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LONG-TERM OUTCOMES OF LAPAROSCOPIC REPAIR OF COMPLEX URETERAL INJURIES: A Single-Center Experience

Heterozygous Frameshift Genetic Variant in *TNFRSF13C* Gene Associated with Specific Antibody Deficiency Memory Phenotype

BRIDGING THE GAP: Patient Perspectives on Access to Dermatologic Care in a Student-Run Free Clinic in Puerto Rico

ISSUE
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EDITORIAL BOARD

We are pleased to present the second edition of the PHSU Scientific Journal. This issue reflects our continued commitment to fostering rigorous scholarship, interdisciplinary collaboration, and academic excellence within the Ponce Health Sciences University and Puerto Rican community.

We extend our sincere gratitude to the authors, reviewers, and contributors whose dedication and thoughtful work made this edition possible. As the journal continues to grow, we remain focused on providing an accessible platform that amplifies impactful research and supports the development of future scholars.

Thank you for your continued engagement and support. We look forward to building on this momentum in the editions to come.

Sincerely,

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MESSAGE FROM THE
EDITOR-IN-CHIEF

DR. WILFREDO DE JESÚS
EDITOR-IN-CHIEF

It is my distinct honor to present the second issue of the Ponce Health Sciences University Scientific Journal, reflecting the continued intellectual vitality, clinical innovation, and translational research excellence emerging from our academic and healthcare community. This edition highlights the power of interdisciplinary collaboration across medicine, public health, biomedical sciences, and clinical education, reinforcing our mission to advance science in service of patients and society.

The manuscripts featured in this issue showcase the important role academic medicine in Puerto Rico plays in addressing both global health challenges and locally relevant clinical needs. From surgical outcomes research evaluating minimally invasive approaches to complex ureteral reconstruction to studies exploring dermatologic health disparities in underserved populations, our authors demonstrate how rigorous scientific inquiry can directly improve patient care and promote health equity. Case reports and genetic investigations further expand understanding of rare conditions, emphasizing multidisciplinary collaboration and the value of careful clinical observation. Our review and innovative imaging sections address emerging questions in patient safety and technological advancement. Analyses of radiation exposure during scoliosis monitoring highlight the responsibility to balance diagnostic necessity with long-term risk reduction in pediatric populations, while artificial intelligence-enhanced 3D imaging illustrates how advanced computational tools are transforming diagnostic precision and clinical decision-making. The Research Letter section highlights the importance of patient perspectives and healthcare accessibility, examining barriers to dermatologic care through community-based clinical models that promote culturally responsive healthcare delivery and medical student engagement.

Collectively, the work presented in this issue reflects the collaborative efforts of students, trainees, faculty, and healthcare partners committed to improving outcomes for diverse patient populations. I extend my sincere gratitude to our authors, reviewers, editorial staff, and institutional supporters whose dedication ensures the scientific rigor and continued growth of this journal. We invite our readers to engage with the research presented in these pages and to join us in advancing a culture of inquiry that strengthens science, education, and compassionate patient care.

Thank you for your continued support.

AUTHOR GUIDELINES

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Use Times New Roman 12 pt, double-spaced, 1" margins. Submit manuscripts in Word format using the official journal template. Label and cite all tables/figures in order.

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Original Article	250 characters	150-250	Intro: 500-800 Methods: 700-1200 Results: 500-800 Discussion: 800-1500 Conclusion: 150-300	150-300 words	≥30	≤8
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Case Report	250 characters	150-250	Intro: 300-700 Case presentation: 250-500 Discussion: 500-1000	-	15-40	≤2
Clinical Pearls	250 characters	-	Up to 1000	-	≤5	≤2
Innovative imaging	250 characters	-	Up to 1000	-	≤5	≤10
Research Letter	250 characters	150-250	Up to 1600	-	≤5	≤2
Letter to the Editor	250 characters	-	Up to 1200	-	≤5	-

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ORIGINAL ARTICLES

Original Article

Long-Term Outcomes of Laparoscopic Repair of Complex Ureteral Injuries: A Single-Center Experience

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Abstract: Ureteral injuries, often iatrogenic during gynecological or endo-urological procedures, can severely impact quality of life and renal function, potentially causing sepsis or renal failure. The distal ureter is most vulnerable, and resulting strictures require management based on their cause, location, and length. Short distal strictures are treated with ureteroureterostomy or ureteroneocystostomy, while longer ones may require a Boari flap with psoas hitch or ileal ureter replacement. This study evaluates postoperative renal function and symptoms recurrence in patients treated with these techniques for complex ureteral injuries. A retrospective review of 14 patients treated between 2007 and 2017 was conducted. Nine underwent laparoscopic Boari flap and five ileal loop interposition, with at least five years of follow-up. Intraoperative and postoperative outcomes were analyzed. Indications included endoscopic surgery strictures (3), radiation-induced strictures (2), and non-urological iatrogenic injuries (7). Two patients had primary ureteral cancer. Mean operative time was 158 minutes, and hospital stay averaged 2.1 days. Preoperative creatinine was 1.3 mg/dL, increasing to 1.4 mg/dL and 1.5 mg/dL at one and three months postoperatively. CT cystogram showed vesicoureteral reflux in all Boari flap patients. At five years, all patients were symptom-free with unobstructed ureters. Complications included one ileus and one anastomotic stricture. Boari flap and ileal ureter replacement are effective alternatives for complex ureteral strictures, preserving renal function. Larger studies are needed to validate these findings against standard open techniques.

Keywords: Ureteral injuries; Ureteral strictures; Boari flap; Ileal ureter replacement.

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1. Introduction

Ureteral injuries adversely impact both patient quality of life and renal function. Although ureteral injury is uncommon, it can lead to sepsis and renal failure [1]. Iatrogenic injury, particularly following gynecological or endourological surgeries, has emerged as the primary cause of such injuries, with the distal ureter being the most vulnerable region [1]. This susceptibility is compounded in scenarios involving radiation-induced injuries, malignancy, which, along with iatrogenic causes, contribute significantly to the prevalence of ureteral strictures. Therapeutic management for ureteral strictures is tailored based on the cause, location, and length of the stricture. Short distal ureteral strictures, generally up to 4–5 cm, are often effectively managed with ureteroureterostomy or ureteroneocystostomy [2]. Although these techniques are used for shorter ureteral strictures, they might induce tension at the anastomosis site for ureteral strictures of 12-15 cm, which compromise surgical outcomes.

Regarding longer distal and middle ureteral strictures and how to address them, the Boari flap, supplemented by a psoas hitch, presents a robust solution. This technique, capable of bridging defects up to 12 to 15 cm, leverages the rich vascular supply from adjacent ureteral tissue and depends on sufficient preoperative bladder capacity [3]. In addition to facilitating anatomical continuity, the Boari flap combined with a psoas hitch has been shown to evade the risk of recurrent urinary tract infections and prevent electrolyte derangements in patients with long segmental ureteral strictures [3]. This technique involves vesicular mobilization to the affected side and pulling superiorly to ensure a tension-free connection, usage of a submucosal conduit to decrease the risk of ureteral reflux for the re-anastomosis and securing the suture to the ipsilateral psoas tendon to evade coiling of the ureter [3]. However, because this technique depends on bladder capacity, Boari flap supplemented by psoas hitch may not be sufficient for more complicated cases, such as retroperitoneal fibrosis or total ureteral avulsion.

Other studies have shown that for longer and more complex ureteral strictures, where ureterolysis fails, intestinal substitution emerges as a suitable alternative [4–6]. This method, although used sparingly, helps avert nephrectomy by replacing the ureter with intestinal segments, thus preserving renal function [5–7]. The technique of ileal ureter entails medialization of the colon and subsequent Gerota Fascia incision with the purpose of both visualizing anatomy and exposure of the renal pelvis [5,8]. After excision of the superior ureteral portion, the ileal segment is measured and isolated at 20 cm from the ileocecal valve and bowel continuity is re-established by an endostapler [5]. Transverse holes are then sealed with continuous suture for further configuration of the bowel segment with the purpose of ileal placement completion by both pyelo-ileal and ileovesical anastomoses [5]. This streamlined approach to addressing ureteral injuries underscores the necessity of a tailored surgical strategy that adapts to the unique challenges posed by the nature and extent of the ureteral damage. Recent studies have demonstrated that this surgical technique, when performed laparoscopically, results in shorter operative times when compared to robotic alternatives [9, 10]. In contrast, other authors have suggested that, while traditional open surgery is vital for reconstructive procedures, minimally invasive techniques, like laparoscopic and robotically-assisted procedures, represent a compelling alternative associated with less morbidity and mortality [11].

An essential component of the population our center serves is the fact that it is not only underserved, but also that there is an ever-increasing demand for specialized surgical practitioners. Hence, providing accessibility for patients in need and training for those who will be performing these interventions on their own in the near future is of the utmost importance. In this study, we aim to present these surgical approaches to complex ureteral strictures stemming from previous radiation, trauma, iatrogenic injury, or idiopathic retroperitoneal fibrosis and evaluate for any changes in renal function and recurrence of symptoms postoperatively.

2. Methodology

Study population: Retrospectively acquired data of fourteen patients that underwent surgical correction of ureteral stricture from 2007-2017 by an experienced surgeon at St. Luke's Episcopal Medical Center in Ponce, Puerto Rico was evaluated. All methods were carried out in accordance with relevant guidelines and regulations. Informed consent was obtained from all subjects as per institutional protocol. The cohort of patients (n=14) included in this study was stratified into two groups: one group underwent Boari flap with psoas hitch (n=9) and the other group underwent ileal ureteral substitution (n=5). All procedures were performed by a single surgeon using a laparoscopic approach. Epidemiological and clinical data were extracted for each patient. Variables such as age, sex, body mass index (BMI), and stricture etiology (endoscopic surgery, radiation-induced, non-urological surgery, iatrogenic injury, and primary ureteral cancer) were evaluated in the study. Patients (n=14) with radiologic imaging results showing ureteral strictures at 10 cm or more and patients (n=2) with underlying malignancies localized in the mid and distal ureter from the aforementioned etiologies were included in this study.

Operative technique: The patients were placed in a supine position. Trocar placement was arranged in a fan-like configuration approximately 2 cm above the umbilicus. One is in the midline, and the other two trocars are on each side. In cases involving ileal loop anastomosis, an additional trocar was placed between the xiphoid process and the trocar above the umbilicus. The ileum was the segment used in all cases, with the proximal end anastomosed to the renal pelvis and the distal portion to the bladder. The segment of the ileum was harvested using an endoscopic stapler.

Evaluation of clinical outcomes: Parameters for intraoperative analysis were divided in operative time and intraoperative complications. Perioperative outcomes were compared between the groups. Creatinine was assessed preoperatively and, at one and three months postoperatively. Average hospital length of stay and operating time were calculated for both cohorts. Post-op CT Cystogram was performed to evaluate for vesicoureteral reflux. Follow-up at five years was performed to evaluate for symptoms and ureteral obstruction via CT Urogram.

Statistical analysis: Central tendency measurements were used to describe the sample distribution. The distribution of clinical variables was analyzed using contingency tables and Fisher's or Chi-squared (X2) tests. To assess the statistical significance of mean differences in continuous variables, the Mann–Whitney U test was used.

3. Results

As summarized in Table 1, our study cohort consisted of eight female and six male patients. A total of nine cases underwent the Boari flap procedure after having a stricture as a result from an endoscopic surgery or a non-urological surgery iatrogenic injury. From that group, three cases had

a stricture from an endoscopic surgery (21.4%) and six cases (42.9%) from a non-urological surgery iatrogenic injury. There were no cases involving any radiation or malignancies. The mean age for the Boari flap group was 61 years old, and seven female patients underwent this procedure, which notably accounted for 50% of our total cohort. A total of five cases were included in the Ileal ureter procedure group. The causes for strictures in this group of patients were varied, including radiation-induced strictures, non-urological surgery iatrogenic injury, and a stricture followed by a primary ureteral cancer. From this group, two cases (14.3%) presented with a radiation-induced stricture, one case (7.1%) had a non-urological surgery iatrogenic injury (multiple endoscopic and reconstructive procedures), and two cases (14.3%) had a stricture followed by a primary ureteral cancer. There was no case involving endoscopic surgery stricture under this group. The mean age for this group was 60 years of age, from which 28.6 % of the whole cohort involved male patients.

Table 1. Description of the study cohort, including cases that underwent Boari flap and Ileal loop interposition procedures.

