Demographic Differences in MRI Presentation and Management of Foot Plantar Fibroma: An Epidemiological Study

Anish Goel
The University of Texas Southwestern Medical Center
Cindy Weinschenk
The University of Texas Southwestern Medical Center
Natalie Velez
The University of Texas Southwestern Medical Center
Caroline Pennington
The University of Texas Southwestern Medical Center
Elona Malja
The University of Texas Southwestern Medical Center
Dhilip Andrew
The University of Texas Southwestern Medical Center
Tomas Amerio
The University of Texas Southwestern Medical Center
Sadeem Lodhi
The University of Texas Southwestern Medical Center
Yin Xi
The University of Texas Southwestern Medical Center
Avneesh Chhabra
avneesh.chhabra@utsouthwestern.edu

The University of Texas Southwestern Medical Center

Research Article

Keywords: Plantar fibroma, Plantar fibromatosis, Demographics, MRI, Treatment

Posted Date: July 16th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10269917/v1

Additional Declarations: No competing interests reported.

Abstract

Background. Plantar fibroma (PF) is a benign growth on the plantar aponeurosis potentially causing pain, swelling, and sensory changes. This study seeks to determine demographic differences in PF's MRI presentation and treatments.

Methods. This retrospective cross-sectional study included cases of MRI-confirmed PF interpreted by fellowship-trained MSK radiologists. Demographics, symptoms, MR-findings, and treatments provided were studied. Treatments were correlated with symptoms and demographics. All symptoms were weighted equally, and analysis of the number of cumulative symptoms was performed. Fisher's exact test, Chi Square test, and Kruskal-Walis rank sum test were performed.

Results. Among 196 PF in 177 patients, male:female ratio was 53:47. The race distribution was Indigenous 2%, Asian 2%, Black 30%, White 61%, and Unknown 5%. Hispanic:Non-Hispanic ratio was 28:69. The cumulative symptoms for patients receiving physical therapy (n = 8), steroid injections (n = 26), surgery (n = 26), and pain medications (n = 126) were 1.38, 1.15, 1.05, and 0.5, respectively. Hispanic patients had multiple cords involved ($p = 0.023$) and more homogenous MR-signal ($p < 0.001$). Female patients are more likely to exhibit hyperintense PFs on fluid-sensitive sequences ($p = 0.037$) and receive aggressive treatments ($p < 0.001$). Male patients had larger PFs ($p = 0.03$). Black patients had the largest and Indigenous patients had the smallest PFs ($p = 0.001$). Patients with more symptoms, and symptoms of pain received focused treatments ($p < 0.001$). Black patients were more likely to receive surgery, and White patients were more likely to receive pain medication alone ($p = 0.025$).

Conclusion. In this epidemiological study of a large database of MRI-confirmed PF, several demographic factors varied for patients' MRI presentations and treatments.

Background

Plantar Fibroma (PF), also known as plantar fibromatosis, is a rare disorder in which a benign mass grows on the plantar aponeurosis, affecting less than 200,000 patients a year[1, 2]. The affected patients are usually middle-aged males, with an age range of 30 to 50 years[1]. Patients can present with a soft tissue mass and symptoms of pain, sensory changes, and discomfort[3]. The typical differential diagnoses for a PF can include a variety of benign and malignant soft tissue masses such as: lipoma, sarcoma, neurofibroma, among other tumors[4, 5]. A timely and accurate diagnosis aids in the appropriate management of the patient.

Imaging plays an important role in diagnosing PF using ultrasound or magnetic resonance imaging (MRI)[6, 7]. There is limited literature on the diagnosis of PF using MRI and a description of the typical features it displays on various sequences. On US, PF has been shown to have findings of a fibrillar pattern due to collagen's hyperechoic pattern overlaying the matrix's hypoechoic pattern[8]. MRI is

preferred for confirming the diagnosis of PF short of biopsy due to better soft tissue contrast than X-ray, ultrasound, and CT[9]. MRI also aids in management and excision planning[10].

