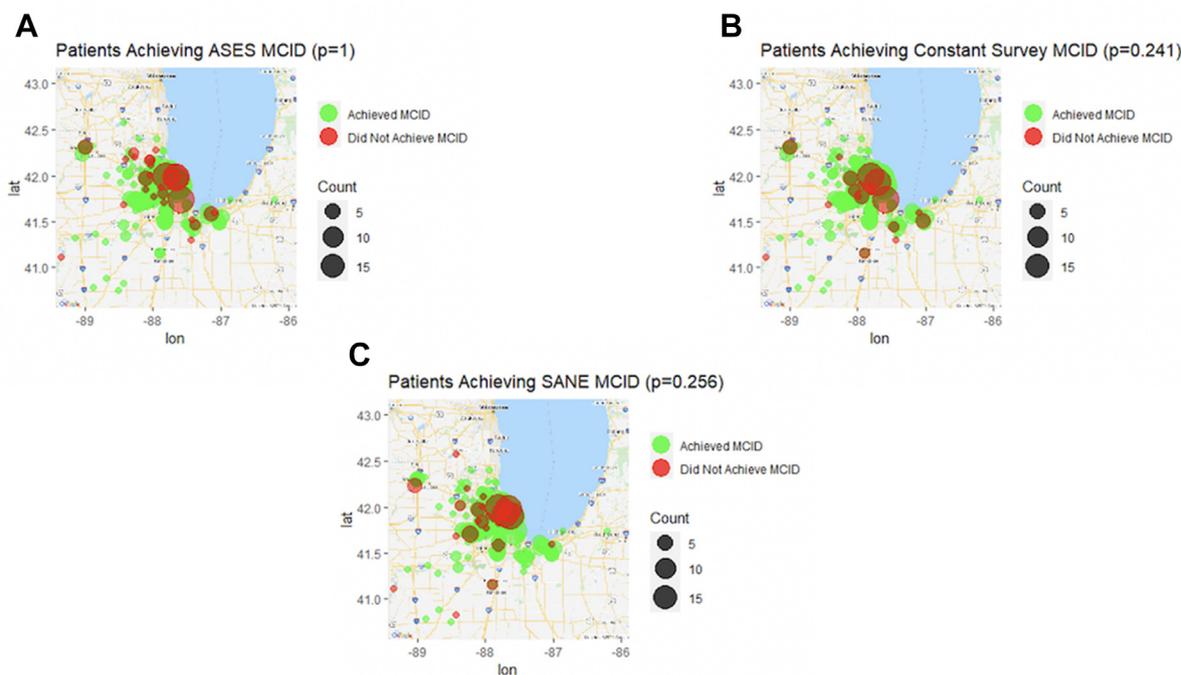
	Local group	Referral group	P values
Preoperative			
ASES	39.4 ± 13.9	42.4 ± 16.8	.109
Constant	11.7 ± 4.3	11.8 ± 5.4	.876
SANE	25.3 ± 20.1	35.3 ± 22.7	<b>&lt;.001</b>
Postoperative			
ASES	90.2 ± 11.7	84.7 ± 15.9	<b>.001</b>
ASES MCID	143 (86.7)	42 (85.7)	1
Constant	27.3 ± 6.5	26.5 ± 7.1	.349
Constant MCID	150 (90.9)	41 (83.7)	.241
SANE	81.9 ± 20.1	82.4 ± 18.2	.855
SANE MCID	147 (89.1)	40 (81.6)	.256

ASES, American Shoulder and Elbow Surgeons; SANE, Single Assessment Numeric Evaluation; MCID, minimal clinically important difference.

Bold indicates statistical significance value ( $P < .05$ ).

Categorical variables displayed as n (%). Continuous variables displayed as mean ± standard deviation.

characteristics associated with increased risk of not achieving MCID on all of ASES, SANE, and CS included BMI >30 (odds ratio [OR], 5.78; 95% confidence interval [CI], 1.53-30.28;  $P = .018$ ), worker's compensation (as compared to Medicare; OR, 16.78; 95% CI, 2.34-161.39;  $P = .007$ ), and higher preoperative ASES score (OR, 1.04; 95% CI, 1.01-1.07;  $P = .018$ ) (Table V). Age, AGI, private insurance, and travel distance were not significantly associated with risk for not achieving all MCIDs (Table V).



**Figure 2** Geospatial representation of the relative density of patients achieving MCID for ASES score (A), Constant Survey (B), and SANE Score (C). *MCID*, minimal clinically important difference; *ASES*, American Shoulder and Elbow Surgeons; *SANE*, single assessment numeric evaluation.