Variables	Boari flap (n=9)	Ileal ureter (n=5)	p-value
Age mean (SD)	61.3 (12.3)	60.0 (6.3)	1.000
Sex			
Female	7 (50.0)	1 (7.1)	0.1261
Male	2 (14.3)	4 (28.6)	
BMI			
<25 kg/m^2	4 (28.6)	0 (0)	0.2516
≥25 kg/m^2	5 (35.7)	5 (35.7)	
Stricture Etiology			
Endoscopic Surgery	3 (21.4)	0 (0)	
Radiation Induced	0 (0)	2 (14.3)	
Non-Urological Surgery Iatrogenic Injury	6 (42.9)	1 (7.1)	
Primary Ureteral Cancer	0 (0)	2 (14.3)	
Stricture Etiology			0.0050
Surgery-related	9 (64.3)	1 (7.1)	
Radiation-induced	0 (0)	2 (14.3)	
Primary ureteral cancer	0 (0)	2 (14.3)	

Table 1. *p*-value was obtained from Mann-Whitney test, Chi-square or Fisher's exact test. SD: standard deviation; BMI: body mass index

Perioperative results are summarized in Table 2. Mean creatinine levels from the Ileal ureter procedure were higher compared to the Boari flap procedure. In both groups, levels increased from preoperative to postoperative (one and three months), respectively. The average preoperative creatinine was 1.3 mg/dL and postoperative 1.4 mg/dL and 1.5 mg/dL in one and three months, respectively. Same results appear in operating time with 162.02 ± 91.56 minutes and the hospital length of stay with 4.00 ± 1.73 days (p =0.0005) from the Ileal ureter group compared with the Boari flap group. Mean operative time for both groups was 158 minutes with a mean hospital stay of 2.5 days.

Table 2. Description of the perioperative variables in cases that underwent Boari flap (n=9) and ileal loop interposition (n=5).

Perioperative variables	Boari flap (n=9)	Ileal ureter (n=5)	p-value
Creatinine (mg/dL)			
Pre-op mean ± SD	1.16 ± 0.36	1.50 ± 0.21	0.0629
Post-op (1 month) mean ± SD	1.27 ± 0.42	1.62 ± 0.19	0.1374
Post-op (3 months) mean ± SD	1.42 ± 0.47	1.77 ± 0.24	0.2542
Operating time (min) mean ± SD	155.50 ± 8.28	162.02 ± 91.56	0.0784
Hospital length of stay (days) mean ± SD	1.11 ± 0.33	4.00 ± 1.73	0.0005

Table 2. *p*-value was obtained from Mann-Whitney test. SD: standard deviation.

Follow-ups at a mean of five years with CT Urogram after the surgical operation from both groups were assessed. All patients in the Boari flap cohort (n=9) that underwent a postoperative CT Cystogram presented with vesicoureteral reflux. All patients from Boari flap (n=9) and Ileal ureter groups (n=5) showed no symptoms with unobstructed ureters. One patient developed a postoperative ileus, and another presented with a uretero-vesical anastomosis stricture 16 months after the procedure, which was treated with an endoureterotomy.

4. Discussion

The present study emphasizes the importance of employing a tailored approach in managing ureteral strictures while weighing the effectiveness of the Boari flap with psoas hitch compared to the ileal ureteral substitution procedure. The Boari flap has been demonstrated to be a successful procedure for managing short to medium-length ureteral strictures. This procedure relies heavily on the leveraging of the rich vascular supply from the adjacent ureteral tissue and appropriate bladder capacity to support the implantation of the ureter [3]. Our results indicate that the Boari flap with psoas hitch procedure provides patients with favorable outcomes in the form of absent postoperative symptoms and lack of obstruction in the ureter [3]. In addition, there is a minuscule risk for recurrent urinary tract infections, stable levels of creatinine, shorter operative time, and shorter length of hospital stay. Nonetheless, the dependence of this procedure on bladder capacity may limit its

applicability in more complex cases, such as those with total ureteral avulsion of retroperitoneal fibrosis [3].

In contrast, the ileal ureteral substitution procedure has been proposed as an alternative solution for managing longer and more complex ureteral strictures [5–7]. In essence, this technique aims to preserve renal function and avoid a total nephrectomy by replacing the damaged ureter with an intestinal segment [5,6]. In this cohort, the patients in the ileal group had higher average creatinine levels at all time points, a difference which may be reflective of baseline differences rather than a disproportionate impact of the operation itself. Most notably, the preoperative creatinine in this group was elevated at baseline compared to the Boari group, while the observed postoperative rise was smaller. Furthermore, the ileal group consisted of 80% males, while the Boari group consisted of 22% males. The disproportionate presence of males in the ileal group may partially explain the higher baseline creatinine levels, as males typically have higher serum creatinine, especially in old age [5,6]. In addition, patients who underwent this procedure had longer operative times and hospital stays, likely reflecting the complexity and degree of underlying pathology. Despite these challenges, the long-term follow-up data is promising, as none of the patients reported any postoperative symptoms, and no signs of ureteral obstruction were present [5,6]. These signs are a testament to the durability and effectiveness of this approach.

Operative time and hospital stay were markedly varied between our groups. Patients undergoing ileal ureteral substitution had longer operative times (162.02 ± 91.56 minutes) and hospital stays (4.00 ± 1.73 days) compared to those who underwent Boari flap with psoas hitch (155.50 ± 8.28 minutes and 1.11 ± 0.33 days, respectively; $p = 0.0784$ and $p = 0.0005$). Despite these differences, neither procedure showed significant intraoperative complications, indicating that both are safe alternatives when performed by experienced surgeons. With regards to the creatinine levels, while absolute values were higher in the ileal ureter group at all time points, the relative rise during the postoperative period was greater in the Boari flap group. This finding suggests that renal function remained stable overall, with no disproportionate impact with either surgical approach. It is worthwhile to note that both techniques are directed towards preserving renal function and preventing further deterioration, which was successfully achieved in both groups. Long-term follow-up of these patients reveals the success of both procedures. At five-years postoperatively, no patients reported any symptoms, and imaging confirmed that no ureteral obstruction was present. These findings evidence the efficacy of both approaches and their ability to provide long-term relief from ureteral obstructions and associated symptoms.

The results of this study align with those reported by Benson et al., who described their institutional experiences with Boari flap, ileal interposition, and autotransplantation of the kidney in a cohort of 18 patients [12]. This study reports a high success rate of all techniques, with more

than 90% of patients preserving renal function and having positive radiographic outcomes at the latest follow-up. Similarly, no difference in outcomes between the Boari or ileal groups were observed, reinforcing the importance of a patient-specific tailored approach to addressing these pathologies, accounting for patient anatomy and case complexity. Our findings expand on this earlier work by reporting on long-term follow-up in the complex of new laparoscopic techniques. As a whole, the results from both studies highlight the need for prospective, multicenter trials to evaluate patient selection and long-term outcomes of these procedures.

Nonetheless, the current study is not without limitations. The small sample size of our cohort and the retrospective nature of the design can limit the generalizability of our findings. While the single-surgeon component can be beneficial for outcome consistency, it may not fully reflect the outcome diversity that could occur in larger centers and practices. Finally, the lack of radiation or malignancy-induced strictures in the groups can be a potential source of bias and may also limit the applicability of our findings. Future research should focus on conducting larger, multicenter studies that validate these findings and further explore additional techniques that can offer patients improved outcomes. Additionally, further study of the cost-effectiveness and accessibility of these procedures is needed, especially in the context of underserved populations.

5. Conclusions

The laparoscopic Boari flap with psoas hitch and ileal loop ureteral substitution are both feasible alternative surgical techniques for patients with complex ureteral strictures. They provide long-term relief and preserve renal function without any reported symptoms and with no evidence of ureteral obstruction after a five-year follow-up. Ileal loop ureteral substitution can be considered for the management of longer and more complex cases of ureteral strictures. However, more extensive studies are needed to validate these results compared to traditional open technique and to the level of complexity of strictures.

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Original Article

Non-neoplastic cutaneous manifestations of HIV infection in patients from a community-based clinic in Puerto Rico

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Abstract: Although skin conditions are frequent in people living with HIV (PLWH), no prior studies have described them in Puerto Rico. This study assesses non-neoplastic cutaneous conditions in PLWH at a community clinic. We performed a cross-sectional analysis of 1,000 PLWH treated from January 2019 to December 2024. Sociodemographic, clinical, and dermatologic data were extracted from electronic records. Descriptive and bivariate analyses (Chi-square or Fisher's exact) were conducted with $p<0.05$ considered significant. Non-neoplastic skin conditions were identified in 19.1% of participants (241 diagnoses). The most common were herpes simplex virus (5.3%), dermatitis (2.8%), and warts (2.5%). Longer duration of HIV infection was significantly associated with skin conditions ($p=0.004$). No associations were found with sex, age, CD4 count, or viral load. Non-neoplastic dermatologic conditions remain prevalent among PLWH in Puerto Rico. These findings support incorporating routine dermatologic assessment into HIV care.

Keywords: HIV; Skin conditions; Puerto Rico

1. Introduction

Human Immunodeficiency Virus (HIV) remains a global public health burden, with approximately 39.0 million people infected as of 2023. In 2022 alone, 1.3 million people acquired HIV, and 630,000 died from HIV-related illnesses [1]. Moreover, approximately 1.2 million people in the U.S. have HIV. According to the CDC, around 31,800 people acquired HIV in the U.S. in 2022 [2]. In Puerto Rico, 367 new HIV diagnoses were reported in 2023, contributing to the population of people living with HIV (PLWH); additionally, 61 HIV diagnoses were reported through April 30, 2024, based on partial-year surveillance data [3].These figures underscore the ongoing impact of HIV in the region and the importance of continued efforts in prevention, early diagnosis, and comprehensive treatment. While the introduction of antiretroviral therapy (ART) has significantly reduced mortality, PLWH continues to experience comorbidities, including dermatologic conditions [4].

Skin conditions are among the earliest and most common clinical manifestations of HIV, affecting a significant proportion of PLWH [5]. The spectrum of HIV-associated skin conditions is broad, encompassing early eruptions, malignancies, opportunistic infections, non-infectious diseases, and drug-related eruptions associated with ART. As HIV progressively weakens the immune system, the skin becomes increasingly vulnerable to both infectious and non-infectious manifestations [6].

Among non-infectious cutaneous disorders, seborrheic dermatitis, atopic dermatitis, psoriasis, and xerosis are commonly observed in PLWH. These conditions tend to be more severe, diffuse, and recurrent than in the general population [7]. Seborrheic dermatitis is the most reported dermatosis in PLWH, occurring in 85%–95% of patients with advanced HIV infection [7,8]. In this population, it

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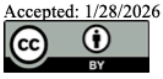

often begins early in the disease course, particularly when CD4 counts fall below 450–550 cells/μL and tends to become more severe at CD4 levels around 100 cells/μL [9]. However, the use of ART frequently leads to improvement in most cases [10].

Viral infections are also common in PLWH, with Herpes Simplex Virus (HSV) being one of the most common. HSV can involve multiple sites, including the oral, ocular, genital, and even central nervous system regions. In immunocompetent individuals, HSV infections are typically self-limited, with lesions resolving within two weeks. In contrast, PLWH may develop chronic lesions, sometimes progressing to epidermal necrosis. Herpes zoster (VZV) reactivation is also more common in this population and may present with multi-dermatomal or disseminated lesions [5]. Approximately 20%–30% of PLWH experience one or more episodes of VZV [11]. These patients are more susceptible to severe VZV manifestations, including necrotic or hemorrhagic lesions and, rarely, cutaneous dissemination [5]. Human papillomavirus (HPV) is another relevant viral pathogen in this population, with PLWH more likely to acquire HPV and present with larger or more numerous warts [12].

Fungal infections, including dermatophytes and candidiasis, are similarly prevalent. Dermatophyte infections in PLWH are typically more extensive and resistant to treatment than in the general population. *Candida* species, while commonly colonizing the skin, mouth, gastrointestinal tract, and vagina in healthy individuals, can become pathogenic at any stage of HIV infection. Clinical manifestations include oral thrush, cutaneous candidiasis, onychomycosis, paronychia, and vaginal candidiasis. On the other hand, bacterial skin infections, particularly those caused by *Staphylococcus aureus*, are also frequently reported in PLWH [13]. These infections may present as primary lesions or develop as superinfections over pre-existing conditions such as eczema, scabies, herpetic ulcers, or Kaposi sarcoma [13,14].

Despite the clinical importance of these cutaneous manifestations, research on HIV-associated skin conditions remains limited, particularly in Puerto Rico. This study aims to assess the presence of non-neoplastic cutaneous manifestations in PLWH receiving care at a community-based clinic in Puerto Rico. By focusing on this specific demographic, the study seeks to address a critical gap in the literature and provide data that may inform future healthcare interventions and management strategies for HIV-associated skin conditions in this population.