There is a paucity of data on the demographical differences on MRI variations in PF, which can result in inaccurate diagnoses for patients and delays in receiving appropriate treatment. It is well understood that patient factors of ethnicity, race, and sex play an important role in a patient's likelihood to receive certain diagnoses and treatments[11]. A lack of understanding about the demographical differences limits the creation of structural interventions and standardized diagnostic criteria that may improve care for underserved patient populations[12]. Analyzing the differences in MRI features and treatments of PF can help bridge the gap between the social determinants of health and patient outcomes[13]. Understanding these differences helps remedy disparities in treatment through the development of a better understanding of the variation of imaging features across different demographics.

This epidemiological study aimed to systematically review the demographical variation of MRI features and treatments provided for PF from a database created from our tertiary care center with over a decade of data. We hypothesized that there are differences in MRI appearance and treatment received by the patient, based on: ethnicity, race, and sex. We further hypothesized that the patient's symptoms and number of symptoms would play a role in their chosen treatment modality, with patients having more cumulative symptoms receiving more invasive treatments.

Methods

This retrospective cross-sectional study was performed with an approved IRB to analyze a sample of an institutional database with over a decade of data. All HIPAA regulations were followed, and informed consent was waived.

Patient Sample

The database for this study was created by an electronic search for the keywords (foot, ankle, fibroma, fibromatosis, and MRI) in the hospital Picture Archival and Communications System to collate MRI-confirmed PF over a decade: between February 2014 to May 2024. The MRI scans were all prospectively interpreted by fellowship-trained musculoskeletal (MSK) radiologists in our tertiary care set-up as a standard of care. An electronic chart analysis was performed to ensure that the final diagnosis of PF was made based on biopsy, surgery, or treatment. The inclusion criteria were patients: a minimum of 18-years-old and images obtained on both 1.5 tesla (T) (Siemens, Erlangen, Germany) and 3.0T (Philips, Best, Netherlands) MRIs. These confirmed PF MRI scans were re-interpreted by an independent MSK fellowship trained radiologist to confirm the presence of PF. MSK radiology fellows, blinded to clinical information and prior reports re-interpreted the scans to evaluate MRI features. Patients without a final clinical diagnosis of PF or with MRI artifacts limiting the quality of assessment on imaging were excluded. A final sample of 196 cases from 178 patients was identified.

Data Collection

Electronic chart analysis was performed by two medical students to collect: patient demographics (race, sex, age, and ethnicity), patient symptoms (pain, sensory changes, swelling), histopathological results, and treatments (physical therapy, pain medication, steroid injections, surgical resection). Sex was defined as assigned at birth. Each patient chart was evaluated for prior history of foot infection without osteomyelitis, foot infection with osteomyelitis, foot fracture, previous foot surgery, diabetes mellitus, and Charcot neuroarthropathy (Table 1).

Table 1
– Demographics of the Sample with Comorbidities and Treatment Information by Foot

Measure	Item	n = 196	Percentage (%)
Sex	Male	102	52
	Female	84	48
Race	Asian	4	2
	Black	60	31
	White	119	61
	Indigenous	3	2
	Unknown	10	5
Ethnicity	Hispanic	55	28
	Non-Hispanic	141	71
Imaging Indication	Symptomatic	122	62
	Incidental finding	74	38
Comorbidities	Diabetes mellitus	104	53
	Prior foot infection	37	19
	Prior osteomyelitis	37	19
	Prior fracture	35	18
	Previously known fibroma	31	16
	Charcot neuroarthropathy	8	4
	Prior foot surgery	46	23

MRI Analysis and Feature Evaluation

After all cases were re-reviewed by an independent MSK fellowship trained radiologist to confirm the presence of PF, four MSK radiology fellows blinded to clinical information and previous MRI reports re-reviewed all cases of PF (approximately 50 each) to document: location in regard to the cords of the plantar fascia, the number of lesions, shape in the longest access, signal intensity characteristics for T1W, T2W, and fsT2/STIR, enhancement characteristics, local fracture deformity, muscle denervation signal alterations, cystic or necrotic areas, signal heterogeneity, and thickening or tears of the plantar fascia at the calcaneal attachment.