**Table IV**  
Rates of achieving MCID on ASES, Constant, and/or SANE at 1 year postoperatively.

	Local group	Referral group	<i>P</i> values
Achieved all 3 MCID	131 (79.4)	35 (71.4)	.328
Did not Achieve all 3 MCID	34 (20.6)	14 (28.6)	.328
Achieved 2 of 3 MCID	19 (11.5)	5 (10.2)	1
Achieved 1 of 3 MCID	9 (5.5)	8 (16.3)	<b>.03</b>
Achieved 0 of 3 MCID	6 (3.6)	1 (2.0)	1

*MCID*, minimal clinically important difference; *ASES*, American Shoulder and Elbow Surgeons; *SANE*, single assessment numeric evaluation.

Bold indicates statistical significance value ( $P < .05$ ).

Displayed as n (%).

**Discussion**

The primary findings of our study were 1) distance to a high-volume referral center for TSA did not have an effect on achieving the MCID on all three PROMs at 1 year postoperatively, and 2) BMI >30, worker’s compensation status, and higher preoperative ASES score were associated with an increased risk of failure to achieve all MCIDs after TSA. These results supported our hypothesis.

Regionalization of elective orthopedic surgery is becoming increasingly common.<sup>11</sup> Concentrating patients into high-volume centers has the purported benefit of optimizing the quality of care. This is particularly important in anatomic TSA because of the extensive rehabilitation involved after this procedure. Our findings suggest that conducting surgery at a high-volume center with remote rehabilitation is feasible and demonstrates no significant differences in postoperative functional outcomes.

Several studies have investigated whether undergoing shoulder surgery at such centers leads to more positive outcomes.<sup>16</sup> Hammond et al found that a higher average annual surgeon caseload was associated with a decreased complication rate and hospital stay compared to lower volume surgeons in patients undergoing TSA or hemiarthroplasty.<sup>15</sup> Similarly, Jain et al reported that

**Table V**  
Logistic regression analysis of variables with risk for not achieving all MCIDs (ASES, SANE, and Constant).

	OR	2.5% CI	97.5% CI	<i>P</i> values
Sex				
Male	Ref.			
Female	1.08	0.49	2.33	.844
Age (y)				
<56	Ref.			
56-70	0.69	0.24	2.10	.499
>70	1.32	0.29	6.13	.717
BMI				
<26	Ref.			
26-30	2.29	0.59	11.74	.264
>30	5.78	1.53	30.28	<b>.018</b>
CCI	1.05	0.80	1.37	.713
Adjusted gross income				
<\$60k	Ref.			
\$60k-100k	0.73	0.25	1.87	.527
>\$100k	1.07	0.26	3.79	.917
Primary insurance				
Medicare	Ref.			
Private	1.22	0.51	2.99	.653
Work Comp	16.78	2.34	161.39	<b>.007</b>
Preoperative PROs				
ASES	1.04	1.01	1.07	<b>.018</b>
SANE	1.02	1.00	1.04	.098
Constant	0.99	0.90	1.08	.768
Driving distance >49 miles	1.72	0.75	3.89	.194

*OR*, odds ratio; *CI*, confidence interval; *BMI*, body mass index; *CCI*, Charleston Comorbidity Index; *PROs*, patient-reported outcomes; *ASES*, American Shoulder and Elbow Surgeons; *SANE*, Single Assessment Numeric Evaluation; *MCID*, minimal clinically important difference.

Bold indicates statistical significance value ( $P < .05$ ).

patients who have shoulder arthroplasty at a high-volume hospital or by a high-volume surgeon are more likely to have a better outcome, with fewer complications and shorter length of stay.<sup>17</sup> Surgery at higher volume centers may also have implications

regarding costs. Using a large national database, Ramkumar et al found that length of stay and cost after TSA were inversely correlated with hospital and surgeon volume.<sup>27</sup>

In comparison to prior studies, one major strength of our study was its setting. Most patients hailed from Illinois, where our main office is based. It is unique compared to many states in the United States, as it fully represents all geographic, socioeconomic, and ethnic populations with extensive urban, suburban, and rural communities. In fact, Illinois has been called the most representative of all American states.<sup>18</sup>

A byproduct of the establishment of COEs and regional tertiary referral centers is the reliance on referral networks that require patients to travel from a distance to receive care. Prior studies have shown that patients referred from large geographical areas may present with a wide spectrum of medical and surgical complexity, potentially affecting outcomes.<sup>6,12</sup> However, the literature on whether travel distance affects outcomes is mixed, with some studies reporting fewer complications in patients who travel farther,<sup>6,12,19</sup> and others reporting the opposite effect.<sup>23,31</sup> There are few studies investigating this relationship in the orthopedic literature. Nwachukwu et al demonstrated no significant association between travel distance and complication risk in patients undergoing total joint arthroplasty at a COE.<sup>25</sup> Likewise, Beck et al showed that travel distance of  $\geq 50$  miles from a specialty center did not affect postoperative outcomes or MCID achievement 2 years after undergoing hip arthroscopy for femoroacetabular impingement syndrome.<sup>3</sup>