2. Methodology

An analysis was conducted using data collected from PLWH at the Puerto Rico Community Network for Clinical Services, Research and Health Advancement, Inc. (PRCONCRA), an urban community-based clinic and Ryan White HIV/AIDS Program grantee located in Puerto Rico. This study employed a cross-sectional design approved by the Institutional Review Board (IRB) of Universidad Central del Caribe, School of Medicine (UCCSoM). The study population consisted of adults aged 21 years or older who had tested positive for HIV and received care at PRCONCRA between January 2019 and December 2024. Participants were selected through convenience sampling based on the availability of electronic medical records.

Information was extracted from medical records and shared electronically via Microsoft Excel through secure messaging. No personal identifiers were included in the dataset. Variables analyzed in the study included age, sex, health insurance, federal poverty level, years with HIV, high risk behavior, CD4 cell count, viral suppression status, substance use disorder, and skin manifestations. A total of 1,000 individuals were included in the study. Skin manifestations were identified using International Classification of Diseases, 10th Revision (ICD-10) codes. Inclusion criteria included adults with a confirmed HIV diagnosis and at least one recorded clinical visit within the study window. Exclusion criteria included records with missing demographic data, missing HIV-related variables (CD4 count, viral load), duplicate records, and individuals who died before their first visit within the study period.

Univariate analyses were performed to summarize frequencies and percentages for categorical variables, and measures of central tendency and dispersion for continuous variables. Normality tests were conducted for all continuous variables. Patients were stratified based on the presence or absence

of skin manifestations to evaluate differences in sociodemographic and clinical characteristics. Bivariate analyses were conducted using Chi-square or Fisher's exact tests for categorical variables, and independent-samples t-tests or Mann–Whitney U tests for continuous variables, depending on the normality of distribution. A p-value of <0.05 was considered statistically significant. All statistical analyses were performed using R-Studio version R-4.5.1 and Intellectus Statistics 360.

3. Results

Sociodemographic characteristics

A total of 1,000 PLWH were included in this analysis. Most participants reported being assigned male at birth (78.8%) versus female (21.2%). Most participants reported being Hispanic (98.9%). The most common represented age group was 55-64 years (23.7%), followed by 35-44 years (22.7%). In terms of geographical distribution, most participants were from San Juan (66.6%), which is part of the metropolitan area of Puerto Rico. The minority of participants were from non-metropolitan regions. Healthcare insurance was predominantly through Medicaid (63.4%), and over half of the participants (55.1%) reported being below the 100% Federal Poverty Level (FPL).

Clinical profile

Most patients had been living with HIV for 1 to 10 years (35.3%), and 10 to 20 years (35.1%). Smaller proportions had been living with HIV for 20 to 30 years (21.0%), 30 years or more (6.1%), or less than 1 year (2.5%). Among reported HIV transmission categories, men who have sex with men (MSM) accounted for the largest proportion of cases (63.3%). Most participants (96.5%) had a CD4 count ≥200 cells/mm^3 , and 91.8% had a suppressed viral load of <200 copies/mL. Additionally, 92.4% were prescribed ART.

Dermatological conditions

Non-neoplastic cutaneous manifestations prevalence between 2019 and 2024 were 191 per 1,000 patients (19.1%). Table 4 presents all the non-neoplastic cutaneous manifestations identified among PLWH in the study. Because patients could present with more than one condition, the total of 241 related diagnoses represent the total number of identified diagnoses, not unique cases. For analysis, the non-neoplastic cutaneous manifestations were classified into two main categories: infectious and non-infectious. Infectious conditions included those of viral, bacterial and fungal origin. Non-infectious dermatoses encompassed chronic and inflammatory skin disorders commonly seen in PLWH.

Among the viral conditions, the most frequently diagnosed was HSV, as well as the most common condition overall (5.3%), followed by warts (2.5%). Less frequent viral conditions included secondary syphilis, VZV and molluscum contagiosum. On the other hand, bacterial skin conditions included infection of the skin (1.2%), cellulitis (1.1%), skin abscess (0.5%) and less frequently, folliculitis, furuncle and impetigo. Fungal infections were also noted, primarily dermatophyte infections (1.3%).

In the category of non-infectious inflammatory dermatoses, the most common diagnosis was dermatitis (2.8%). The latter included, atopic, seborrheic, radiodermatitis, contact dermatitis and unspecified dermatitis. Other inflammatory entries were psoriasis (0.4%), pruritus (0.3%), and xerosis (0.1%). Unspecified entries were also present. The most frequent was "dermatology skin condition, unspecified" (3.8%) and "rash unspecified" (1.0%). Additional entries included urticaria (0.2%), alopecia (0.2%), epidermal inclusion cyst (0.1%), and chronic cutaneous non-pressure ulcers (0.1%).

Associations between sociodemographic, clinical factors and cutaneous manifestations

Bivariate analyses were performed to evaluate potential associations between non-neoplastic cutaneous manifestations sociodemographic and clinical variables among 1,000 PLWH. As presented in Table 4, patients were divided into two groups based on the presence or absence of these diagnoses, and associations were evaluated using chi-square and fisher tests.

Among sociodemographic characteristics, neither sex assigned at birth (p=0.139) nor gender identity (p=0.135) showed a statistically significant association with the presence of skin conditions. However, a slightly higher representation of females (25.1%) is presenting with non-neoplastic cutaneous manifestations compared to males (19.7%) (p=0.095). Age was also not significantly associated with the presence of cutaneous manifestations (p=0.122), though notable differences were observed among age groups. The highest proportion of PLWH diagnosed with at least one skin condition was seen in those aged 55-64 years (26.7%), followed by those aged 45-54 (23.5%), 35-44 (19.3%), 65 years or more (13.6%) and 21-34 years.

An association was found between years living with HIV and the presence of cutaneous manifestations (t=2.99, p=0.003). On average, patients with non-neoplastic cutaneous manifestations had been living with HIV for a longer time (15.84 ± 8.31) compared to those without such manifestations (13.78 ± 9.15 years). This difference was statistically significant (p=0.003), as indicated by the Welch's t-test (t=2.99).

Regarding HIV transmission categories, no significant association was found (p=0.516). However, MSM represented the largest proportion of PLWH with cutaneous manifestations (60.7%). Other groups, such as individuals with heterosexual contact (32.9%), injection drug use (4.7%) or others (1.5%) had lower representation. Other variables such as insurance type, FPL, HAAR prescription, CD4 level, viral load and AIDS diagnosis did not show statistically significant differences.

Table 1. Sociodemographic characteristics of HIV patients.

Sociodemographic Characteristics	n	%
Sex at birth		
Male	788	78.8
Female	212	21.2
Age		
21-34 years old	186	18.6
35-44 years old	227	22.7
45-54 years old	198	19.8
55-64 years old	237	23.7
>65 years old	152	15.2
Health region		
Aguadilla-Mayagüez	3	0.3
Arecibo	41	4.1
Bayamón	169	16.9
Caguas	78	7.8
Fajardo	31	3.1
Ponce	12	1.2
San Juan	666	66.6
Health insurance		
Medicaid	634	63.4
Medicare	139	13.9
Private	200	20.0

Uninsured	27	2.7
Federal Poverty Level (%)		
<100	551	55.1
100-199	257	25.7
200-299	118	11.8
300-399	40	4.0
400-499	18	1.8
≥500	16	1.6

Table 1. *Values represent frequencies (n) and percentages (%) of the study population. Age groups were categorized in 10-year intervals. Federal Poverty Level (FPL) was classified according to U.S. Department of Health and Human Services guidelines. Health region categories correspond to the Puerto Rico Department of Health regional designations. Percentages may not total 100% due to rounding.*

Table 2. Clinical profile of HIV patients

Clinical Profile	n	%
Years with HIV		
<1	25	2.5
1-9	353	35.3
10-19	351	35.1
20-29	210	21.0
≥30	61	6.1
Transmission Categories		
Heterosexual	291	29.1
MSM	633	63.3
IDU	54	5.4
Others	22	2.2
CD4 value		
<200 cells/mm^3	35	3.5
<200 cells/mm^3	965	96.5
Viral load		
<200 copies/mL	918	91.8
<200 copies/mL	82	8.2
ART prescription		
Yes	924	92.4
No	76	7.6

Table 2. *Values represent frequencies (n) and percentages (%) of the study population. MSM = men who have sex with men; IDU = injection drug use. CD4 count and viral load categories reflect clinical thresholds commonly used in HIV management (<200 cells/mm³ and <200 copies/mL, respectively). ART refers to antiretroviral therapy. Percentages may not total 100% due to rounding.*

Table 3. Non-neoplastic cutaneous manifestations among HIV patients

Non-Neoplastic Cutaneous Manifestations	**n**	**%**
Non-infectious cutaneous disorders		
Dermatitis:		
Seborrheic dermatitis	4	0.4
Atopic dermatitis	8	0.8
Radiodermatitis	1	0.1
Contact dermatitis	1	0.1
Dermatitis due to other substances taken internally	2	0.2
Unspecified	12	1.2
Psoriasis	4	0.4
Xerosis	1	0.1
Photosensitivity Disorders:		
Rosacea	1	0.1
Pemphigus Vulgaris	1	0.1
Polymorphous Light Eruption	1	0.1
Pruritus	3	0.3
Infectious cutaneous disorders		
Viral:		
HSV	53	5.3
Molluscum contagiosum	2	0.2
Secondary syphilis	12	1.2
Herpes zoster	7	0.7
Warts	25	2.5
Bacterial:		
Cellulitis	11	1.1
Skin abscess	5	0.5
Folliculitis	1	0.1
Furuncle	1	0.1

Impetigo	1	0.1
Infection of Skin	12	1.2
Fungal:		
Dermatophytes (Tineas)	13	1.3
Candida (Skin, Genital)	5	0.5
Others Non-neoplastic Cutaneous Disorders (Unspecified)		
Urticaria	2	0.2
Alopecia	2	0.2
Rash unspecified	10	1.0
Dermatology skin condition, unspecified	38	3.8
Epidermal inclusion cyst	1	0.1
Chronic cutaneous non-pressure ulcer	1	0.1

Table 3. *Values represent frequencies (n) and percentages (%) of the study population. HSV = Herpes Simplex Virus. Conditions were grouped into non-infectious and infectious cutaneous disorders for descriptive purposes. Dermatologic diagnoses reflect those documented in the medical record at the time of evaluation. "Unspecified" indicates cases in which the chart did not provide a more precise diagnosis. Percentages may not total 100% due to rounding.*

Table 4. Associations between sociodemographic and clinical factors and non-neoplastic cutaneous manifestations

	Non-Neoplastic Cutaneous Manifestations			
Factors	**Yes**	**No**		
	n (%)	**n** (%)	**X^2**	**p-value**
Sex at birth				
Male	143 (74.87)	645 (79.73)	2.18	0.139
Female	48 (25.13)	164 (20.27)		
Age				

21-34 years old	26 (13.62)	160 (19.78)	7.27	0.122
35-44 years old	37 (19.37)	190 (23.49)		
45-54 years old	45 (23.56)	153 (18.91)		
55-64 years old	51 (26.70)	186 (22.99)		
>65 years old	32 (16.75)	120 (14.83)		
Health insurance				
Private	39 (20.42)	161 (19.90)	2.98	0.395
Medicare	30 (15.71)	109 (13.47)		
Medicaid	120 (62.83)	514 (63.54)		
No Insurance	2 (1.04)	25 (3.09)		
Federal Poverty Level (%)				
(mean ± SD)	1.09 ± 1.00	1.18 ± 1.36	t= -1.03	0.302
Years with HIV				
(mean ± SD)	15.84 ± 8.31	13.78 ± 9.15	t=2.99	0.003
Transmission Categories				
Heterosexual	63 (32.98)	228 (28.18)	6.21	0.516
MSM	116 (60.73)	517 (63.91)		
IDU	9 (4.72)	45 (5.56)		
Others	3 (1.57)	19 (2.35)		
CD4 value				
≥200 cells/mm^3	187 (97.90)	778 (96.17)	1.38	0.240
Viral load				
<200 copies/mL	178 (93.19)	740 (91.47)	0.61	0.435
Substance Use Disorder				
Yes	9 (4.71)	35 (4.33)	0.05	0.815
No	182 (95.29)	774 (95.67)		

Table 4. *Values represent frequencies (n), percentages (%) for categorical variables and mean ± standard deviation (SD) for continuous variables. The x^2 test was used to evaluate associations between categorical variables and the presence of non-neoplastic cutaneous manifestations. Independent samples t-tests were used to compare continuous variables (Federal Poverty Level percentage and years with HIV). MSM = men who have sex with men; IDU = injection drug use. Statistical significance was set at $p < 0.05$. Percentages may not total 100% due to rounding. Substance use disorder was defined as a documented diagnosis by a qualified healthcare provider based on ICD-10 codes F10–F19 and was analyzed as a dichotomous variable (yes/no).*

4. Discussion

This study evaluated the prevalence of non-neoplastic dermatologic diagnoses among 1,000 PLWH at a community-based clinic in Puerto Rico between 2019 and 2024. Among these PLWH, 191 of 1,000 patients (19.1%) presented with at least one non-neoplastic skin condition. Because some patients had more than one condition, a total of 241 non-neoplastic dermatologic diagnoses were identified and are summarized in Table 3. The most frequently documented were viral infections, with HSV reported at 5.3% and warts at 2.5%. These were followed by non-infectious dermatoses such as dermatitis (2.8%) and psoriasis (0.4%). Notably, seborrheic dermatitis and atopic dermatitis were frequently observed, consistent with existing literature suggesting that these conditions can be more severe and treatment-resistant in PLWH [7,10].

