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Clinical Studies

Do racial disparities exist in a spine surgery practice that serves a predominately minority population? Outcomes of transforaminal lumbar interbody fusion: A retrospective review

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ABSTRACT

Background: Racial minority status is associated with inferior peri-operative outcomes following spinal fusion. Findings have largely been reported within institutions serving few minority patients. This study aimed to identify if racial disparities exist for transforaminal lumbar interbody fusion (TLIF) procedures within an urban academic medical center which serves a majority non-White population.

Methods: This is a retrospective review of patients who underwent a TLIF procedure at our institution between 06/2016-10/2019. Primary outcome measures included length of stay (LOS), discharge disposition, 30-day return to the emergency department (ED), 30-day readmission rate, and 30-day complication rates. One-hundred-fifty-six patients (female: male, 99: 57) met inclusion criteria. Demographic and clinical data (body mass index (BMI), comorbidities, preoperative lab values) were compared.

Results: The mean LOS was 6.2, 5.9, and 6 days in the White, Hispanic, and Black cohorts, respectively ($p = 0.92$). There were no differences in discharge disposition between groups ($p = 0.52$). Thirty-day post-operative complication rates did not differ between groups ($p > 0.07$). Readmission rates did not differ between groups ($p > 0.05$). ED visits were more prevalent in the Hispanic group with 16 visits as compared to 8 and 4 in the White and Black groups respectively ($p = 0.01$).

Conclusions: We found no racial disparities in terms of LOS, discharge disposition, or 30-day readmission rates. Hispanic patients demonstrated an increased utilization of the ED in the early post-operative period. Efforts to overcome language barriers, communicate instructions clearly, and outline post-operative expectations and plans may prevent the need for post-operative ED visits.

Introduction

There is ongoing recognition of racial disparities in medicine, which are also relevant to the operative care of spinal disorders. These inequalities have been widely reported and include decreased access to imaging modalities [1], decreased hospitalization rates [2], and disparities in procedure utilization amongst non-White patients [3]. Black patients, for example, are less likely to undergo spine fusion surgeries than White patients with similar pathologies [4–6]. More worrisome is that when minority patients do undergo spinal fusion procedures, they often experience inferior post-operative outcomes [5,7], incur more costs [3,8,9], and experience increased morbidity and mortality [4,8,10–13]. However, these findings have been largely reported from datasets where mi-

nority patients were underrepresented. It has been suggested that race alone is not sufficient to prognosticate outcomes, and that race, contextualized, within a specific community or region offers more insightful foresight. This study aimed to determine if minority patients experience inferior early post-operative outcomes after spinal fusion procedures at a medical center that serves a primarily minority population.

Materials and methods

Study design

We retrospectively reviewed all TLIFs done between June of 2016 and October of 2019. Institutional Review Board approval was obtained

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from the institutional IRB prior to study initiation. As this was a retrospective review, consent was not necessary for data collection.

Inclusion and exclusion criteria

Patients eligible for inclusion in the study were those who (1) underwent a TLIF procedure during the study period, (2) patients indicated for a spinal fusion procedure, (3) patients with available demographic, radiologic, treatment, and outcome data, (3) patients with minimum of 30-day post-operative follow up data. Patients younger than 18 years of age, or patients presenting with acute traumatic injuries, infections or tumors were excluded.

Demographics and variables

Data collection included the following demographic variables: patient age, sex, and body mass index (BMI). Comorbidities which have been previously associated with inferior peri-operative outcomes were recorded, including diabetes, hypertension, end-stage renal disease (ESRD), chronic kidney disease (CKD), history of renal transplant, coronary artery disease (CAD), chronic heart failure (CHF), history of cancer, history of IV drug use, and history of previous myocardial infarction (MI). Patient variables and preoperative variables collected included smoking status, history of alcohol use, history of prior spinal surgery and/or history of spinal revision surgery, listhesis grade, serum sodium, hemoglobin (Hgb), white blood cell (WBC) count, platelet (PLT) count, and serum albumin. Operative variables included number lumbar levels fused, intra-operative time, and estimated blood loss (EBL). Post-operative variables included days to patient-controlled analgesia (PCA) stop, post-operative hemoglobin on post-operative day 0 (POD 0 Hgb) and, POD 1 Hgb, and lowest Hgb.