Statistics

Apart from descriptive statistics of counts and percentage of the sample, the differences between the patient sample and the locoregional metro area population as per institutional records were assessed using the Chi-squared goodness of fit test. The association between imaging characteristics and demographic factors was assessed using Fisher's exact test and Kruskal-Wallis rank sum test for categorical and continuous variables, respectively. Association between treatment method and demographic factors and symptoms was assessed using Chi-squared test and Fisher's exact test for categorical values and Kruskal-Wallis rank sum test for continuous variables. Additionally, pairwise comparisons were performed with Fisher's exact test for categorical variables and Wilcoxon rank-sum test with Holm's adjustment for continuous variables. The significance level for p value and q value was set at < 0.05. All analyses were done in R 4.4.2 (R Core Team, Vienna, Austria) with packages tidyverse, readxl, gtsummary,and gt.

Results

Demographics

The study sample differed from the locoregional population in race and ethnicity. Hispanic patients were overrepresented and non-Hispanic patients were underrepresented in the sample ($p < 0.001$). The sample overrepresented Black patients and underrepresented White patients ($p = 0.03$). The sample did not differ from our locoregional population with respect to the patient sex ($p = 0.749$).

Treatment Methods and Differences

Treatments for PF included: surgery for 11%, pain medication alone for 70%, steroid injections for 15%, and physical therapy for 4.1% (Fig. 1). There was not a significant difference in treatment with respect to patient ethnicity (Table 2). Female patients were more likely to receive invasive treatments ($q < 0.001$). There was a significant difference in treatment distribution with respect to race ($q = 0.043$). Black patient PFs were more likely to receive surgery than pain medications alone compared to White patient PFs ($p = 0.025$). PFs with the more cumulative symptoms were more likely to receive treatments of surgery, steroid injections, and physical therapy ($q < 0.001$). Similarly, PFs with pain were more likely to receive

treatments of surgery, steroid injections, and physical therapy (p < 0.001). PFs with symptoms of sensory changes were more likely to receive treatments of surgery and physical therapy (p = 0.007).

Table 2
– Comparison of Treatment with Demographics Number of Symptoms

Characteristic	Surgical Resection N = 21[1]	Pain Medication Alone N = 138[1]	Steroid Injections N = 28[1]	Physical Therapy N = 8[1]	p-value[2]	q-value[3]
Race					**0.021**	**0.043**
Black	13 (65%)	37 (30%)	8 (31%)	2 (25%)		
White	7 (35%)	88 (70%)	18 (69%)	6 (75%)		
Ethnicity					0.3	0.3
Hispanic	4 (20%)	43 (32%)	5 (17%)	3 (38%)		
Non-Hispanic	16 (80%)	90 (68%)	23 (83%)	5 (62%)		
Sex					**< 0.001**	**< 0.001**
Male	6 (29%)	85 (62%)	7 (25%)	4 (50%)		
Female	15 (71%)	53 (38%)	21 (75%)	4 (50%)		
Number of Symptoms	1.05 ± 0.74	0.50 ± 0.68	1.07 ± 0.46	1.38 ± 0.52	**< 0.001**	**< 0.001**

MRI Features

Male patients exhibited larger PFs by 3 mm on average (p = 0.030) and were more likely to have hypointense signal alterations on fluid sensitive sequences such as fsT2W/STIR (p = 0.037).

Hispanic patients were more likely to have multi-cord involvement (p = 0.023) and overall homogenous lesions (p < 0.001). Non-Hispanic patients were more likely to have hypointense T1W signal alteration (p = 0.019) and cystic-necrotic areas (p = 0.004).

Asian and Indigenous patients were more likely to have cystic-necrotic areas on the PF (p = 0.013). PF sizes also differed by race (Fig. 2). Indigenous patients had the smallest average PF at 7 ± 6 mm (Fig. 3), and Black patients had the largest average PF at 22 ± 16 mm (Fig. 4) (p = 0.001).

Discussion

Plantar fibroma is a benign mass of the sole of the foot with MRI being an accepted diagnostic modality. While MRI appearances and treatments vary for PF, they had not been previously studied due to overall paucity of MRI studies on PF. Understanding these differences can allow for more equitable treatment of patients and improved diagnosis and management of PF.

This study adds to the body of literature on PF in its treatment modalities and varying MRI features across demographic factors. We found that symptoms of pain or sensory changes received more invasive treatments. Treatments of surgical resection, physical therapy, and steroid injections were reserved for PF cases with more symptoms. PF sizes varied with Black patients having the largest and Indigenous patients having the fewest. Black patients and female patients were more likely to have surgery than white patients or male patients as well.