While conditions such as seborrheic dermatitis have been reported at higher prevalence in the era of ART (2–25%), the relatively low rate observed in our study (0.4%) may be associated to immune stability as the majority of participants were receiving ART and had CD4 counts ≥200 cells/mm³ and viral loads <200 copies/mL (Table 1) [16]. Additionally, a key limitation of our cross-sectional study design is that it may not capture resolved manifestations that occurred before the study period (2019-2024). This is particularly relevant given that many participants had been living with HIV for over ten years, meaning cutaneous manifestations that arose and resolved prior to 2019 would not have been documented in our database.

Regarding non-infectious cutaneous manifestations, the prevalence of psoriasis in our study (0.4%) was slightly lower than that reported in the general population (~2–3%) and is consistent with findings from a large HIV clinic in Trinidad, which documented a prevalence of 0.42% [17]. Atopic dermatitis has been documented in approximately 30–50% of patients with advanced immunosuppression, but only 0.8% of our study was affected [18]. Xerosis, one of the most persistent cutaneous complaints in the ART era, has been reported in 19–28% of PLWH, yet it was recorded in just 0.1% of our population [19]. Similarly, chronic pruritus is commonly reported among PLWH, with one U.S. study noting a prevalence of 45% [20]. In contrast, only 0.3% of participants in our sample reported pruritus, likely reflecting the immunological stability of this population and a lower burden of pruritogenic dermatoses.

Viral infections such as HSV (5.3%) and HPV (0.7%) were observed among PLWH, reflecting the presence of chronic viral co-infections in this population in the ART era. In a Romanian study, viral infections including vulgar warts and herpes simplex had a combined prevalence of 5.25%, comparable to our findings [21]. Other viral conditions, such as molluscum contagiosum and herpes zoster, while less frequently observed in this cross-sectional sample, are well-documented in the literature for their atypical or disseminated presentations in immunocompromised populations [22].

Bacterial infections were also observed, including cellulitis (1.1%) and abscesses (0.5%), which aligns with findings from other studies reporting low rates of bacterial skin conditions among PLWH in the ART era [21]. These findings are clinically relevant, as bacterial infections may arise as primary conditions or as complications of pre-existing dermatoses such as eczema or herpes. Notably, *Staphylococcus aureus* remains the most common cutaneous pathogen in HIV patients, and its clinical manifestations can range from localized abscesses to extensive soft tissue infections, particularly in individuals with advanced disease.

Additionally, fungal infections were also present, including dermatophyte infections (1.3%) and candidiasis (0.5%). These conditions are typically more widespread and refractory to treatment in immunocompromised individuals, including PLWH [23]. Candidiasis, especially in oral and

intertriginous forms, remains a hallmark fungal manifestation in HIV and can occur across all stages of infection. The presence of fungal infections observed in this study likely reflects the combined influence of host-related factors as well as environmental conditions, as tropical climates are known to have a higher incidence of dermatological fungal infections []23,24]. In our study, no statistically significant associations were found between cutaneous manifestations and most sociodemographic or clinical factors, including sex, age, viral suppression, and CD4 count. A significantly longer duration of HIV infection was observed among patients with non-neoplastic cutaneous manifestations compared to those without (15.84 vs. 13.78 years, p=0.003). This association may reflect cumulative immune dysregulation or chronic inflammation over time; however, increased duration of follow up and greater opportunity for clinical documentation may also contribute to this finding.

In contrast to our findings, several studies have demonstrated a significant trend between cutaneous manifestations in PLWH and immunosuppressive markers such as CD4 count. For example, a cross-sectional study in Madagascar observed that decreases in CD4 count were strongly correlated with certain skin conditions – notably oral candidiasis, syphilis, and cutaneous warts (condyloma acuminatum) occurred more frequently in patients with low CD4 levels [25]. These findings underscore that advanced HIV disease is often accompanied by more cutaneous manifestations, even though our study did not show such trends, possibly due to ART use and control of the disease and the study design.

While these findings provide important insights, several limitations must be acknowledged. First, the cross-sectional design limits the ability to infer causality between HIV status and the presence or severity of dermatologic conditions. In addition, because only bivariate analyses were performed, we were unable to adjust for potential confounding factors such as age, sex, socioeconomic status, antiretroviral therapy exposure, viral suppression, and substance use disorder; therefore, observed associations should be interpreted as descriptive and non-causal. Moreover, the study relied on data analysis using ICD-10 codes, which may have resulted in underreporting or misclassification of skin conditions, particularly in the absence of dermatologist evaluations at the clinic. In addition, a substantial proportion of diagnoses were recorded using nonspecific ICD-10 classifications (e.g., “dermatology skin condition, unspecified” and “rash, unspecified”), which likely reflects real-world documentation practices in community-based settings and may have led to underestimation and incomplete characterization of the true dermatologic burden in this population.

We were also unable to assess the number of distinct cutaneous manifestations per patient, as data were limited to whether a patient had at least one dermatologic diagnosis during the study period. Several variables of interest, such as the specific type of ART regimen, were not available. This is particularly relevant given that earlier antiretroviral medications were associated with dermatologic side effects, and it remains unclear whether long-term exposure to those agents may have lasting cutaneous consequences.

Despite these limitations, the study has several important strengths. It contributes novel epidemiologic insight into the burden of skin disease among PLWH in Puerto Rico, a population seldom examined in dermatologic HIV research. Strengths include a relatively large sample size and the inclusion of a wide range of dermatologic diagnoses within an outpatient setting, reflecting real-world clinical patterns. Notably, this is the first cross-sectional study to evaluate the prevalence of dermatologic conditions exclusively among Hispanic PLWH, providing a valuable foundation for future research and public health initiatives aimed at this underserved population.

Compared to ART-era cohorts (e.g., the recent global meta-analysis by Silva et al., 2024), which reported pooled prevalences of 42%–69% for dermatologic conditions in PLWH, our observed prevalence (19%) is substantially lower. This discrepancy likely reflects under-ascertainment due to limited dermatology access and reliance on ICD-10 coding rather than specialist-confirmed diagnoses. PRCONCRA is a community-based, non-dermatology clinic, where general practitioners may under-document cutaneous findings. Therefore, our results likely underestimate the true dermatologic burden in this population.

5. Conclusions

This study highlights the ongoing burden and clinical relevance of non-neoplastic cutaneous manifestations among PLWH in Puerto Rico. Despite high rates of viral suppression and immunologic stability in the cohort, nearly one in five patients presented with dermatologic conditions most commonly viral infections, dermatitis, and fungal disorders. The findings underscore the persistence of skin disease in the ART era and emphasize the importance of recognizing cutaneous signs as part of comprehensive HIV care. Given the diversity and frequency of these manifestations, even in outpatient settings, routine dermatologic evaluation should be integrated into HIV management strategies. Future efforts should prioritize dermatologist-led screenings and prospective studies to better characterize skin disease progression, treatment outcomes, and quality-of-life impacts in this population.

Author Contributions: Conceptualization - Itzamar Pastrana-Echevarría, Alicia Báez-Cruz, Alexandra Conde-Toro, Angel Mayor-Becerra and Diana Fernández-Santos. Methodology - Itzamar Pastrana-Echevarría, Alicia Báez-Cruz, Alexandra Conde-Toro, Angel Mayor-Becerra and Diana Fernández-Santos. Software - Oscar Lugo-Capera. Validation - Alicia Báez-Cruz, Mileidy Hernandez-Nieves, and Oscar Lugo-Capera, Alejandro Pinilla-Baquero. Formal analysis - Oscar Lugo-Capera. Investigation - Itzamar Pastrana-Echevarría, Alicia Báez-Cruz, and Mileidy Hernandez-Nieves. Resources - Diana Fernández-Santos. Data curation - Alicia Báez-Cruz. Writing—original draft preparation - Itzamar Pastrana-Echevarría; Alicia Báez-Cruz. Writing—review and editing - Alexandra Conde-Toro, Angel Mayor-Becerra and Diana Fernández-Santos. Visualization - Oscar Lugo-Capera. Supervision - Alexandra Conde-Toro, Angel Mayor-Becerra and Diana Fernández-Santos. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement: Data is unavailable as PRCONCRA clinic asks for their data to be secure to protect their patients' privacy.

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REVIEW ARTICLES

Review Article

The risk of receiving multiple spinal x-rays during treatment of scoliosis: analysis based on 2025 standards.

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Abstract: Scoliosis is a deformity of the spine in all three planes. The most common types emerge in otherwise healthy children during adolescent growth. Spine imaging is required for diagnosis and surveillance to determine whether the deformity is progressing. Epidemiologic studies that looked at the long-term effects of receiving multiple spine x-rays in childhood showed a concerning increase in adult malignancy. However, many of those studies were based on exposure from x-ray equipment 50 or more years ago. This paper examines the current risk of receiving necessary spinal x-rays using modern equipment and up to date exposure recommendations from the leading medical organizations. Using example treatment scenarios, children are receiving x-ray exposure that is well below the safe limits. Results show that cumulative radiation doses in adolescents with typical AIS range from 2.04 – 12.21 mSv, a safe cumulative dosage, while the most extreme cases would reach up to 28.45 mSv, a slight increase in risk.

Keywords: Scoliosis; Diagnostic Imaging; Risk Reduction

1. Introduction

Scoliosis is a condition in which the curvature of the spine in the frontal plane is greater than 10° (as measured by the Cobb Angle) and is accompanied by rotation of the spinal column in the axial plane. Scoliosis can be classified into subtypes, including early onset, neuromuscular, syndromic, congenital, and even degenerative scoliosis in older adults [1]. Adolescent Idiopathic Scoliosis (AIS) is the most common form of scoliosis, accounting for 80-85% of all case types in children and young adults. The prevalence of AIS with a Cobb angle >10° in the general population is about 3%, but only one in ten of those patients have progression of their curve to a magnitude that requires treatment. The female to male ratio is 1.4:1 in small curves, but as high as 9:1 in larger curves, with the risk of curve progression also significantly higher in females than in males [2].

When children experience a growth spurt, the risk of curve progression is at its highest, making it important to diagnose the condition in its early stages. When caught early, the curve is carefully monitored by periodic physical examination and spinal x-ray. AIS is usually first noticed by the patient or caregivers, during school-based scoliosis screening, or as an incidental finding during pediatric physical examinations [3].

In patients with AIS, the risk of curve progression is based on age, gender, skeletal maturity, and curve magnitude, with larger curves in younger female patients carrying the highest risk. Approximately two-thirds of skeletally immature patients will progress to some extent before they reach skeletal maturity [1]. Research continues to define each of these factors in the development of a more accurate predictive model. Until curve progression can be predicted in each patient, surveillance remains a very important part of patient care [4-6].

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Surveillance for curve progression consists of regular clinical appointments for physical examination and scheduled radiographic imaging. The goal of surveillance is to catch curve progression and offer treatment before the Cobb Angle reaches 40°. Curves that reach 50° are often candidates for surgical intervention. Treatment to prevent surgery consists of rigid bracing of the trunk to harness the remaining growth, and scoliosis-specific physical therapy exercises focusing on elongation of the spinal posture and de-rotation of the curve. The frequency of follow-up visits and x-rays depends on the severity of the spinal curve and the skeletal maturity of the patient. In younger children with more growth remaining, patients are observed radiographically every 4-6 months until skeletal maturity. In children with little growth remaining, patients are observed radiographically every 6-12 months until skeletal maturity [1]. We sought to understand, gthe need for surveillance and radiographic follow up in this population, do these necessary x-rays pose harm to the patients due to repeated exposure?