The results of the current investigation show that patients achieved excellent outcomes after TSA regardless of whether they traveled from a distance to receive care. Our results support those by Dubiel et al, who showed no difference in complications or reoperation rates between local and referral groups undergoing reverse TSA.<sup>10</sup> Our results expand upon those previously published by investigating the effect of travel distance on PROMs, which are increasingly being recognized as imperative in assessing both surgical outcomes and in quantifying the value of a procedure.<sup>8,21,29</sup> Investigating achievement on all three PROMs provides a more comprehensive assessment of postoperative outcomes throughout all functional domains, as each PROM measures a different aspect of function. The majority of our cohort (77%) reached MCID on all three PROMs collected, indicating that patients experience reliable and durable improvement after shoulder arthroplasty. Overall, our results argue against the existence of a reverse travel distance bias in the context of TSA and support the potential for high-volume COEs to fulfill their intended purpose.

Our cohort did not demonstrate the same referral bias as reported by Dubiel et al, who showed that referred patients traveling from a distance to undergo primary reverse TSA were older, sicker, and required longer operative times and hospital costs.<sup>10</sup> In our cohort, demographics and comorbidities were largely similar between referral groups. Though not statistically significant, the referral group tended to have a lower activity level than the local group, which is reflective of the differences between rural and suburban lifestyles and dependence on the automobile in these more spread-out communities.

Finally, we found that worker's compensation status, higher preoperative ASES score, and BMI  $> 30$  were risk factors for not achieving MCID on all three PROMs postoperatively. The challenges of achieving excellent functional outcomes in patients with obesity and those with worker's compensation claims are well-documented in the literature. In a cohort of patients undergoing anatomic TSA, Wu et al found a significantly higher rate of failure to achieve the MCID on Simple Shoulder Test scores in workers' compensation patients.<sup>32</sup> Similarly, Morris et al similarly reported significantly worse outcomes in this population after reverse TSA.<sup>24</sup>

With regards to BMI, multiple studies have demonstrated that obese patients experience a higher risk of readmission and complications as well as more inferior functional results after TSA.<sup>2,9,26,30</sup> Lastly, because MCID is a metric based on magnitude of improvement, MCID achievement may be less likely in those with higher preoperative functional scores.<sup>20</sup> Our cohort shows that these trends hold when assessing MCID on three of the most commonly used PROMs.

### Limitations

This study is not without limitations. First, our cohort included patients who were operated on by multiple surgeons, which may introduce minor variability in surgical technique and postoperative care. However, all providers perform a high-volume of TSA procedures, belong to the same institution, and use similar surgical techniques and postoperative rehabilitation protocols. Second, our use of a 50-mile cutoff for determining local vs. referral groups is not a validated distance but was chosen according to the geography of our particular metropolitan area and based on its use in prior similar studies.<sup>3</sup> Third, this study was conducted in a large metropolitan area and may not be generalizable to other geographic locations. This fact is mitigated by Illinois's unique diversity and characteristics, which maximize its generalizability within the United States. Furthermore, this study does not compare outcomes of TSA at high-volume vs. low-volume centers, or at COEs vs. other facilities.

This study did not include information regarding radiographic or clinical outcomes, or data regarding complications or reoperations during the study period, as these data were unavailable for our cohort. It is possible some patients who did not achieve the MCID had complications or reoperations within the follow-up time period that were unable to be measured. It is also important to note that the PROM collection database did not collect the exact time the survey was completed, only the follow-up timepoint (ie, 6 months, 12 months, etc.). Therefore, we are unable to determine the exact time of average follow-up for our cohort. Our results may have been affected by loss to follow-up (69% at 1 year postoperatively); however, among patients excluded because of incomplete PROMs, 26% were in the referral group (vs. this group making up 23% of the final cohort), indicating that there is a low risk of selection bias.

### Conclusion

After controlling for age, sex, and adjusted gross income, distance to a high-volume referral center did not have an effect on achieving the MCID on all three commonly used PROMs for the shoulder at least 1 year after undergoing TSA. Elevated BMI, worker's compensation status, and higher preoperative ASES score were associated with an increased risk of failure to achieve all MCIDs after TSA.

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