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# Racial disparities in patients with proliferative diabetic retinopathy treated with pars plana vitrectomy in an underserved population

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## Abstract

**Background** Proliferative diabetic retinopathy (PDR) is a serious microvascular complication of diabetes that can lead to irreversible vision loss. Prior research studies have documented how racial minorities with PDR experience less routine screening, less frequent treatment, and more complications. Although pars plana vitrectomy (PPV) is a widely used treatment modality for PDR, minimal research is currently available addressing how race impacts surgical presentation and outcomes.

**Methods** This study is a retrospective case series involving a sample of patients who underwent PPV for PDR at a county hospital between January 1, 2014, and December 30, 2019. Patients were included if they had a follow-up period of at least six months. The data collection included demographic data, medical history, surgical indications, operative outcomes, and complications. Snellen best corrected visual acuity (BCVA) was converted to logMAR for data analysis. Statistical analysis included chi-square testing, analysis of variance, generalized linear modeling, and multivariate analysis.

**Results** The study cohort consisted of 715 patients (915 eyes) receiving PPV for the treatment of PDR. In the patient cohort, 576 patients were Hispanic (80.6%), 103 patients were Black (14.4%), and 36 patients were Non-Hispanic White (5.0%). The majority of the patient cohort (75%) received charity insurance. Black patients had significantly higher pre-operative HbA1c levels than Hispanic patients (8.779 vs. 8.271, $p=0.011$). Black patients were more likely to undergo surgery for a TRD than Hispanic patients (OR: 0.901, $p<0.001$) and White patients (OR: 0.870, $p<0.001$) and were more likely to have macula-involving TRDs compared to Hispanic patients (OR: 1.194, $p<0.001$) and White patients (OR: 1.289, $p=0.005$). Based on the multivariate analysis performed, race did not impact surgical outcomes, including post-operative visual acuity, anatomic success rate, and the need for a repeat surgery.

**Conclusions** The main findings of this study indicate that Black patients are receiving surgery when they have more advanced diabetic retinopathy. However, there were no significant differences in surgical outcomes.

**Keywords** Racial disparities, Diabetic retinopathy, Pars plana vitrectomy, Diabetes

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## Background

Proliferative diabetic retinopathy (PDR) is a serious microvascular complication of diabetes that can lead to irreversible vision loss. It is the most severe form of eye disease in both type 1 and type 2 diabetes. With the expansion of screening programs, the prevalence of non-proliferative diabetic retinopathy and proliferative diabetic retinopathy among diabetic patients in the United States is 22% and 6% respectively [1], making this clinical course a significant public health issue.

Previous studies have shown that social determinants of health play a role throughout the clinical course of diabetic retinopathy. Racial and ethnic minorities experience inadequate screening [2]. Poor housing conditions and the absence of a regular medical provider are correlated with worse adherence to appropriate eye exams [3]. In regard to disease development, racial minorities are more likely to suffer from complications of diabetes [4]. For patients who develop diabetic retinopathy, education, economic stability, and race can be associated with outcomes [5]. Moreover, a recent study showed that Hispanic and Black patients, along with patients on Medicaid, were started on anti-VEGF therapy when their baseline diabetic retinopathy and best-corrected visual acuity (BCVA) were much worse than patients from other race categories and with private insurance coverage [6]. Regarding diabetic macular edema, Black patients received fewer anti-VEGF injections over the course of one year than White patients. Lower incomes were also associated with fewer injections [7].

Although pars plana vitrectomy (PPV) is a widely used treatment modality, there is currently minimal research considering how social determinants of health may impact patient outcomes. With the important role this surgery plays in the treatment of severe PDR, and with diabetes and its sequelae disproportionally affecting racial minorities, it is important to understand how a patient's background affects their treatment success [2–6]. This study aims to explore the impact of race on disease severity at the time of surgery and the surgical outcomes of PPV for PDR patients. The overall surgical outcomes of this cohort have already been analyzed and published in 2024 [8]. This study utilizes the same data set, specifically exploring the impact of race on outcomes.