Due to the need for repeat radiographic imaging for monitoring of the spinal curve progression, concern has been raised over the harmful effects of x-ray radiation on the developing bodies of children. Ronckers et al. studied 5,513 females who were exposed to an average of 22.9 radiographs during treatment and follow up of scoliosis between 1912-1965. The findings showed that the risk of early mortality was 46% higher than in the general population. Cancer was the primary cause of death in 23% of patients, with breast cancer being the most common type [7]. This increased morbidity and mortality was attributed to the x-rays they had received as growing children. Ronckers calculated the median value for the cumulative dose of radiation to the breast at 100-150 mSv (millisieverts), or about 4.4 to 6.6 mSv per radiographic image. Imaging equipment used much higher doses of radiation in the mid 1900's, amounting to more than a 50-fold increase in what a person would receive from a chest x-ray today [7]. The researchers acknowledged this limitation, but the increased cancer risk attributed to scoliosis surveillance still caused great concerns among many clinicians.

In the years since radiation exposure has been known to be harmful, the US Government has placed limits on the amount of patient radiation exposure. Those limits have been revised and have decreased throughout the last several decades. Prior to 1950, the limit was 250 mSv per year; after 1950, it was lowered to 150 mSv; since 1957, the limit has been 50 mSv per year [8]. Each change in recommendation was based on new information about the damaging effects of radiation on humans, as well as the development of radiographic techniques that required less radiation. Meanwhile, Thorne reported that the dose limit under which there are no negative consequences to radiation exposure is 10 mSv per year [9]. Using these guidelines, a yearly limit of 10 mSv would be ideal, but up to 50 mSv would be the limit when repeated imaging was medically necessary.

More recent studies have examined the cancer risk in patients with exposures greater than 15 mSv. Smith et al. looked at children who had developed hematologic cancer after previous radiation exposure from CT scans and found that 15-30 mSv exposure was associated with a 1.8-fold increased risk. This increased to a 2.5-fold risk for exposures >30 mSv [10]. Brenner et al. found that total radiation doses in the 50-100 mSv range causes a measurable increase in cancer incidence [11]. It is also known that children are more sensitive to radiation than adults because of their developing organs and tissues, resulting in higher excess relative risk of leukemia (70 per 1000 mSv), brain cancer (0.7-1.4 per 1000 mSv), breast cancer (0.5-1.3 per 1000 mSv), skin cancer (2-4 per 1000 mSv), and thyroid cancer (7.7 per 1000 mSv) [12]. Ron et al. found that children under 5 years of age who received radiation exposure were significantly more prone to develop thyroid tumors than older children, with 90 mSv in children <5 years old conferring a 3.0 relative risk compared to children >10 years old, demonstrating this greater risk of cancer when exposed to radiation at a younger age [13].

The positioning of the patient during radiographic spine imaging is also important in reducing the harmful effects of radiation. In female patients, breast tissue absorbs more damaging radiation when an AP x-ray is taken compared to a PA x-ray. A study done by Nash et al. found that females with AIS who had about 22 AP and lateral spine films taken during a 3-year period had a 10% increased lifetime risk of breast cancer. When PA films were taken rather than AP films, this risk was reduced to 3.8% [14].

In 2022, the US Nuclear Regulatory Commission reported that the average annual dose of background radiation exposure is 6.2 mSv for most people on earth. Of that dose, half (3.1mSv) comes from natural radiation from the sun which can vary at different altitudes, and from naturally occurring radon gas released from the ground. The rest of our background radiation exposure comes from man-made sources such as radiographic imaging, commercial, and industrial sources [15].

Over the last several decades, a number of organizations have weighed in on what level of radiation exposure from imaging is safe. The Centers for Disease Control (CDC) published a radiation safety guideline called ALARA, which is an acronym for "As Low As Reasonably Achievable." Its purpose is to avoid any amount of radiation that is not necessary to produce the imaging. The three protective measures outlined are the time of the exposure, the distance from the radiation source, and the shielding of parts of the body that do not need to be included in the image [16]. The US Food and Drug Administration (FDA) refer to the CDC ALARA guidelines in its recommendations, especially when dealing with pediatric patients [17].

The American College of Radiology produced a white paper on radiation dose in medicine. They show that radiation exposure has increased 7-fold in the US over the last 40 years due to the increased use of imaging studies, despite the lower dose of radiation exposure per study. Myocardial perfusion imaging accounted for 22% of the total increase, and CT scans of the abdomen, pelvis and chest accounted for another 38%. Radiological imaging in the US makes up about 12% of all imaging studies worldwide [18].

Non-governmental organizations have also published guidelines. The Image Gently Alliance is a group of pediatric imaging clinicians who have published guidelines for both clinicians and parents. To make the information understandable to non-clinicians, they compare common pediatric imaging exposures to the yearly background radiation that we all receive, explaining that a single chest x-ray with modern equipment is equal to only one day of background radiation [19]. Similarly, a head CT is equal to 8 months of background radiation, and an abdominal CT is equal to 20 months. They state that there is no consensus for the threshold of radiation exposure in pediatrics, so the principle is to always image as little as possible without compromising the quality of care. Their estimate is that a single CT scan only increases the cancer risk later in life by 0.03 to 0.05%. They warn that some imaging facilities use the same dosage protocols for children and adults, and advocate for the adjustment of those protocols to account for the smaller pediatric patient size. The potential use of non-radiographic studies such as ultrasound and MRI is also explained [19].

International institutions, such as the World Health Organization (WHO) and the International Commission on Radiological Protection (ICRP), have also made recommendations. The WHO has studied the effects of short-term and long-term radiation exposure in populations, and describes the acute radiation syndrome in doses greater than 1000 mSv. They recognize the increased sensitivity to radiation in children, and describe the effects based on age groups. They recommend childhood exposure to be no greater than 50-100 mSv because of increased risk of cancer, and they stress that exposure during pregnancy of 100 mSv at 8-15 weeks of gestation and 200 mSv at 16-25 weeks of gestation can result in significant fetal brain damage [20]. The ICRP updated its recommendations in 2007 and described limits for both occupational exposure and patient exposure. In the occupational setting, their dose limit is 20 mSv per year averaged over 5 years, while in the patient setting it is 1 mSv per year averaged over 5 years. They also provide exposure limits for different parts of the body, with skin being 500 mSv per year, and hands/feet being 500 mSv per year in the occupational setting [21].

The US Occupational Safety and Health Administration (OSHA) provides similar guidelines for US healthcare workers. They require employers to measure employee exposure on a daily basis, and report these exposure levels to the federal government. Limits include 12.5 mSv to the whole body per quarter, and 187.5 mSv per quarter for hands and forearms. They allow for a healthcare worker to exceed these limits in certain situations, but only if the single quarter exposure remains below 30 mSv to the whole body. These recommendations have not been revised since 1971, however [22].

In an effort to reduce radiation exposure in medical imaging, new techniques and technology have been introduced. EOS Imaging (TM) is a company producing a new method of radiologic

imaging that reduces radiation exposure through slit-scan photon emission and low-dose and flex-dose technology that changes the dose amount dependent on the part of the body [23]. Rose et al. measured the radiation dose of spinal x-rays in 206 children with scoliosis and found that plain film gave a total mean dose of 0.68mSv (PA plus lateral views) while EOS scans gave a total mean dose of 0.13 mSv (PA and lateral taken at the same time) [24]. One study showed that children with large curves in the surgical range have a mean of 12.2 (95% CI, 10.8-13.5) full-spine radiographs per year during treatment [25]. Therefore, the number of radiographs in these more severe cases would yield 8.16 mSv per year using plain x-rays or 1.56 mSv through EOS scans. (Table 1)

Table 1. Comparison of radiation dose using different methods

Method	**PA + Lateral image**	**1 per year**	**4 per year**	**12 per year**
Plain Film	0.68 mSv	0.68 mSv	2.72 mSv	8.16 mSv
EOS scan	0.13 mSv	0.13 mSv	0.52 mSv	1.56 mSv
Target Dose	Less than 10 mSv per year			

Both these radiographic techniques fall under the 10 mSv per year limit, in which Thorne suggests there are no negative consequences [9], as well as below the 50 mSv federal limit. In cases where the curve magnitude is smaller, less radiographic images are required per year, and the annual dose of radiation for these patients would be well below the recommended limit. While the safest dose of radiation is always the lowest possible dose, the tradeoff between the lower dose of radiation using EOS and the higher cost of the EOS equipment must be considered.

2. Materials and Methods

In order to calculate whether children with scoliosis are receiving radiation doses that are within the safe limits recommended by the different organizations described above, a series of typical patient scenarios were created to estimate the total treatment dosage each would receive. Each case represents a common type of scoliosis patient entering treatment based on the age that their spinal deformity was discovered:

A 3-year-old child with early onset scoliosis could need up to 4 x-rays per year until they are 18 years old. Over the course of 15 years, this child would receive 25.5 mSv from plain films, which is about 1.7 mSv per year, accounting for exposure that is comfortably below the 10 mSv limit suggested by Thorne. However, if this child requires surgery and received 2 pre-operative CT scans (0.942 mSv each), intraoperative fluoroscopy, and a post-operative CT scan, the total dose would rise to 28.45 mSv.

An 11-year-old child with moderate AIS that needs 3 x-rays per year until age 16 would receive 6.8 mSv across 5 years, or 1.36 mSv per year.

A 12-year-old child with AIS whose curve is worsening needs 4 x-rays per year, receiving 1.7 mSv per year. When this child undergoes surgery, they could receive 1 pre-operative CT scan, intraoperative fluoroscopy, and 1 post-operative CT scan, bringing their total dose to 12.21 mSv.

A 14-year-old child with a small curve that needs 1 x-ray per year until age 16 would receive 2.04 mSv across 3 years, or 0.68 mSv per year.

3. Results

Table 2. Calculation of radiation doses in example cases

Example Case	X-rays	CT scans	Intraoperative Fluoroscopy	Dose per year	Total Dose
3-year-old with early onset scoliosis operative category	4 per year	2 pre-op, 1 post-op	Yes	1.7 mSv	28.45 mSv
11-year-old with AIS who is immature	3 per year	-	-	1.36 mSv	6.8 mSv
12-year-old with worsening curve, operative category	4 per year	1 pre-op, 1 post-op	Yes	1.7 mSv	12.21 mSv
14-year-old with small curve	1 per year	-	-	0.68 mSv	2.04 mSv

4. Discussion

In these examples, all patients would receive a radiation dose from x-rays that falls under the safe parameter of 10 mSv/year set by Thorne, as well as the federal limit. For mild to moderate curves, the total dose of x-ray during the course of treatment is also very low. In the case of younger patients who need more imaging over a longer period of time, the total dose of radiation is higher. The clinician might ask how a treatment dose of 25 mSv of radiation would change the level of risk. For comparison, during that 15-year treatment period, the patient would be exposed to 46.5 mSv of radiation from the sun and radon gas. Although the additional 25 mSv is not ideal, it is just half of what we experience every day on earth. If an EOS scanner was used of standard x-ray, that 25 mSv dose would be reduced to 4.8 mSv. Cases such as this one would pose the strongest argument for the use of EOS, despite its higher cost.

5. Conclusions

AIS will always raise concerns among patients and their parents, and when repeated x-rays are used to monitor curve progression, there will always be a question of whether the radiation dose will prove to be harmful in the future. While radiation should always be used sparingly in growing children, this analysis of the evidence shows that the risk of medically necessary x-rays in 2026 is likely very low. Studies, like those of Ronckers, were critical in pointing out the long-term effects of higher radiation exposure and helped drive clinical medicine to improve technology and reduce exposure. Notably, studies that measure post-radiation effects from half a century ago do not represent the current level of risk. Applying modern equipment and implementing today's limits for re-calculation, it is very likely that those patients would have received less than a tenth of the recommended dose.

Using the analysis from this paper, a clinician could calculate the expected radiation exposure for a patient in their care, which could help parents understand the improvements that have been made in technology and safety in radiologic imaging. A comparison could be made between standard and EOS imaging to assist in decision-making about which technique should be used. Increased transparency about the actual risks of medical treatment will improve patient understanding, enhance the quality of medical discussions, and strengthen the consent process.