Research on PF MRI features is sparse, and research on health equity is relatively new. This study is unique in its combination of these two features. Acknowledging differences in presentation can allow for more accurate diagnosis. Further, analysis of treatment distribution of PF regarding demographic factors can allow clinicians to better ensure justice in healthcare. Comparing the number of symptoms to treatment options can help develop a standardized model for treatment.

Currently, there is limited research regarding PF, especially regarding MRI features and treatment distribution across demographic factors. This sample has a very large sample size, and every image was confirmed by a fellowship-trained MSK radiologist, and then further confirmed by an MSK radiology fellow. This ensures that the presence of sampling errors is reduced. Further, utilizing data from the same institution ensures the use of the same protocols and consistent image quality to allow for improved characterization of PF.

This study is limited by its retrospective nature and the mixed methodology of confirmation of lesions ranging from imaging alone to biopsy. However, each image was read three times: by the initial MSK fellowship trained reader, then by an MSK radiology attending, and further by a MSK fellow. Additionally, data on treatment satisfaction or severity of symptoms was not collected.

Conclusion

This large systematic study adds to the current research on PF by evaluating the MRI features of PF across the demographic factors of race, sex, and ethnicity. The study additionally evaluates how treatment options for PF vary in their distribution based on race, sex, and number of symptoms. Future research can validate with larger cohorts and analyze treatment satisfaction to measure efficacy.

Declarations

Author Contribution

Study and methodology design – ACManuscript draft and literature search – AG, NV, ACManuscript editing – AG, CW. NV, YX, ACInvestigation – AG, CW, NV, EM, DA, TA, SLStatistics – AG, YXFinal approval – ACResponsible for all contents of the study – AC

Data Availability

The data that support the findings of this study are not openly available due to reasons of sensitivity and are available from the corresponding author upon reasonable request.

References

1. Young JR, Sternbach S, Willinger M, Hutchinson ID, Rosenbaum AJ. The etiology, evaluation, and management of plantar fibromatosis. Orthop Res Rev. 2018;11:1–7. doi: 10.2147/ORR.S154289. PMID: 30774465; PMCID: PMC6367723.
2. Yoshida S, Shidoh M. Plantar fibromatosis. Postgrad Med J. 2003;79(929):158. doi: 10.1136/pmj.79.929.158. PMID: 12697916; PMCID: PMC1742644.
3. Stewart BD, Nascimento AF. Palmar and plantar fibromatosis: a review. J Pathol Transl Med. 2021;55(4):265–270. doi: 10.4132/jptm.2021.06.14. Epub 2021 Jul 7. PMID: 34225446; PMCID: PMC8353138.
4. Meyers AL, Marquart MJ. Plantar Fibromatosis. [Updated 2024 Feb 28]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK557674/
5. Nduka JC, Lam K, Chandrasekar CR. Diagnosing plantar fibromas - Beware of sarcomas. Foot (Edinb). 2021;49:101736. doi: 10.1016/j.foot.2020.101736. Epub 2020 Sep 8. PMID: 33268229.
6. Morrison WB, Schweitzer ME, Wapner KL, Lackman RD. Plantar fibromatosis: a benign aggressive neoplasm with a characteristic appearance on MR images. Radiology. 1994;193(3):841-5. doi: 10.1148/radiology.193.3.7972835. PMID: 7972835.
7. Velez N, Weinschenk C, Goel A, Malja E, Andrew D, Amerio T, Lodhi S, Xi Y, Bishop J, Chhabra A. MRI characteristics of plantar fibromas: a large consecutive series from a tertiary care center with symptom analysis. Skeletal Radiol. 2025 Sep 16. doi: 10.1007/s00256-025-05036-8. Epub ahead of print. PMID: 40958075.
8. Draghi F, Gitto S, Bortolotto C, Draghi AG, Ori Belometti G. Imaging of plantar fascia disorders: findings on plain radiography, ultrasound and magnetic resonance imaging. Insights Imaging. 2017;8(1):69–78. doi: 10.1007/s13244-016-0533-2. Epub 2016 Dec 12. PMID: 27957702; PMCID: PMC5265197.
9. Koudela K Jr, Koudela K Sr, Kunešová M, Koudelová J. Plantární fibromatóza (Ledderhoseova nemoc) [Plantar fibromatosis (Ledderhose's disease)]. Acta Chir Orthop Traumatol Cech. 2010;77(4):341–5. Czech. PMID: 21059334.