Primary outcome measures

The primary outcomes studied were (1) length of stay (LOS), (2) discharge disposition, which was defined as home discharge versus non-home, (3) 30-day return to the emergency department, (4) 30-day readmission rate and (5) 30-day complication rates. Post-operative complications were monitored for all patients and included surgical site infection, urinary tract infection (UTI), symptomatic deep vein thrombosis (DVT, symptomatic pulmonary embolism (PE), post-operative pneumonia (PNA), myocardial infarction (MI), acute kidney injury (AKI) and return to the operating room.

Statistical analysis

Parametric data were expressed as means \pm standard deviation (SD) and compared via ANOVA. Nonparametric data were expressed as median (interquartile range) and compared via the Mann-Whitney *U* test. Nominal data were compared with the χ^2 test. All tests were two sided and were statistically significant if the $p < 0.05$. Apriori power analysis was performed using "IBM SPSS 21" which determined that a sample size of 37 patients per cohort would be sufficient to detect significant differences in LOS, discharge disposition, 30-day return to the ED, and 30-day readmission rates at an alpha error of 0.05 and a beta error of 0.08.

Results

Demographics

A total of 156 patients met the inclusion criteria for this study. This cohort was comprised of 54 White patients, 50 Black patients, and 52 Hispanic patients. The mean age of White patients was 58.4 ± 11.9 years old, Black patients was 58.1 ± 7.8 years old, and Hispanic patients was 58.6 ± 11.2 . This did not differ significantly between groups ($p = 0.98$).

The gender ratios did not differ significantly between cohorts ($p = 0.14$) (Table 1). Hispanic patients were found to have significantly higher rates of chronic kidney disease (CKD) ($p = 0.01$) and coronary artery disease (CAD) ($p = 0.04$).

No other differences were present between patient groups in terms of demographic characteristics or comorbidities such as smoking status, alcohol use, history of cancer, diabetes, hypertension, COPD, hyperlipidemia, end-stage renal disease (ESRD), history of renal transplant, or IV-drug use. Demographic data organized by group can be seen in Table 1.

Pre-operative, intra-operative, and post-operative variables

The patient cohorts did not differ in history of prior spinal surgery ($p = 0.69$) or listhesis grade ($p = 0.21$). In patients without spondylolisthesis, the indications for fusion included >3 mm of instability on flexion-extension radiographs, decompression requiring bilateral facetectomy, and >2 repeated discectomies. Pre-operative lab work, including serum sodium, hemoglobin, white blood cell count, platelet count, and serum albumin did not differ between groups (Table 2). Patient groups did not differ in number of levels fused ($p = 0.19$), estimated blood loss (EBL) ($p = 0.49$), or in need for post-operative transfusion ($p = 0.85$). Post-operatively, patients stopped PCA use at similar times (White: 1.6 ± 1.5 days, Black: 1.8 ± 1.7 days, and Hispanic: 1.3 ± 1.4 days, ($p = 0.32$). Post-operative hemoglobin levels did not differ between groups on POD 0 ($p = 0.50$) or POD 1 ($p = 0.98$).

Primary outcomes

Patient groups did not differ in terms of length of stay, with a mean LOS of 6.2 ± 5.5 , 6.1 ± 3.3 , and 5.9 ± 3.4 for the White, Black, and Hispanic cohorts, respectively ($p = 0.92$). There was no difference in discharge disposition between groups, with 66.7%, 56%, and 63.5% of White, Black, and Hispanic patients being discharged home, respectively ($p = 0.52$).

The rate of post-operative complications, including infection, UTI, symptomatic DVT/PE, post-surgical pneumonia, myocardial infarction, and acute kidney injury, did not differ between groups (Table 3). Approximately 3.7% of White patients underwent re-operation vs. 2% of Black patients and no Hispanic patients; however, this was not statistically significant ($p = 0.381$). Hispanic patients did demonstrate an increased rate of return to the ED when compared to other groups with 16 ED visits in contrast to 8 in the White group and 5 in the Black group ($p = 0.01$). However, 30-day readmission rates did not differ between groups with 3, 2, and 2 readmissions in the White, Black, and Hispanic groups, respectively ($p = 0.90$).

Discussion

This retrospective cohort study of patients undergoing TLIF procedures, which included a large proportion of minority patients, demonstrated no racial disparities in terms of length of stay (LOS), discharge disposition, post-operative complication rates, and 30-day readmission rates. However, there was a significantly higher rate of 30-day post-operative ED visits among Hispanic patients.