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CASE REPORTS

Case Report

Heterozygous Frameshift Genetic Variant in *TNFRSF13C* Gene Associated with Specific Antibody Deficiency Memory Phenotype

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Abstract: Specific antibody deficiency (SAD) is a primary immunodeficiency disease (PID) in which patients present with recurrent sinopulmonary bacterial infections and decreased antibody responses to polysaccharide antigens following vaccination. SAD memory phenotype refers to an initial serologic and clinical response to the 23-valent polysaccharide vaccine followed by the loss of protective antibodies within six months. Various PID can present with diminished specific antibody responses, and it is known that patients with SAD can develop Common Variable Immunodeficiency (CVID) later in life. We present the case of a 7-year-old male with significant history of recurrent sinopulmonary infections since the age of two, who was diagnosed with SAD memory phenotype. A PID genetic panel revealed a *TNFRSF13C* genetic variant of unknown significance in Exon 3: c.534_543delinsAATAGCAGG (p.Ala179Ilefs*46). This variant results in a frameshift in the B cell-activating factor receptor (BAFFR) encoding gene. BAFFR is essential for the survival and maturation of transitional B cells into mature follicular and marginal zone B cells and has an important role in the development of T-independent antibody responses. BAFFR deficiency is known to be a genetic etiology for CVID and heterozygous missense polymorphisms have been implicated as risk factors for the development of CVID. The patient's phenotype, which demonstrates inadequate T-independent antibody responses, correlates with the previously described phenotype of patients with *TNFRSF13C* variants. Here, we present a patient with SAD memory phenotype harboring a frameshift heterozygous variant in BAFFR. This case highlights the need to consider rare genetic causes in patients with PID.

Keywords: Specific Antibody Deficiency; BAFFR; *TNFRSF13C*

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1. Introduction

Specific antibody deficiency (SAD) is a primary immunodeficiency disease (PID) in which patients present with recurrent sinopulmonary bacterial infections and decreased antibody responses to polysaccharide antigens following vaccination. Patients with SAD have normal responses to protein or conjugate vaccines and immunoglobulin levels, including IgA, IgM, IgG and IgG subclasses [1-3]. SAD is estimated to affect up to 6-10% of individuals referred for evaluation of primary immunodeficiency, although it is likely underdiagnosed. SAD is clinically classified in mild, moderate, severe, and memory phenotype based on the persistence and degree of vaccine response. The memory phenotype refers to an initial serologic and clinical response to the 23-valent polysaccharide vaccine followed by the loss of protective antibodies within six months [4]. Various inborn errors of immunity (IEI) can present with diminished specific antibody responses, including some combined immunodeficiencies such as *MALT1* and *RELB* deficiency, Hyper IgE Syndromes including STAT3 LOF, IL-6 receptor deficiency and CARD11 deficiency, and defects with predominantly antibody deficiencies such as common variable immunodeficiency (CVID), CD21, TWEAK deficiency (*TNFSF12* genetic variants), among others [5]. Although the prevalence of

SAD in Puerto Rico is currently unknown, it is likely underreported, as seen in other underrepresented populations.

B cell-activating factor receptor (BAFFR) deficiency was first described in two related patients that presented with late-onset CVID. These first patients carried a homozygous deletion within the BAFFR encoding *TNFRSF13C* gene [6]. BAFFR, which is highly expressed in mature naive follicular or marginal zone B cells but not in plasma cells, is part of the large tumor necrosis factor (TNF)-receptor superfamily (TNFRSF) that includes other receptors such as TACI, CD40, and Fas [7]. TACI (*TNFRSF13B* gene) genetic variants have been reported as the most common genetic defects in patients with CVID [8]. Both homozygous and heterozygous variants in TACI have been described in patients with CVID [9-10]. CVID is the most prevalent clinically significant primary immunodeficiency in humans and is characterized by hypogammaglobulinemia in association with an increased susceptibility to infections and other clinical manifestations of immune dysregulation [11-12]. It has been reported that patients with SAD can develop CVID later in life, and even though cases of CVID have been associated with *TNFRSF13C* homozygous variants and one missense heterozygous variant, frameshift mutations in *TNFRSF13C* have not been reported to be associated with predominantly antibody deficiencies [6, 13-14]. In Puerto Rico, the prevalence of CVID, SAD and genetic variants associated with humoral immunodeficiencies remains unknown. This report aims to present the first documented case of a BAFFR genetic defect in a Puerto Rican pediatric patient, contributing to the understanding of SAD and its genetic underpinnings in this population.

2. Case Presentation

We present the case of a 7-year-old male with history of allergic rhinitis, moderate persistent asthma, and eosinophilic esophagitis (EoE) recently diagnosed with Specific Antibody Deficiency (SAD) at the age of seven. The patient presented with remarkable history of recurrent sinopulmonary infections since the age of two, leading to more than 20 hospitalizations over the last five years. Family history was only remarkable for asthma in paternal grandmother; parents denied consanguinity or family history of inborn errors of immunity. He is followed in the pediatric pulmonary clinic and was given a diagnosis of moderate persistent asthma for which he was started on high dose inhaled corticosteroid (ICS) treatment and leukotriene inhibitors.

Given the patient's unusual medical history, including recurrent bronchitis, acute bacterial sinusitis, and multiple episodes of *Mycoplasma* pneumonia, which often required hospitalization for intravenous antibiotics, genetic testing was ordered by the pulmonary service. The genetic panel for primary immunodeficiencies, primary ciliary dyskinesia, and cystic fibrosis included 471 genes. The genetic testing results were significant for six heterozygous variants of unknown significance (VUS) in genes: *ATM, C6, C9, CIITA, FCHO1, TNFRSF13C*. Besides the *TNFRSF13C* variant in Exon 3 c.534_543delinsAATAGCAGG (p.Ala179Ilefs*46), the other VUS did not correlate with his clinical phenotype.

Following the genetic testing results, further immune evaluation was ordered including immunoglobulin levels, lymphocyte subset panel, and tetanus and diphteria antibody levels that were within normal limits for age (Table 1, 2). However, 23 *Streptococcus pneumonia* titers were only protective for three serotypes (8, 17F, 19F) even though he had received his childhood vaccinations, including four doses of Pneumococcal 13-valent conjugate vaccine. Based on these results, the patient was instructed to get vaccinated with pneumococcal vaccine polyvalent for 23 serotypes (PPV23). Post-vaccination titers showed seroprotective levels (>1.3 μg/mL) for nineteen titers (83%) six weeks after vaccination (Table 3).

Table 1. Lymphocyte subset panel

Lymphocyte subset	**Results**	**Normal Range**
% CD3 T Cells	79	60-76%
Absolute CD3+ Cells	2884	1200-2600 cells/uL
% Cd4	37	31-47%
Absolute CD4+ Cells	1296	650-1500 cells/uL
%CD8	36	18-35%
Absolute CD8+ Cells	1257	370-1100 cells/uL
CD4/CD8 Ratio	1.03	1-3
% CD16+CD56 (NK Cells)	3	4-17%
Absolute NK Cells	95	100-480 cells/uL
%Cd19 (B Cells)	18	13-27%
Absolute CD19+ Cells	669	270-860 cells/uL
Absolute Lymphocytes	3656	1500-6800 cells/uL

Table 1. *Results showing normal B cell count, mildly increased total T cell count, and mildly decreased NK cell count.*

Table 2. Immunoglobulin levels

Immunoglobulin	**Results (mg/DL)**	**Normal Range (mg/DL)**
IgA	74.04	70.00-400.00
IgG	1009.58	700.00-1600.00
IgM	105.74	40.0-230.00

Table 2. *Normal immunoglobulin levels for age.*

Even after vaccination with PPV23 with an adequate protective response and being on antibiotic prophylaxis with macrolides, the patient continued to have recurrent sinopulmonary infections. Given a high suspicion for a humoral immunity defect, 23 pneumococcal serotype titers were repeated six months after vaccination by the Immunology service with results showing seroprotective levels (>1.3 µg/mL) in only 10 out of 23 serotypes (43%) (Table 3, Figure 1). Due to the recurrent *Mycoplasma*

pneumonia diagnoses, an antibody level to *Mycoplasma* was ordered which showed undetected levels of specific IgG.

Table 3. 23 pneumococcal serotype titers

IgG	Pre-vaccination (mcg/mL)	Six weeks Post-vaccination (mcg/mL)	Six months Post-vaccination (mcg/mL)
Serotype 1	0.4	51.9	2.8
Serotype 2	<0.3	9.1	1.7
Serotype 3	<0.3	>44.0	0.4
Serotype 4	<0.3	15.5	0.7
Serotype 5	0.7	61.7	2.5
Serotype 8	3.5	>86.0	11
Serotype 9 (9N)	<0.3	9.8	0.8
Serotype 12 (12F)	<0.3	<0.3	<0.1
Serotype 14 (14)	<0.3	56	6.5
Serotype 17 (17F)	<0.3	40.1	4.8
Serotype 19 (19F)	1.3	35.5	3.3
Serotype 20 (20)	3.3	>54.0	15.6
Serotype 22 (22F)	<0.3	2.4	0.6
Serotype 23 (23F)	0.4	23.1	1
Serotype 26 (6F)	0.6	24.5	0.8
Serotype 34 (10A)	<0.3	1.1	0.3
Serotype 43 (11A)	<0.3	0.7	0.2

Serotype 51 (7F)	0.4	46	1.5
Serotype 54 (15B)	<0.3	1.2	0.9
Serotype 56 (18C)	<0.3	17.2	0.6
Serotype 57 (19A)	<0.3	9	1.3
Serotype 68 (9V)	<0.3	7.9	0.5
Serotype 70 (33F)	<0.3	1.8	0.8

Table 3. *23 Streptococcus pneumoniae IgG levels showing inadequate protective levels pre-PPV23 vaccination, adequate response six weeks post-vaccination, and loss of protective levels six months after PPV23 vaccination.*

Figure 1. 23 pneumococcal serotype titers pre- and post-PPV23 vaccination

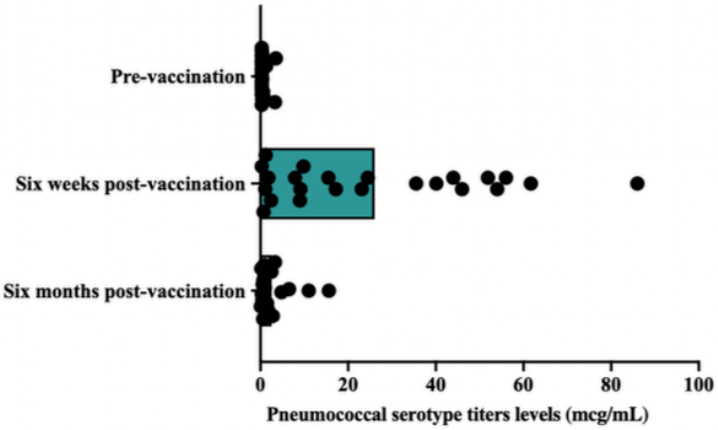

Figure 1. *Visual representation of 23 Streptococcus pneumoniae IgG levels pre- and post-vaccination (six weeks and six months after PPV23 vaccination).*

According to the working group report of the Basic and Clinical Immunology Interest Section of the American Academy of Allergy, Asthma & Immunology, a serotype-specific level of 1.3 mg/mL or greater is considered protective against invasive disease following polysaccharide immunization [4]. Based on the clinical findings and laboratory results, the patient was diagnosed with SAD memory phenotype. The SAD memory phenotype criteria include an adequate initial response to PPV23 (>50% protective for children 2-5 years of age and >70% protective for those 6-65 years of age) with loss of this response within 6 months. At this time the patient was started on immunoglobulin replacement therapy and continues treatment for EoE, Asthma, and Allergic Rhinitis.

3. Discussion

This case describes a pediatric patient with SAD memory phenotype and genetic testing results showing a VUS in the exon 3 of the *TNFRSF13C* gene (p.Ala179Ilefs*46). This genetic variant results in a frameshift in the gene that encodes for BAFFR. BAFFR is essential for the survival and maturation of transitional B cells into mature follicular and marginal zone B cells. BAFFR is also thought to enhance the survival and expansion of germinal center B cells by promoting the selection of high affinity switched memory B cells and plasma cells. BAFFR is also expressed in central and effector memory T cells, providing a costimulatory signal [15].

BAFFR deficient mice are known to have impaired antibody responses to T cell-dependent and T cell-independent antigens, but this is less likely in human, as BAFFR expression is absent in resting and activated $CD4^+$ T cells [6,16]. These mice also have severely reduced follicular and marginal zone B cells, but have normal IgA secreting plasma cells [17]. Deficiency of BAFFR in humans has only been described once in two siblings. The patients carried a homozygous 24-bp in-frame deletion (del89–96) located in exon 2. The described patients had B cell lymphopenia, low IgG levels with normal IgA, and decreased IgM^+ $CD27^+$ marginal zone B cells, which are thought to be the precursor cell of T-independent antibody responses against encapsulated bacteria. The most clinically severely affected patient had absent T-independent and T-dependent antibody responses, but the second sibling only had impairment of T-independent humoral responses and did not meet criteria for CVID diagnosis. These findings demonstrated variable expressivity of BAFFR deficiency [6].

SAD is a subtype of primary immunodeficiency characterized by the inability to mount an adequate T-independent antibody response to specific antigens despite having normal immunoglobulin levels. While SAD is often distinguished from other primary immunodeficiencies by its isolated antibody response impairment, a specific genetic mutation has not been associated with isolated SAD. Rather, emerging evidence suggests potential intersections of SAD in multiple inborn errors of immunity, such as *NEMO, TACI*, *MALT1, RelB, STAT3* deficiencies, among others [5,7].