10. Lu H, Chen Q, Shen H, Shen XQ, Wu SC. Fibroma of tendon sheath in planta. Springerplus. 2016;5:575. doi: 10.1186/s40064-016-2260-z. PMID: 27247872; PMCID: PMC4864826.
11. Thornton RL, Glover CM, Cené CW, Glik DC, Henderson JA, Williams DR. Evaluating Strategies For Reducing Health Disparities By Addressing The Social Determinants Of Health. Health Aff (Millwood). 2016;35(8):1416–23. doi: 10.1377/hlthaff.2015.1357. PMID: 27503966; PMCID: PMC5524193.
12. Luchenski S, Maguire N, Aldridge RW, Hayward A, Story A, Perri P, Withers J, Clint S, Fitzpatrick S, Hewett N. What works in inclusion health: overview of effective interventions for marginalised and excluded populations. Lancet. 2018;391(10117):266–280. doi: 10.1016/S0140-6736(17)31959-1. Epub 2017 Nov 12. PMID: 29137868.
13. Korn AR, Walsh-Bailey C, Correa-Mendez M, DelNero P, Pilar M, Sandler B, Brownson RC, Emmons KM, Oh AY. Social determinants of health and US cancer screening interventions: A systematic review. CA Cancer J Clin. 2023 Sep-Oct;73(5):461–479. doi: 10.3322/caac.21801. Epub 2023 Jun 17. PMID: 37329257; PMCID: PMC10529377.