## Methods

This study is a retrospective case series involving a sample of patients who underwent PPV at a county hospital between January 1, 2014, and December 30, 2019. This study was in strict accordance with the Declaration of Helsinki. It was approved by the Ethics Committee of the University of Texas Southwestern Medical Center and the University of Texas Southwestern Institutional Review Board (STU-2020-0519). The requirement for informed consent of human subjects was waived due to the retrospective nature of the study and the minimal risk to subjects. Patients with a surgical indication other than PDR and patients with less than 6 months of follow up were excluded. Hispanic patients, Non-Hispanic White patients, and Black patients were the only racial groups included in this study. Other racial groups were excluded due to small sample size and incomplete data.

Following patient identification, a chart review was performed. The data collection included demographic data, medical history, surgical indications, operative outcomes, and complications. Racial data was self-reported by patients. Snellen BCVA was converted to logMAR for data analysis.

Patient zip code information was collected to estimate income levels. Using United States Census Bureau data, we identified the median household income of the patients' zip codes for all five years of the study period. These values were averaged together as the mean income for a particular zip code in the study timeframe [9]. This income number was used to calculate the average income of the overall cohort and racial subgroups.

Patients were divided by race for data analysis. Demographic data (as found in Table 1) was analyzed using ANOVA and chi-square testing. Other data was analyzed using multivariate generalized linear models, with racial category as the fixed factor. Multiple imputations were utilized to account for missing data points. Additional separate multivariate analyses were performed based on the classification of diabetes (Type 1 and Type 2) and can be found in the appendix (Tables A-D). Surgical outcomes were analyzed using multivariate analysis with likelihood-ratio testing.

## Results

The study cohort consisted of 715 patients (915 eyes) receiving PPV for the treatment of PDR. Of the surgeries, 48.5% were performed on the right eye (444 eyes) and 51.5% were performed on the left eye (471 eyes). There were 384 male patients (53.7%). In the patient cohort, 576 patients were Hispanic (80.6%), 103 patients were Black (14.4%), and 36 patients were Non-Hispanic White (5.0%; Table 1). The patients had an average follow up time of 33.5 months +/- 21.1 months. Of the cohort, 3.5% had type 1 diabetes mellitus (25 patients) and 96.5% had type 2 diabetes mellitus (690 patients). There was a greater proportion of type 1 diabetes in Black patients than in Hispanic patients (8.7% vs. 2.6%; $p = 0.01$). Among the entire cohort, 539 patients (75.4%) used charity insurance, 60 patients (8.4%) used Medicaid, 59 patients (8.3%) used Medicare, and 57 patients (8.0%) used commercial insurance. In our study, charity insurance refers to a financial assistance program available for low-income patients that covers 100% of medical expenses for county

**Table 1** Study population demographics

| | All Patients ($n=715$) | Hispanic Patients ($n=576$) | Black Patients ($n=103$) | Non-Hispanic White Patients ($n=36$) | $p$-value |
|---|---|---|---|---|---|
| **Sex** | | | | | 0.11 |
| Male (%) | 384 (53.7) | 308 (53.5) | 51 (50.0) | 25 (69.4) | |
| Female (%) | 331 (46.3) | 268 (46.5) | 52 (50.0) | 11 (30.6) | |
| **Age** | | | | | 0.25 |
| Mean | 52.0 | 52.3 | 50.7 | 51.3 | |
| **Disease Classification** | | | | | **0.01** |
| Type 1 (%) | 25 (3.5) | 15 (2.6) | 9 (8.7) | 1 (2.8) | |
| Type 2 (%) | 690 (96.5) | 561 (97.4) | 94 (91.3) | 35 (97.2) | |
| **Insurance** | | | | | **<0.01** |
| Charity (%) | 539 (75.4) | 451 (78.3)_ | 59 (57.3) | 29 (80.6) | |
| Medicaid (%) | 60 (8.4) | 46 (8.0) | 11 (10.7) | 3 (8.3) | |
| Medicare (%) | 59 (8.3) | 38 (6.6) | 19 (18.4) | 2 (5.6) | |
| Commercial (%) | 57 (8.0) | 41 (7.1) | 14 (13.6) | 2 (5.6) | |
| **Estimated Income** | | | | | 0.54 |
| Mean | 52,594 | 52,363 | 55,578 | 52,394 | |