Our patient's heterozygous variant is expected to disrupt the last six amino acids of the BAFFR protein and extend the protein by 39 additional amino acid residues. BAFFR is a homotrimeric receptor, and its C-terminal domain, located on the cytoplasmic side, is crucial for downstream signaling through the NF-κB pathway. Alterations in this region could impair signal transduction even in the heterozygous state, potentially explaining the patient's impaired antibody maintenance. Even though the patient presented with a heterozygous variant, previous studies have shown that a single-nucleotide polymorphism in *TNFRSF13C* gene, Pro21>Arg (P21R) (c.62C>G; rs77874543), present in homo- or heterozygous forms may contribute to the development of CVID [14]. This is a phenomenon also recognized in the *TNFRSF13B* (TACI) gene, in which homozygous and heterozygous mutations have been described as risk factors for the development of CVID [9-10].

The clinical presentation of our patient, including recurrent sinopulmonary infections and a decline in pneumococcal serotype-specific antibody titers within six months post-immunization, aligns with the memory phenotype of SAD. Although, no other functional studies have been done in this case to prove abnormalities in the BAFFR protein, the patient's SAD memory phenotype, which demonstrates inadequate T-independent antibody responses, correlates with the previously described clinical phenotypes of patients with *TNFRSF13C* genetic variants [6,14].

Management of SAD primarily focuses on preventing infections and optimizing the patient's quality of life. This includes immunization with conjugate vaccines, prophylactic antibiotics, and, in severe or refractory cases, immunoglobulin replacement therapy. While this patient achieved protective titers for most pneumococcal serotypes shortly after vaccination, the subsequent decline highlights the limitations of polysaccharide vaccine responses in individuals with SAD. The progressive decline in pneumococcal serotype-specific antibody titers highlights the importance of regularly monitoring specific antibody responses in patients with recurrent infections, even when their immunoglobulin levels are within normal limits. The patient's history of eosinophilic

esophagitis, asthma, and allergic rhinitis highlights the interplay between immune dysregulation and atopic conditions, which may contribute to an increased susceptibility to infections.

This case contributes to the understanding of SAD as a potentially heterogeneous disorder, where underlying genetic variants, such as those involving BAFFR, may play a contributory role. Highlighting genetic contributors, such as this novel frameshift variant, not only advances our understanding of SAD but also underscores the importance of equitable diagnostic access for both local and diaspora Puerto Rican populations. Notably, there is a lack of information about genetic variants associated to inborn errors of immunity in populations from Puerto Rico, highlighting the need for localized research and awareness. In Puerto Rico, the diagnosis of SAD remains challenging due to limited awareness and access to immunologic and genetic testing. These barriers can delay appropriate care and increase the risk of complications such as bronchiectasis and chronic lung disease. Early diagnosis is essential, as effective interventions - including conjugate vaccine boosting, prophylactic antibiotics, and immunoglobulin replacement - can significantly reduce infections and improve long-term outcomes. Also, further research is needed to explore the genetic and molecular mechanisms linking specific antibody deficiencies to broader immune dysregulation and to explore the potential progression of SAD to CVID. Pediatricians, immunologists, pulmonologists, infectious disease specialists, and other health care providers must collaborate to recognize and manage cases promptly. Physicians practicing in our region may need to maintain a high index of suspicion to accurately diagnose both SAD and CVID, given their potential for under-recognition.

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Case Report

A Diagnostic Trifecta Case Report: Struma Ovarii with Pseudo-Meigs Syndrome and Subsequent Ovarian Remnant Syndrome

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Abstract: Struma ovarii is a rare ovarian teratoma composed predominantly of thyroid tissue, representing less than 1% of all ovarian tumors. The clinical presentation of struma ovarii can vary widely, from an asymptomatic palpable abdominal mass, hyperthyroidism (elevated free T4 and/or T3; low TSH), and, in rare cases, pseudo-Meigs syndrome. Diagnosis is often based on postoperative histopathological confirmation of thyroid tissue. We present a case of a 44-year-old Hispanic female with an incidental finding of an adnexal mass, pleural effusion, and ascitic fluid, but with normal tumor markers, cancer antigen 125 (CA-125), and carcinoembryonic antigen (CEA). Postoperative pathological examination confirmed struma ovarii, with pseudo-Meigs syndrome. Unexpectedly, the patient developed ovarian remnant syndrome (ORS). This case contributes to the limited literature describing struma ovarii associated with pseudo-Meigs syndrome and normal tumor markers, highlighting the diverse clinical spectrum of this tumor. It also underscores the need for a high index of suspicion for struma ovarii in atypical cases, regardless of tumor marker levels. The development of ORS further emphasizes the importance of long-term follow-up after definitive surgical management.

Keywords: struma ovarii, ovarian tumor, pseudo-Meigs syndrome, ovarian remnant syndrome

1. Introduction

Struma ovarii is a rare and often underrecognized variant of ovarian dermoid tumors in which thyroid tissue is the major constituent [1, 3, 6]. Struma ovarii was first described in 1889 by Boettcher, who noted thyroid tissue within an ovarian dermoid [2, 3]. Later, in 1899, Gottschalk published a report of an ovarian tumor composed entirely of thyroid-like tissue [3]. Struma ovarii accounts for less than 1% of all ovarian tumors and 2% to 4% of all ovarian teratomas; 5% to 10% are bilateral, and 5 to 10% are malignant [4]. Although struma ovarii contains functioning thyroid tissue, only about 5% of cases produce sufficient thyroid hormones to cause clinical hyperthyroidism [1].

The clinical presentation of struma ovarii is highly variable, ranging from an asymptomatic pelvic or abdominal mass to pelvic pain or abnormal vaginal bleeding. In rare cases, it may be associated with pseudo-Meigs syndrome, characterized by the triad of ascites, pleural effusion, and an ovarian tumor. Laboratory findings can be misleading, as serum tumor markers such as cancer antigen 125 (CA-125) and carcinoembryonic antigen (CEA) may be normal or elevated. Elevated CA-125 levels are frequently reported and may incorrectly suggest ovarian carcinoma. A pelvic ultrasound is necessary based on these findings, and struma ovarii would be indicated by a complex ovarian mass with cystic and solid areas [6]. Computed tomography (CT) or magnetic resonance imaging (MRI) should also be performed to assess the tumor's extent and to screen for possible metastases.

Management of struma ovarii is primarily surgical and may involve unilateral or bilateral oophorectomy using laparoscopic or open approaches, depending on patient age, fertility considerations, tumor characteristics, and concern for malignancy. An added complexity arises when struma ovarii is followed by ovarian remnant syndrome (ORS), a rare condition. Here, residual ovarian tissue remains after oophorectomy and later becomes symptomatic. ORS is most often

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reported in patients with endometriosis, pelvic inflammatory disease, multiple past surgeries, or pelvic adhesions, although its occurrence after struma ovarii is not well characterized in the literature. Patients usually present with chronic pelvic pain, which may be linked to a pelvic mass or found incidentally as an asymptomatic mass [5].

This case report details the diagnostic evaluation, surgical management, and postoperative complications in a 44-year-old Puerto Rican-Hispanic female with struma ovarii and pseudo-Meigs syndrome, normal tumor markers, and subsequent ORS. It highlights the diagnostic and management challenges and underscores the need for long-term postoperative surveillance.

2. Case Presentation

A 44-year-old Hispanic woman, gravida 3 para 3, with a medical history significant for class I obesity (BMI 34kg/m^2), hypertension, and iron deficiency anemia presented to her obstetrician-gynecologist following referral from her primary care provider for evaluation of a pelvic mass found incidentally. The patient reported mild, nonspecific abdominal discomfort but denied genitourinary symptoms. Her last menstrual period occurred two weeks prior to presentation, and she reported regular menstrual cycles. Gynecologic history was notable for menarche at age 12; one cesarean delivery at age 18, followed by two vaginal births. Her surgical history included laparoscopic sterilization and incision and drainage of three prior vulvar abscesses.

On presentation, vital signs were notable for elevated blood pressure measuring 165/92 mmHg; the remainder of her vital signs were within normal limits. Abdominal examination revealed moderate tenderness and distension, with surgical scars consistent with her prior operative history. On bimanual pelvic examination, a palpable right adnexal mass was identified. The uterus was anteverted, normal in size and contour, and freely mobile, with no cervical motion tenderness appreciated.

Abdominopelvic CT (Figure 1) revealed a large, 20.5 cm cystic mass with a calcified soft-tissue component extending into the right adnexa, findings that were concerning for ovarian carcinoma. Additional findings included trace right-sided pleural effusion, mild ascites, and soft-tissue thickening along the omentum, raising suspicion for peritoneal carcinomatosis. The combination of an ovarian mass, ascites, and pleural effusion suggested Meigs syndrome. Laboratory evaluation demonstrated normal TSH (1.341 μIU/mL), T4 (1.37 ng/dL), and human chorionic gonadotropin (hCG) (<2.6 μIU/mL) levels. Additional tumor markers were also normal: CA-125, 32 ng/mL; CEA, 0.14 ng/mL; AFP, 0.2 ng/mL. Given the concern for malignancy, the patient underwent bilateral salpingo-oophorectomy, appendectomy, omentectomy, and peritoneal washings. Gross specimens (Figure 2) were collected and submitted for histopathological evaluation. The cystic ovarian mass measured 19.5 × 15.5 × 5.5 cm and weighed 1,206 g (4.2 lb). Histopathologic examination demonstrated predominant thyroid tissue differentiation, confirming the diagnosis of struma ovarii associated with pseudo-Meigs syndrome.

Four months postoperatively, the patient reported painless vaginal bleeding that had persisted for approximately three months. Physical examination revealed active vaginal bleeding, while bimanual pelvic examination remained unremarkable. Endovaginal ultrasound (Figure 3) demonstrated an anteverted uterus measuring 9.6 × 6.1 × 7.1 cm in longitudinal, anteroposterior, and transverse dimensions respectively. A simple cyst measuring 2.2 × 1.8 × 2.5 cm was identified in the cul-de-sac, with no evidence of residual ovarian tissue or additional adnexal masses. Laboratory evaluation revealed a normal follicle-stimulating hormone (FSH) level (5.44 mIU/mL) and an elevated estradiol level (166.60 pg/mL), findings suggestive of ongoing ovarian hormonal activity despite prior bilateral salpingo-oophorectomy.

The patient's abnormal uterine bleeding was initially managed with diagnostic hysteroscopy and fractional curettage. Histopathologic examination demonstrated chronic endocervicitis and endometrial hyperplasia without atypia. In the setting of persistent estrogen production and prior oophorectomy, ORS was suspected. Medical management with megestrol acetate was initiated to address hormonal imbalance and endometrial changes; however, the patient continued to experience persistent symptoms along with adverse medication effects. Consequently, a supracervical hysterectomy with peritoneal washing was performed.

Gross surgical specimens (Figure 4) were obtained and submitted for pathologic evaluation. Histopathologic analysis revealed benign residual ovarian parenchyma with evidence of hemorrhagic corpora lutea, confirming the diagnosis of ORS. The patient's postoperative course was uneventful, with complete clinical recovery and no reported complications.

2.1 Images

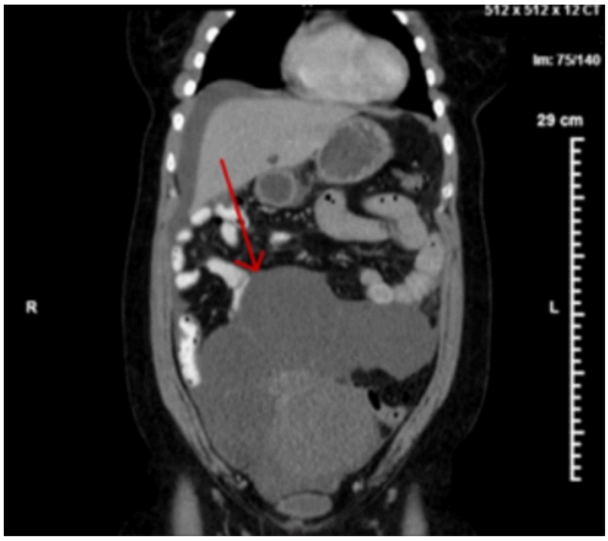

Figure 1. Abdominopelvic CT scan showing a large, 20.5 cm multi-lobulated cystic mass with calcified soft tissue component extending to the right adnexa (red arrow).