Figures

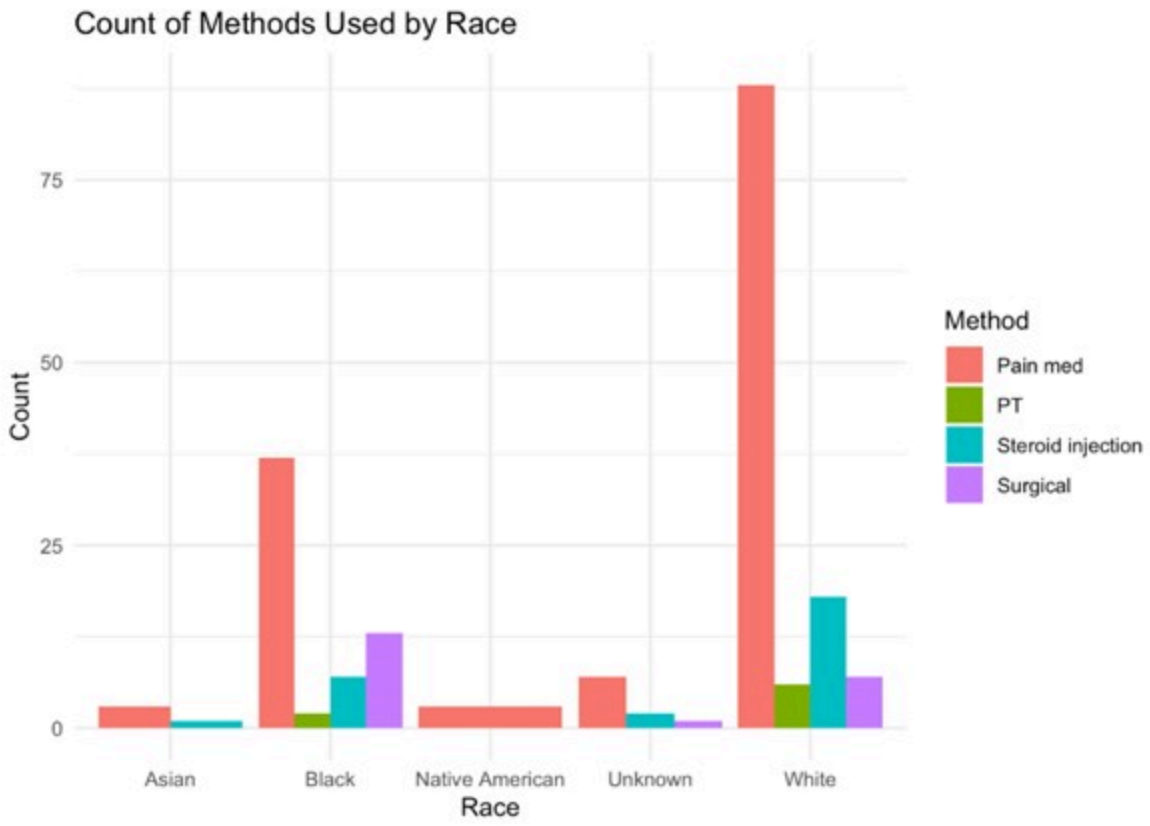

Figure 1

Plantar fibroma treatment variations based on race

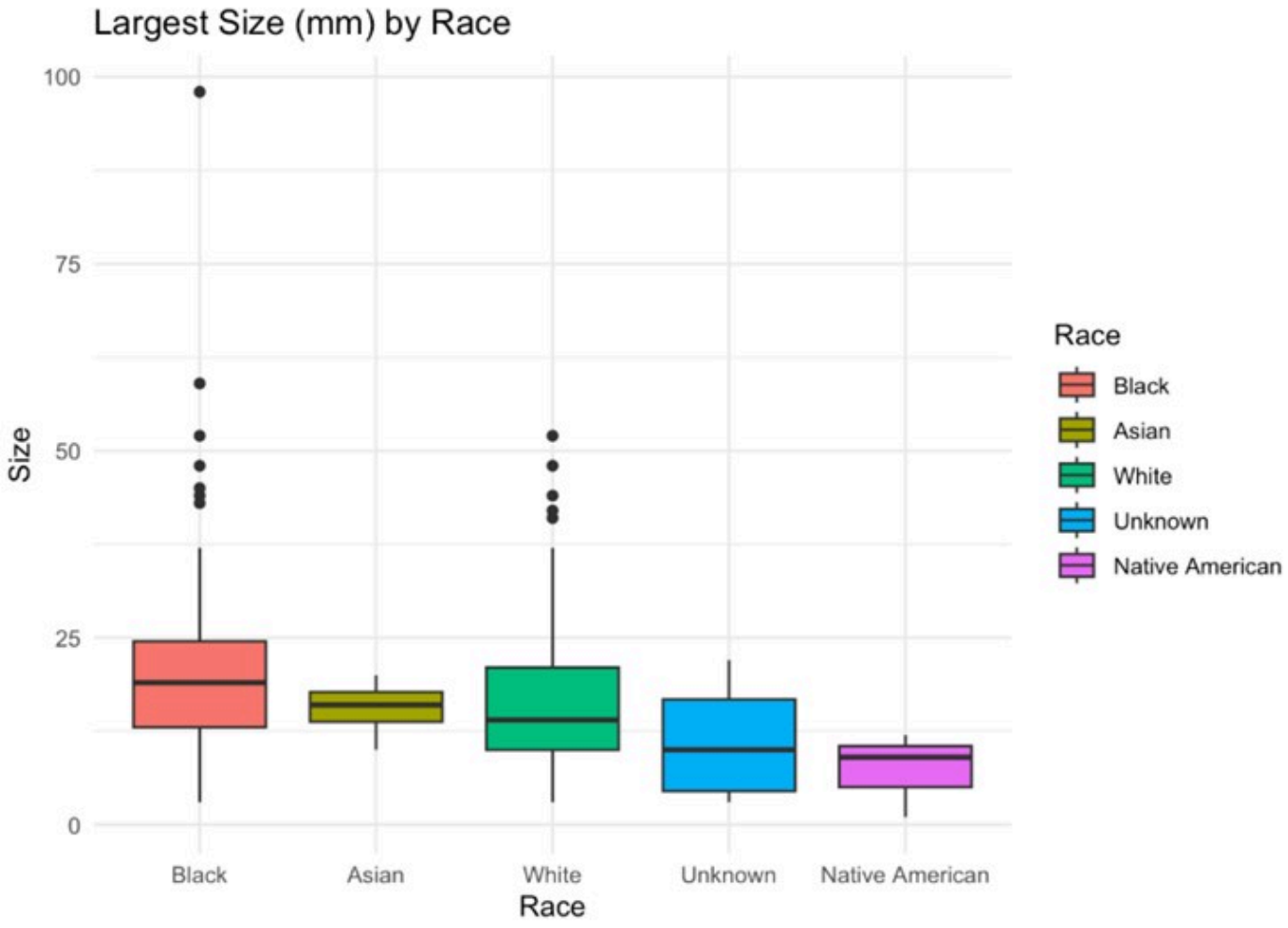

Figure 2