Charity insurance refers to a financial assistance program available for patients with an income below a certain threshold who lived in the county of the county hospital. The financial assistance program covers 100% of medical expenses for the patient when they receive care at that specific hospital (i.e. the patients do not pay any co-pay or receive any charges). Commercial insurance refers to insurance not provided by a government entity. This insurance is either employer-sponsored or privately purchased. Medicaid is a government provided health insurance at the federal level for low-income families and individuals. Medicare is a government provided health insurance provided primarily provided to patients over the age of 65. Medicare can be further supplemented with commercial insurance. Estimated income was based on the median household income of the population within the patient's zip code per US census bureau data averaged over the five-year data collection period

residents. Hispanic patients were more likely to have charity insurance than Black patients (78.3% vs. 57.3%, $p<0.01$) and less likely to have commercial insurance than Black patients (8.0% vs. 13.6%; $p<0.01$). Patients were scheduled at the ophthalmology clinic by internal referral, external referral, or after presenting to the emergency department. Overall, 64% of patients were scheduled via internal referral, 5% of patients were scheduled via external referral, and 31% of patients were scheduled after appearing in the emergency department. The interval from referral to the first appointment was 57.4 days on average. There was no significant difference in the time interval from referral between racial groups. The estimated median income of each racial group is listed in Table 1. Notably, the median income of a resident in Dallas County during the same time period was $52,576. (Insert Table 1)

The presence of co-morbidities that may indicate extensive microvascular disease, including chronic kidney disease (CKD), dialysis, and neovascularization of the anterior segment, were analyzed by racial group (Table 2). Black patients were more likely to have CKD than Hispanic patients (OR: 1.095, $p=0.024$). Black patients were also more likely to be on dialysis (OR: 1.055, $p=0.027$) and have neovascularization of the anterior segment (OR: 1.038, $p=0.007$) than White patients. Similarly, Hispanic patients were more likely to be on dialysis (OR: 1.074, $p=0.004$) and have neovascularization of the anterior segment (OR: 1.060, $p<0.001$) than White patients. (Insert Table 2) Blood glucose control at the time of surgery was estimated by the patient's A1c. Black patients had significantly higher A1c levels than Hispanic patients (8.779 vs. 8.271, $p=0.011$; Table 3). (Insert Table 3)

Insulin usage and prior ocular therapies for diabetic retinopathy were analyzed. Hispanic patients (OR: 0.858, $p<0.001$) and Black patients (OR: 0.897, $p=0.002$) were more likely to be on insulin therapy at the time of surgery than White patients. Black patients were also more likely to have received prior PRP (OR: 1.087, $p=0.03$) and prior anti-VEGF injections (OR: 1.093, $p=0.018$) than White patients.

Patients were referred for PPV surgery due to vitreous hemorrhage (VH), tractional retinal detachment (TRD), and/or vitreomacular interface (VMI) abnormalities (Table 2). Patients were classified as having a surgical indication of TRD if one was present, regardless of the presence of VH or a VMI abnormality. Similarly, if a patient had both a VMI abnormality and VH, then the patient was classified as having a surgical indication of a VMI abnormality. Black patients were more likely to undergo surgery for a TRD than Hispanic patients (OR: 0.901, $p<0.001$) and White patients (OR: 0.870, $p<0.001$). The patients with TRDs were further divided into those with macula-involving and macula-sparing detachments. Black patients were significantly more likely to have a macula-involving TRD than Hispanic patients (OR: 1.194, $p<0.001$) and White patients (OR: 1.289, $p=0.005$). The number of patients with combined tractional and rhegmatogenous retinal detachment pathology