Length of stay (LOS)

Minority patients have been reported to have longer post-operative hospital stays when compared to their White counterparts [3,7–9]. A recent retrospective cohort study, by Reyes *et al.*, evaluated national discharge data of over 149,000 patients who underwent a lumbar spinal fusion in 2016. The authors reported that Black and Hispanic patients had longer LOS and higher rates of prolonged LOS than White patients who underwent the same procedure [3]. In the present study, there were no significant difference in LOS between groups. In the aforementioned

Table 1
Baseline demographic and comorbidity data of patients who underwent TLIF procedure.

| (n = 156) | White (n = 54) | Black (n = 50) | Latino/Hispanic (n = 52) | p Value |
|----------------------------|-------------------|-------------------|-----------------------------|---------|
| Demographics | | | | |
| Mean age (yrs) | 58.4 ± 11.9 | 58.1 ± 7.8 | 58.6 ± 11.2 | 0.98 |
| Male (%) | 44.4 | 26.0 | 38.5 | 0.14 |
| BMI (kg/m ²) | 31.4 ± 6.0 | 31.3 ± 6.1 | 31.1 ± 5.2 | 0.97 |
| Comorbidities | | | | |
| Hypertension (%) | 72.2 | 82.0 | 76.9 | 0.50 |
| Diabetes (%) | 29.7 | 46 | 51.9 | 0.06 |
| HbA1c (%) | 6.1 ± 1.6 | 6.3 ± 1.5 | 6.5 ± 1.2 | 0.53 |
| Smoker (%) | 55.0 | 60.0 | 44.2 | 0.29 |
| COPD (%) | 18.5 | 16.0 | 13.5 | 0.78 |
| ESRD (%) | 1.9 | 2.0 | 3.8 | 0.77 |
| Hx of Renal Transplant (%) | 1.9 | 2.0 | 3.8 | 0.77 |
| CKD (%) | 9.3 | 18.0 | 32.7 | 0.01 |
| Hyperlipidemia (%) | 38.9 | 50.0 | 59.6 | 0.10 |
| CAD (%) | 13.0 | 2.0 | 17.3 | 0.04 |
| CHF (%) | 0.0 | 4.0 | 5.8 | 0.22 |
| Hx of Cancer (%) | 9.3 | 10.0 | 7.7 | 0.92 |
| EtOH (%) | 35.2 | 42.0 | 36.5 | 0.75 |
| IVDU (%) | 5.6 | 2.0 | 7.7 | 0.42 |

Table 2
Pre-operative metrics.

| (n = 156) | White (n = 54) | Black (n = 50) | Latino/Hispanic (n = 52) | p Value |
|----------------------------------|-------------------|-------------------|-----------------------------|---------|
| Spinal Surgical History | | | | |
| Hx of Prior Spinal Surgery | 0.9 ± 1.7 | 0.9 ± 1.9 | 1.2 ± 1.8 | 0.69 |
| Revision of Previous Surgery (%) | 11.1 | 4.0 | 19.2 | 0.06 |
| Listhesis Grade | | | | |
| Grade 0 (%) | 18.5 | 10.0 | 17.3 | 0.21 |
| Grade 1 (%) | 68.5 | 66.0 | 73.1 | |
| Grade 2 (%) | 13.0 | 24.0 | 7.7 | |
| Grade 3 (%) | 0.0 | 0.0 | 1.9 | |
| Pre-Operative Lab Values | | | | |
| Sodium (mEq/L) | 140.2 ± 4.7 | 141.8 ± 2.8 | 140.8 ± 3.2 | 0.09 |
| Hgb (g/dL) | 13.1 ± 2.2 | 12.7 ± 1.5 | 12.6 ± 1.6 | 0.26 |
| WBC (/mm ³) | 7.8 ± 2.5 | 7.2 ± 2.5 | 7.3 ± 2.0 | 0.34 |
| PLT (/mm ³) | 251.3 ± 80.1 | 275.6 ± 81.0 | 262.5 ± 74.7 | 0.29 |
| Albumin (g/dL) | 4.1 ± 0.7 | 4.4 ± 1.5 | 4.3 ± 0.4 | 0.38 |

Table 3
Major outcomes.