Plantar fibroma size variations based on race

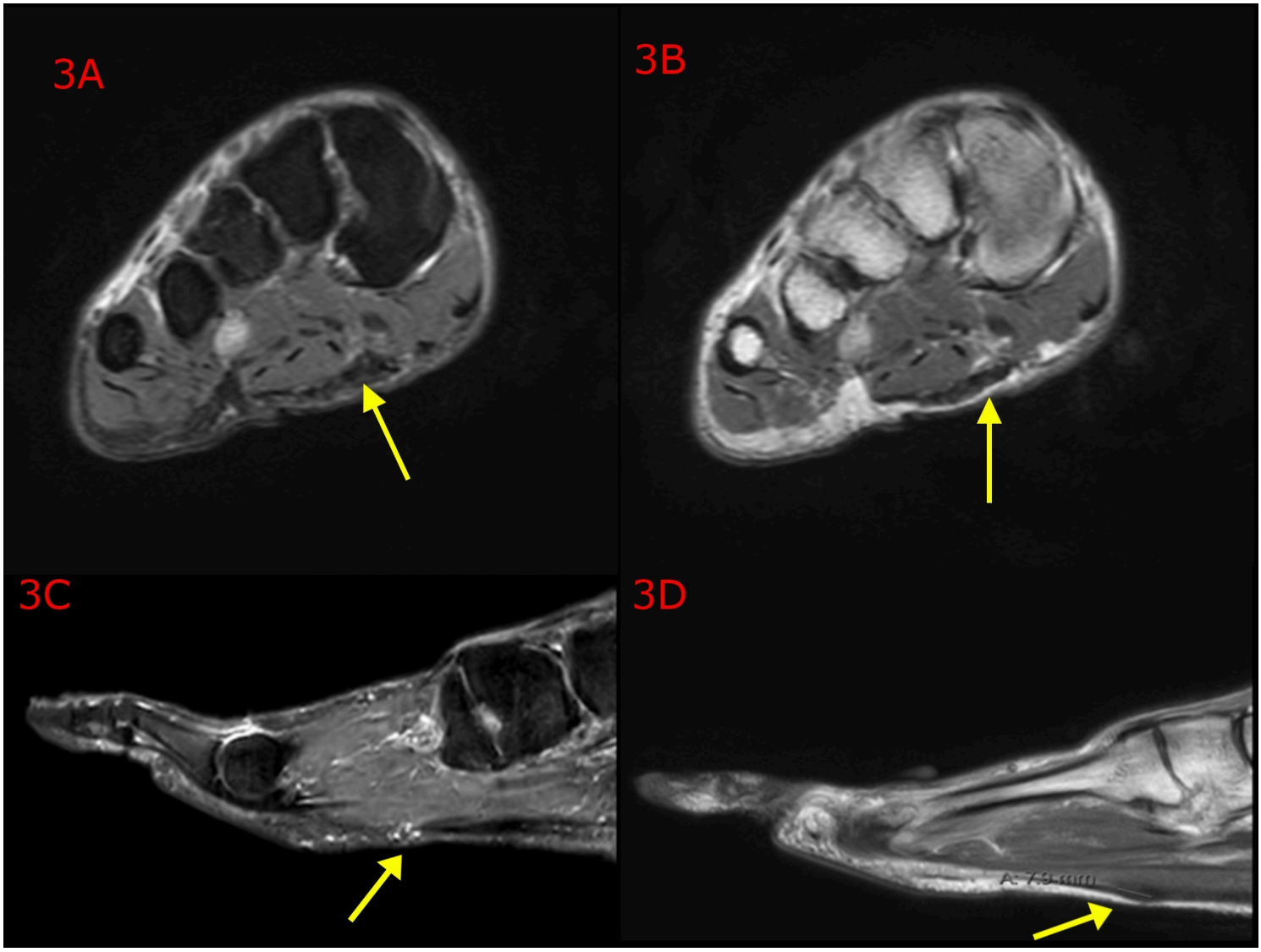

Figure 3

8 mm PF in an Indigenous Male Patient: T2W Dixon water (3A, 3C) and in-phase (3B, 3D)