**Table 2** Comorbidities, prior treatments, indications, and complications of patients undergoing PPV for PDR

| Dependent Variable | Odds Ratio: Hispanic vs. White | *p*-value | Odds Ratio: Black vs. White | *p*-value | Odds Ratio: Black vs. Hispanic | *p*-value |
|---|---|---|---|---|---|---|
| CKD | 0.956 | 0.263 | 1.047 | 0.254 | 1.095 | **0.024** |
| Dialysis | 1.074 | **0.004** | 1.055 | **0.027** | 0.984 | 0.503 |
| NVI/NVG/NVA | 1.060 | **< 0.001** | 1.038 | **0.007** | 0.980 | 0.160 |
| Insulin Use | 0.858 | **< 0.001** | 0.897 | **0.002** | 1.046 | 0.210 |
| Prior PRP | 1.029 | 0.446 | 1.087 | **0.030** | 1.055 | 0.158 |
| History of Prior Anti-VEGF Injections | 1.046 | 0.232 | 1.093 | **0.018** | 1.045 | 0.241 |
| Pre-Operative Anti-VEGF Injection* | 0.882 | **0.003** | 0.937 | 0.125 | 1.063 | 0.131 |
| Surgical Indication: VH | 0.963 | 0.144 | 0.870 | **< 0.001** | 0.901 | **< 0.001** |
| Surgical Indication: TRD | 1.037 | 0.348 | 1.209 | **< 0.001** | 1.166 | **< 0.001** |
| Macula-involving TRD | 1.080 | 0.425 | 1.289 | **0.005** | 1.194 | **< 0.001** |
| Surgical Indication: VMI Abnormalities | 0.980 | 0.537 | 0.980 | 0.535 | 1.000 | 0.988 |
| Surgical Complication: VH | 1.002 | 0.968 | 1.040 | 0.373 | 1.038 | 0.368 |
| Surgical Complication: Elevated IOP | 0.972 | 0.394 | 1.061 | 0.066 | 1.091 | **0.007** |
| Surgical Complication: Re-detachment Post Surgery* | 1.060 | 0.313 | 1.057 | 0.302 | 0.997 | 0.917 |
| Surgical Complication: RRD | 1.033 | 0.208 | 1.005 | 0.805 | 0.973 | 0.144 |
| Surgical Complication: Endophthalmitis | 1.014 | 0.420 | 1.010 | 0.576 | 0.986 | 0.420 |
| Surgical Complication: Cataract | 1.085 | **0.047** | 0.999 | 0.975 | 0.920 | **0.043** |

Insulin use was based on the patient's diabetic treatment regimen at the time of surgery. *Pre-operative anti-VEGF injections were injections within 7 days of PPV surgery. Other anti-VEGF injections were counted under a history of prior anti-VEGF injections. The presence of surgical complications was analyzed six months after surgery. **Re-detachment post-surgery only includes patients who initially received surgery for a tractional retinal detachment. This was assessed six months after surgery. CKD = chronic kidney disease, NVI = neovascularization of the iris, NVG = neovascular glaucoma, NVA = neovascularization of the angle, PRP = panretinal photocoagulation, VH = vitreous hemorrhage, TRD = tractional retinal detachment, VMI = vitreomacular interface, IOP = intraocular pressure, RRD = rhegmatogenous retinal detachment

**Table 3** Visual acuities and A1c of patients undergoing PPV

| Dependent Variable | Hispanic Patients: Mean (Std.Deviation) | White Patients: Mean (Std.Deviation) | Black Patients: Mean (Std.Deviation) | *p*-value: Hispanic vs. White | *p*-value: Black vs. White | *p*-value: Black vs. Hispanic |
|---|---|---|---|---|---|---|
| A1c | 8.271 (2.100) | 8.329 (1.803) | 8.779 (2.349) | 0.877 | 0.238 | **0.011** |
| Pre-op BCVA | 1.699 (0.675) | 1.833 (0.693) | 1.659 (0.669) | **0.012** | **0.001** | 0.448 |
| Post-op BCVA | 1.051 (0.864) | 1.264 (0.865) | 1.15 (0.842) | 0.082 | 0.463 | 0.116 |
| Change in BCVA | -0.649 (0.939) | -0.569 (0.908) | -0.508 (0.934) | 0.500 | 0.695 | 0.297 |

A1c was at the time of surgery. Post-operative BCVA was measured six months after surgery. BCVA = best corrected visual acuity

**Table 4** Multivariate analysis on the impact of race on outcome measures

| Outcome | Log Likelihood with Race | Log Likelihood without Race | *p*-value |
|---|---|---|---|
| Repeat Surgery | 345 | 347.7 | 0.067 |
| Post-operative Visual Acuity of 20/40 or Better | 292.3 | 295 | 0.067 |
| Post-operative Visual Acuity of 20/200 or Worse | 352.8 | 353.9 | 0.333 |
| First Surgery Anatomic Success Rate | 124.2 | 124.6 | 0.670 |

These outcome measures were analyzed with multivariate analysis utilizing the variables previously mentioned in the manuscript. This table displays the impact of race on the model. First surgery anatomic success rate includes only patients with a tractional retinal detachment at the time of surgery. Patients were classified as having anatomic success if the retina was attached 6 months post-surgery

was small, so this information was not included in the tables or analysis. TRDs were detected an average of 83.7 days prior to surgery. The time from detection to surgery was not significantly different across racial groups.