| (n = 156) | White (n = 54) | Black (n = 50) | Latino/Hispanic (n = 52) | p Value |
|-------------------------------------|-------------------|-------------------|-----------------------------|---------|
| Primary Outcome Measures | | | | |
| Length of Stay (days) | 6.2 ± 5.5 | 6.1 ± 3.3 | 5.9 ± 3.4 | 0.92 |
| Discharge Disposition to Home (%) | 66.7 | 56.0 | 63.5 | 0.52 |
| ED visits within 30 days (%) | 14.9 | 8.0 | 30.8 | 0.01 |
| Readmission to Hospital (%) | 5.6 | 4.0 | 3.8 | 0.90 |
| Re-operation (%) | 3.7 | 2.0 | 0.0 | 0.38 |
| Post-Operative Complications | | | | |
| Infection (%) | 9.3 | 4.0 | 0.0 | 0.07 |
| UTI (%) | 1.9 | 6.0 | 3.8 | 0.55 |
| DVT (%) | 1.9 | 2.0 | 7.7 | 0.21 |
| PNA (%) | 0.0 | 4.0 | 1.9 | 0.33 |
| PE (%) | 0.0 | 6.0 | 1.9 | 0.14 |
| MI (%) | 0.0 | 0.0 | 0.0 | N/A |
| AKI (%) | 9.3 | 2.0 | 7.7 | 0.29 |

study, Black and Hispanic patients made up a total of 11.9% of the cohort (7.4% and 4.5%, respectively), while White patients made up the rest [3]. This is in contrast to our cohort, which was comprised of 34.6% White patients, 32.1% Black patients, and 33.3% Latino patients. Reyes *et al.* found the average LOS to be 3.73, 4.35, and 4.07 days for White, Black, and Hispanic patients, respectively [3]. The average LOS in our cohort was 6.2, 6.1, and 5.9 for the White, Black, and Hispanic cohorts, respectively.

The discrepancies in LOS between studies may be secondary to differences in diversity among the cohorts. Other considerations that may account for these differences are that the current study addresses a single institution's experience while the aforementioned work investigated national-level data. Furthermore, LOS result discrepancies may be influenced by socioeconomic status, healthcare literacy, and local hospital policies. The relatively long hospital stays reported in this study may be a reflection of institutional policies, regional practices, and the study

period which is comprised of data recorded prior to the implementation of our enhanced recovery after surgery (ERAS) program. Irrespective of long hospital stays, each individual group in our study appeared to receive similar care and have similar discharge courses.

Discharge disposition

Previous literature has reported that minority patients have higher rates of discharge to advanced care facilities when compared to White patients. A 2011 meta-analysis that evaluated outcomes after spinal surgery from 1966 - 2010 found that Black patients were more likely than White patients to have a “complex disposition,” defined as discharge to somewhere other than home or death [7]. In the present study, there were no differences between the Black and White patient populations in terms of discharge disposition. Additionally, there were no differences when considering the Hispanic patients as well.

Post-operative complications

Minority patients have historically experienced higher rates of post-operative complications than White patients [3,7–9]. In a retrospective review of national data, Reyes *et al.* found that Black and Hispanic patients had higher rates of inpatient medical complications than White patients and that Hispanics had higher rates of surgical complications than White patients [3]. In a separate retrospective review of over 2,800 patients who underwent spinal surgery for lumbar stenosis, Black patients were found to have twice the risk of post-operative complications when compared to White patients [8]. This increased risk of complications was noted to be present at both 30-day and 90-day time points. The present study reported similar 30-day complication rates between White, Black, and Hispanic patients. The aforementioned studies by Reyes *et al.* and Lad *et al.* both evaluated national databases where minority patients accounted for 11.9% and 23.2% of the entire patient population, respectively [3,8]. Although no definitive conclusions can be drawn from this data, it is important to note that minority patients made up most (65.4%) of the patients treated in this cohort. Other possible contributors to the similar complication rates between groups may be comparable socioeconomic status, healthcare literacy, and limited access to care in certain communities. The present study is likely underpowered to make meaningful statistical inferences from the complication data reported herein.