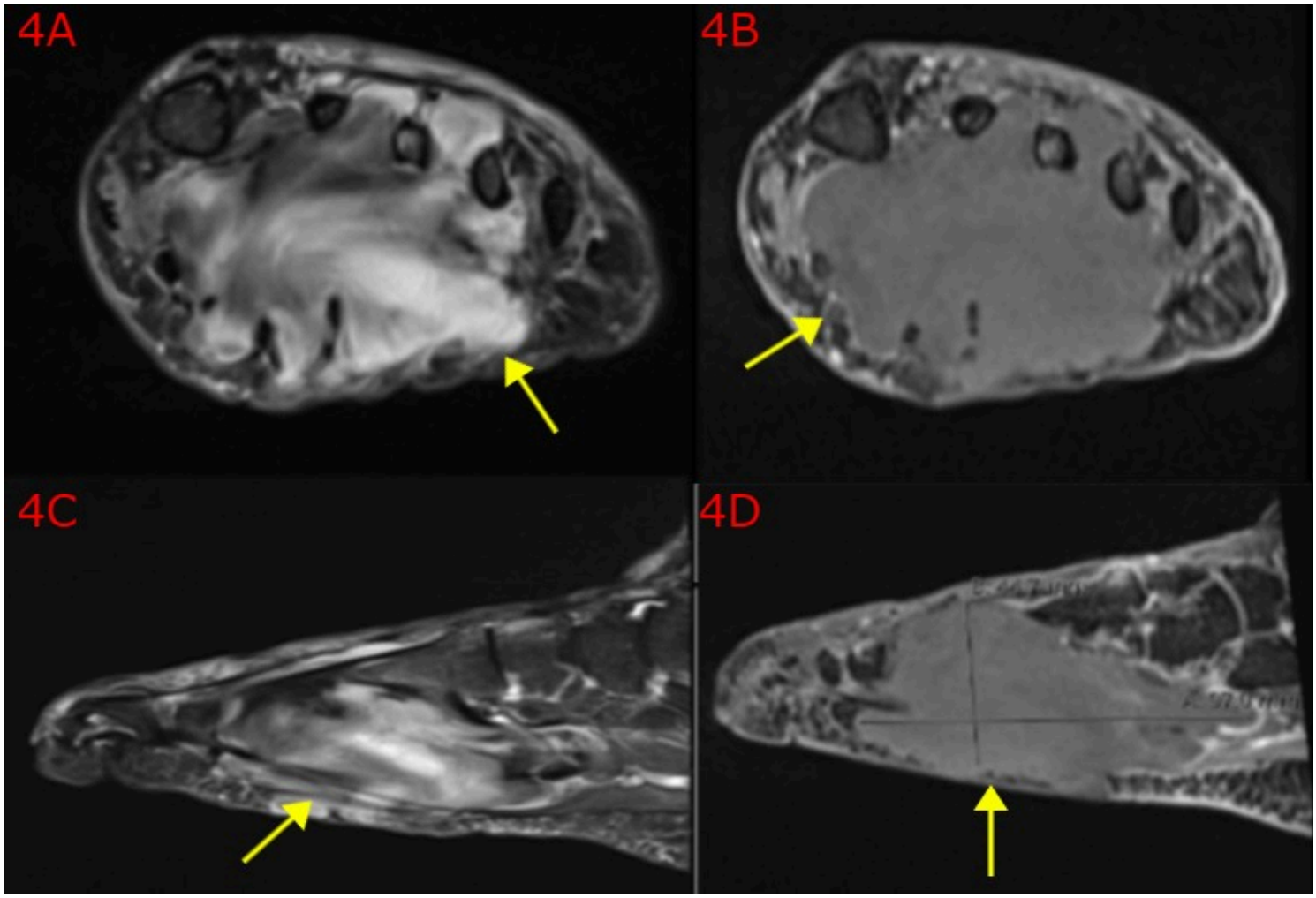

Figure 4

98 mm PF in a Black Male Patient: T2 Dixon-water (4A, 4C) and T1 fat-saturated post-contrast (4B, 4D)