Surgical outcomes were analyzed by racial categories. White patients had significantly worse pre-operative BCVA than Hispanic patients (1.833 vs. 1.699, $p = 0.012$) and Black patients (1.833 vs. 1.659, $p = 0.001$). There were no significant differences in post-operative visual acuities or in the change in visual acuity after surgery (Table 3). Surgical complications were analyzed six months after surgery (Table 2). Race was not a predictive factor for post-operative visual acuity, first surgical success rate, or the need for repeat surgery (Table 4).

## Discussion

This study proposes possible racial disparities particularly impacting Black patients in the presentation of PDR requiring PPV surgery. Disparities in ophthalmic care have long been reported. Two decades ago, the Salisbury eye evaluation study showed that African American patients had a 4-fold increase in vision loss when compared to non-Hispanic White patients [10]. Further national surveys within the following decade showed that Black patients had higher rates of diabetic retinopathy, macular edema, and glaucoma [11–13]. These findings have been further corroborated by recent national studies, such as an IRIS registry-based study which reported a higher proportion of glaucoma in Black patients [14]. While past studies have focused on comparisons with non-Hispanic White patients, our study includes direct comparisons with Hispanic patients, another historical minority group. Multiple prior studies have shown higher rates of diabetic retinopathy and its complications among both Hispanic and Black patients [15, 16]. In our study, however, worse clinical presentations were noted for Black patients despite treatment under one hospital system with similar estimated income levels among patients. There are notable challenges within this particular hospital system due to the patient volume and significant needs of the patient population, but the available data did not show differences in referral patterns or the time from referral to first appointment by racial group that could account for the differences noted in this study.

It's important to recognize that Hispanic and Black patients are already at an increased risk of developing diabetic retinopathy [15]. The main findings of this study indicate that Black patients are receiving surgery when they have more advanced disease progression. Black patients had significantly worse presenting A1c compared to Hispanic patients. Black patients also had high rates of CKD and dialysis, indicating likely substantial systemic microvascular disease. Additionally, Black patients had worse diabetic retinopathy at presentation as shown by a greater TRD rate than both Hispanic and White patients. They were also more likely to have neovascularization of the anterior segment than White patients. While Black patients in our study had the highest percentage of type 1 diabetes, which may result in greater disease progression due to long-standing disease, Black patients with type 1 diabetes did not have a higher presenting A1c or a significantly higher percentage of TRDs. Thus, the disparities in presentation likely cannot be attributed to the high percentage of type 1 diabetics amongst Black patients in our cohort. The data was further analyzed by the classification of diabetes (Type 1 and Type 2) and can be found in the appendix (Tables A-D).

Notably, it is well documented in the literature that Black patients experience longer wait times for surgery [17–19], and have worse disease when initiating therapies [6]. Access to care may account for these disparities. Multiple studies have shown that Black patients are less likely to regularly see an ophthalmologist for eye exams [2, 20]. which likely contributes to a later surgery consultation. There are several other possible contributing factors. Historical abuses and microaggressions have contributed to distrust amongst Black patients that persist [21]. Prior studies have also shown that Black patients have higher odds of reporting delayed care due to transportation barriers [22]. Additionally, Black patients have disproportionately less spatial access to care, with longer travel times than other patients, even when adjusting for racial disparities in socioeconomic status and car access. This may limit the ability of Black patients to attend regular healthcare visits [23]. Black patients are also less likely than White patients to utilize a primary care provider as their usual source of care, which may delay referral and access to a specialist [24].