Readmission rates

A recent retrospective review of 600 patients, by Adogwa *et al.*, who underwent elective spine surgery at a major medical center reported that Black patients had significantly higher 30-day readmission rates than White patients [14]. In that cohort, the majority of patients were White ($n = 458$). Black patients in that cohort were found to be younger, have significantly higher BMIs ($31.85 \pm 7.89 \text{ kg/m}^2$ vs. $29.90 \pm 7.32 \text{ kg/m}^2$, $p = 0.03$), and a higher prevalence of diabetes (33.8% vs. 18.12%, $p = 0.02$) [14]. The authors reported that in their cohort, BMI and patient race were independent predictors of unplanned readmission within 30-days of discharge [14]. The most common reasons for readmission were a combination of medical and surgical complications, including fever, infection (UTI, pneumonia, surgical site infection), and intractable pain [14]. Much like the present study, this report was a single institution experience. In contrast to the aforementioned study, this study did not demonstrate a significant relationship between race and unplanned readmission. This may be partially explained as the patient population in Adogwa *et al.*'s report was less homogenous than the present study, and Black patients represented a minority (23.7%) of the cohort. Further possible explanations include that BMI and the prevalence of diabetes did not significantly differ in our cohort.

Although 30-day readmission rates did not significantly differ in our cohort, there was a significant difference in 30-day post-operative ED

utilization. Over 30% of Hispanic patients in our cohort utilized the ED in that timeframe compared to 8% of Black patients and 14.9% of White patients. It is unclear what caused this finding, but it may be related to Limited English Proficiency (LEP). A 2005 study performed at our medical center evaluated Hispanic patients with LEP by showing them medication prescriptions and asking them questions regarding medication dosing and timing. The study found that only 22% of study participants dosed medication correctly [15]. Given that this study was performed in the same patient population as the present study, it is possible that limited English proficiency played a role in the increased ED utilization for Hispanic patients. Improving pre-operative physician-patient communication and the clarity of post-operative instructions is an important target for future advancement in the care of minority populations.

Another potential contributor to increased 30-day ED utilization among Hispanic patients in our cohort may be inadequate pain control. A recent retrospective cohort study evaluated the differences in post-operative opioid utilization after spine surgery between racial groups and found that Hispanic patients were prescribed and ultimately dispensed more opioids than other patients [16]. Adequately addressing patients post-operative pain and implementing multimodal pain regimens may help to reduce these ED visits. This area constitutes another target area for improvement in patient care via the newly implemented ERAS program at our institution.

Current findings vs. literature

The findings in this study are in direct contrast to many reports of inferior LOS, discharge disposition, postoperative complication rates, and 30-day readmission rates in spine surgery at various institutions. Recent data from our institution has demonstrated a similar phenomenon with regards to COVID-19 outcomes [17]. In a retrospective study of 5902 patients, performed at our institution, Black and Hispanic patients, who represented 65.1% of the entire cohort, did not experience worse outcomes when compared to their White counterparts [17]. We mention this study, as the majority of literature reports inferior outcomes in minority populations. The unique institutional expertise in providing care to minority patients is demonstrated again in the aforementioned study and might suggest that racial disparities are at least, in part, a function of location, population composition, and other similar factors that likely contribute in myriad ways to the delivery of care.

Limitations

The limitations of this study include that it is a relatively small retrospective study performed at a single institution with multiple spine surgeons. Our center serves a patient population comprised of predominantly minority ethnic and racial groups. Other factors that may contribute to the disparities noted in this study include patient educational level, English literacy, social support, and prior narcotic use before surgery. Controlling further for insurance type and using patient zip codes as a surrogate for socioeconomic status could have improved the quality of the data in this manuscript. Additionally, further data regarding the highest educational level achieved and employment status would help to further inform socioeconomic data in this manuscript. This data was not fully available or obtainable. Lastly, given the relatively small sample size, it is possible that the outcomes of this study are subject to type II error.

Conclusion

In this diverse cohort of spine fusion patients, we found no racial disparities in terms of LOS, discharge disposition, or 30-day readmission rates, suggesting care is being delivered in an equitable and unbiased manner. Hispanic patients had increased utilization of the emergency room in the early post-operative period. Efforts to overcome language barriers, communicate instructions clearly, and outline post-operative

expectations and plans may allow for fewer post-operative ED visits amongst Hispanic patients. This study, at a minimum, suggests that equitable outcomes can be achieved among various patient populations and that inherent racial, social, or cultural differences do not appear in and of themselves to dictate variable results following TLIF surgery. By better understanding the different needs, customs, and challenges specific to individual racial/ethnic groups we can better address common aims such as safe surgery, adequate discharge instructions and pain control, among others.

Declaration of Competing Interest

There are no financial conflicts of interest to disclose.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:[10.1016/j.xnsj.2022.100171](https://doi.org/10.1016/j.xnsj.2022.100171).

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