While disparities in presentation and outcome have previously been reported for Hispanic and Black patients compared to White patients, this study highlights disparities between Black and Hispanic patients that are present even under the same hospital system. Three decades ago, the Beaver Dam Study showed that Hispanic patients had a 2-fold rate of macular edema compared to White patients [25]. This contrasts with the 3- fold risk of macular edema reported in the VADT [11] for Black patients compared to White patients. Considering that the results of our study revealed greater rates of TRDs for Black patients, it appears that disparities may be especially great for Black patients when seeking care for advanced diabetic retinopathy. There are various possible reasons for these healthcare disparities among two historically disadvantaged racial groups, including cultural differences (e.g. familism in Hispanic communities) [26, 27]. Black patients also are more likely to have co-morbid hypertension and more likely to smoke than Hispanic patients, both of which can accelerate the progression of diabetic retinopathy [28, 29]. Additionally, Hispanic patients have historically experienced better health outcomes than what would be predicted due to socioeconomic factors. This phenomenon has been acknowledged in several studies, and the reasons for these unexpected outcomes are still under investigation. Interestingly, this paradox is most pronounced in first-generation immigrants, which make up a considerable population in the studied area. Health tends to decline with subsequent generations, likely with further simulation into American culture and lifestyle [30].

In our study, median income did not significantly differ among race categories, which leads us to believe that the patient's income category had little influence on the disparities noted in this study. This indicates that

racial disparities in diabetic retinopathy care may not be attributed to socioeconomic factors alone. However, it's important to recognize we did not assess outcomes based on individual incomes. Additionally, there are limitations to comparing medians, and we did not consider income variability within the racial groups.

Interestingly, Black patients had a much higher rate of private insurance than Hispanic patients, who were more likely to rely on charity insurance provided by the county hospital. One possible explanation is that a significant portion of the Hispanic population in the Dallas area consists of immigrants, including undocumented individuals who are often ineligible for private insurance or national public insurance programs. Additionally, Black workers have the highest union representation of any ethnic group, and workers in unions are far more likely to receive health insurance through their employers [31]. However, Black patients still had worse disease at the time of surgery despite higher rates of private insurance.

This study has several limitations that limit its generalizability. The sample sizes differ vastly among race categories with Hispanic patients being overrepresented and White patients being underrepresented. These patients do not reflect national or state demographics and include only three racial categories. Moreover, analysis is limited to a single county hospital over a 5-year period. This study does not reflect the diversity of health care systems within the United States. Additionally, a portion of the TRDs within the study could not be definitively classified as macula involving or macula sparing based on the medical documentation, which may have impacted the data. Finally, income analysis was limited to census data from zip code information and may not reflect the actual income of patient population; further prospective characterization may be useful to assess the effect of income on outcomes. Future studies could match age, sex and income and include more race categories and hospital systems. Further studies could also include interviews or in-depth analysis of patients belonging to various race categories to characterize possible influences on healthcare disparities among groups.

## Conclusion

In conclusion, this study underscores the persistent and pronounced healthcare disparities in the presentation and outcomes of PDR among different racial groups, particularly highlighting the significant discrepancies between Black and Hispanic patients. These disparities persisted despite all treatment being provided under a single hospital system. Further investigations are crucial to comprehensively delineate the intricate factors contributing to these disparities and devise targeted interventions for equitable healthcare delivery across diverse patient populations.

**Abbreviations**

| | |
|---|---|
| PDR | Proliferative diabetic retinopathy |
| BCVA | Best corrected visual acuity |
| PPV | Pars plana vitrectomy |
| ANOVA | Analysis of variance |
| VH | Vitreous hemorrhage |
| TRD | Tractional retinal detachment |
| VMI | Vitreomacular interface |

## Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12886-025-04037-4.

Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

Supplementary Material 4

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**Author contributions**
Design of the work (KT, AA, AW), acquisition of data (KT, AA), data analysis and interpretation (KT, AA), writing and revising the manuscript (KT, AA, AW), approved of the final manuscript for submission (KT, AA, AW).

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**Data availability**
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Declarations

**Ethics approval and consent to participate**
This study was in strict accordance with the Declaration of Helsinki. It was approved by the Ethics Committee of the University of Texas Southwestern Medical Center and the University of Texas Southwestern Institutional Review Board (STU-2020-0519). The requirement for informed consent of human subjects was waived due to the retrospective nature of the study and the minimal risk to subjects.

**Consent for publication**
Not applicable.

**Competing interests**
The authors declare no competing interests.

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