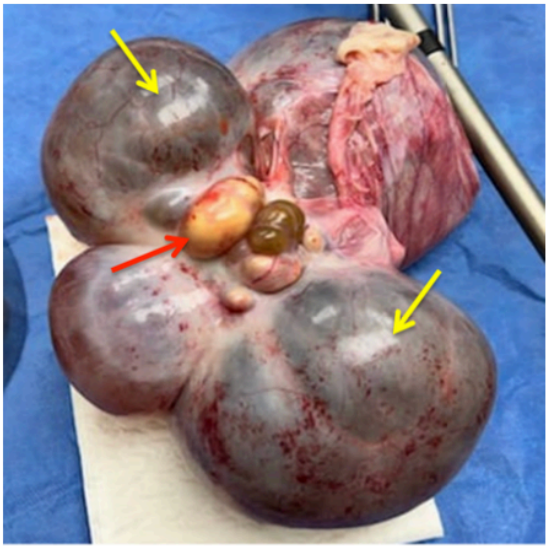

Figure 2. Macroscopic features of the struma ovarii resected surgically. The specimen demonstrates a markedly enlarged, multilobulated ovarian mass with multiple tense, cystic components (yellow arrows). The surface appears soft and gelatinous, with a golden yellow to beefy, reddish-brown color, resembling thyroid tissue (red arrow).

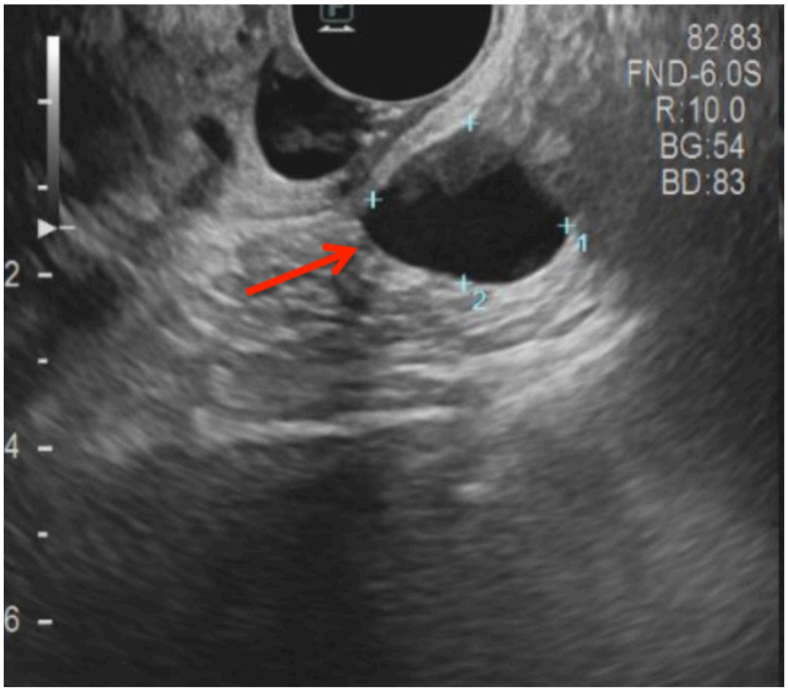

Figure 3: Endovaginal ultrasound showed a simple cyst (red arrow) measuring 2.2 × 1.8 × 2.5 cm was identified in the cul-de-sac region.

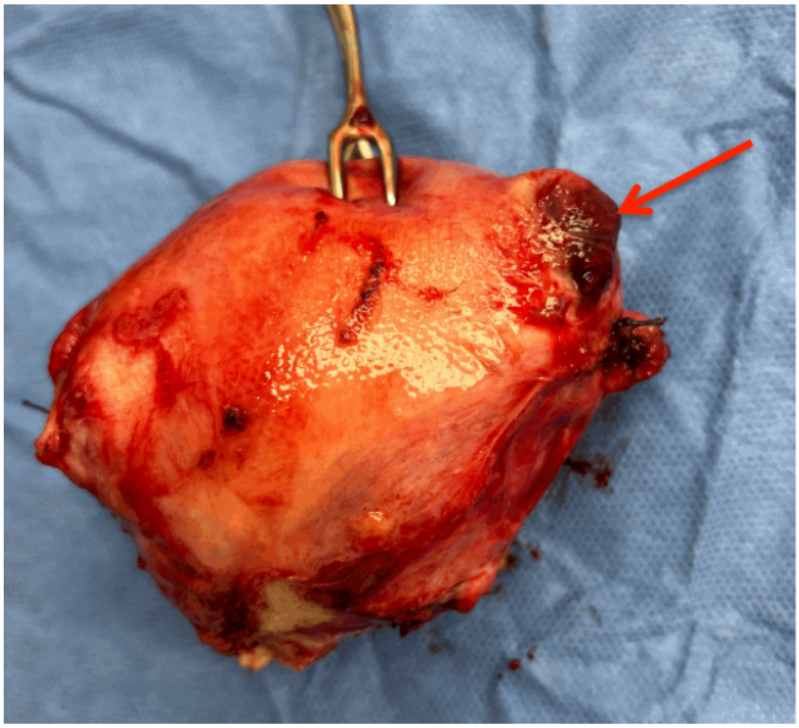

Figure 4: Pathologic evaluation of the uterus after hysterectomy revealed a benign, residual ovarian parenchyma with evidence of hemorrhagic corpora lutea, confirming the diagnosis of ORS.

3. Discussion

Struma ovarii is a rare ovarian teratoma characterized by predominant thyroid tissue, accounting for less than 1% of all ovarian tumors [1,3,6]. Despite the high prevalence of thyroid disease, only

about 5% of cases result in clinical thyrotoxicosis [2,4]. Most cases are unilateral, and bilateral involvement is uncommon [4]. This rarity, combined with its heterogeneous presentation, often contributes to diagnostic uncertainty and delayed recognition.

Pseudo-Meigs syndrome—ascites and pleural effusion associated with an ovarian tumor other than fibroma—is a rare but recognized manifestation of struma ovarii [2,5]. As highlighted in this case, the coexistence of ascites, pleural effusion, and a large ovarian mass in the setting of normal tumor markers can closely mimic advanced ovarian malignancy, complicating preoperative diagnosis [3,6]. While CT and MRI may demonstrate a complex multicystic mass lacking the typical fat content of dermoid cysts, definitive diagnosis ultimately relies on histopathological confirmation [6,7].

A particularly unique aspect of this case is the rapid postoperative development of ORS, a rare complication caused by residual ovarian tissue following oophorectomy that typically presents with pelvic pain, mass effect, or persistent hormonal activity [8,9]. Although it is most often associated with endometriosis, extensive adhesions, or multiple prior pelvic surgeries, its occurrence following struma ovarii is rarely described in the literature [5]. In this case, early onset of ORS may have been influenced by technical challenges related to distorted anatomy and adhesions caused by the large ovarian mass [9].

This case underscores the importance of maintaining a high index of suspicion for struma ovarii in patients presenting with complex ovarian masses and atypical features, even in the presence of normal tumor markers. It also highlights the need for meticulous surgical technique and vigilant long-term follow up to promptly identify and manage rare postoperative complications such as ORS. Further research is needed to better elucidate the pathophysiologic relationships among struma ovarii, pseudo-Meigs syndrome, and ORS, and to improve preoperative diagnostic strategies for these uncommon but clinically significant entities [4,7].

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and deemed exempt by the Institutional Review Board of Ponce Health Sciences University (protocol code 2503249428).

Patient consent: Written informed consent was obtained from the patient for publication of this case report and accompanying images.

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Conflict of interest statement: The authors declare no conflict of interest regarding the publication of this case report.

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RESEARCH LETTERS

Research Letter

Bridging the Gap: Patient Perspectives on Access to Dermatologic Care in a Student-Run Free Clinic in Puerto Rico

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Abstract: Underserved communities face persistent barriers to dermatologic care, yet little is known about their perceptions of barriers to access, knowledge gaps, and motivations to seek care. We conducted a two-day student-run free clinic (SRFC) in Puerto Rico, providing free dermatologic services and administering a Spanish-language questionnaire to assess patient demographics, sun protection behaviors, barriers to care, and perceived impact of the clinic. Of 350 patients, 267 (76.3%) completed the survey. The cohort was predominantly female (91.4%) and Hispanic (97.8%), with 72.7% reporting a dermatologic condition, but over half (51.3%) having never seen a dermatologist. Common barriers included difficulty obtaining appointments (42.5%) and lack of self-perceived need (38.8%). Only 6.4% felt very informed about skin cancer, and 26.6% reported never practicing sun protection. Twelve biopsies revealed both benign and malignant diagnoses, including mammary Paget's and melanoma in situ. Patients who self-identified as informed about skin cancer reported more frequent use of sun protection and greater engagement in sun-avoidant behaviors. Most participants cited the clinic's no-cost services as a major factor improving healthcare access. Our findings highlight the dual burden of high dermatologic disease prevalence and limited access to specialty care in Puerto Rico, exacerbated by a physician shortage and socioeconomic barriers. SRFCs can help reduce dermatologic workforce burnout by supplementing clinical capacity, allowing dermatologists to focus on complex cases while medical students assist with triage, education, and basic care delivery. Incorporating medical students in dermatologic outreach may amplify impact by expanding services capacity and promoting awareness and education in underserved populations.

Keywords: Dermatology; Student Run Free Clinic; Health Disparities; Community Outreach

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1. Research Letter

Student-run free clinics (SRFC) provide free healthcare to underserved communities. They have become increasingly common, with more than 75% of medical schools in the United States participating in similar efforts [1]. Despite documented dermatologic health disparities, defined as differences in skin disease burden, access to care, or outcomes tied to social or economic disadvantage, underinsured individuals often experience greater difficulty accessing dermatologic services and may go years without evaluation of skin conditions [1]. Although existing data underscore the disparity in dermatologic care, little is known about why underserved patients perceive dermatologic services as inaccessible, what knowledge gaps they may have regarding skin cancer and sun protection, or what motivates them to seek dermatologic services. Understanding these patient-reported factors is essential for tailoring outreach, education, and resource allocation in SRFC. The objective of this study was to evaluate patient-reported barriers to dermatologic care,

assess knowledge and behaviors related to sun protection and skin cancer, and describe the population served by a dermatology SRFC in Puerto Rico.

We conducted a two-day SRFC at Coliseito Pedrín Zorrilla, a community venue in San Juan converted into a temporary clinic with multiple exam areas. The event was staffed by volunteer dermatologists, medical students, and undergraduate students. The clinic offered free dermatologic services including screening, treatment, biopsies, and referrals. Medical students (MS) volunteers were trained in dermatologic triage, with a focus on differentiating clinical conditions from cosmetic concerns. Patients with clinical concerns were evaluated by dermatologists, with biopsies performed as indicated, whereas patients with cosmetic concerns or nonspecific requests were provided with educational resources and dermatology referrals. To explore the barriers to dermatologic care and characterize the population served by our SRFC, we administered a non-validated 11-item structured questionnaire, developed in Spanish for this study (Appendix A), with some items allowing multiple responses. Participation was voluntary and not required to receive care. The questionnaire collected information on demographics, sun protection behaviors, dermatologic history, barriers to accessing dermatologic care, reasons for attending the clinic, and perceived impact of the clinic on healthcare access. Data analysis was limited to descriptive statistics. Through this assessment, we aimed to provide a picture of the dermatologic needs, knowledge gaps, and barriers experienced by this Puerto Rican community.

Of the 350 patients who attended the SRFC, 267 (76.3%) completed the survey. The mean age was 40 years, and 91.4% were female. Most participants (97.8%) identified as Hispanic or Latino, 0.7% as non-Hispanic or Latino, and 0.4% were unsure. Regarding race, 56.9% identified as White, 23.6% as Black or African American, 11.6% as Other, and 4.1% as Indigenous or Native American. Most participants (72.7%) reported a history of dermatologic conditions (Figure 1); however, 51.3% had never seen a dermatologist. Among participants without prior dermatologic visits, the most commonly reported barriers were difficulty obtaining an appointment (42.5%), lack of perceived need (38.8%), and long wait times to schedule appointments (18.7%). Sunburn history, sun protection behaviors, and skin cancer knowledge are summarized in Table 1. Notably, only 6.4% described themselves as very informed about skin cancer, and 26.6% reported never using sun protective measures during the week. Most (73.8%) reported experiencing at least one severe sunburn during their life. Table 2 summarizes patient-reported barriers to accessing dermatologic care, reasons for seeking care at the SRFC, and perceptions of how the clinic impacted their access to healthcare. Twelve biopsies were performed, revealing both benign and malignant diagnoses. The most common findings included basal cell carcinoma (n=3) and dysplastic nevus with moderate atypia (n=2), along with single cases of melanoma in situ, invasive mammary carcinoma with pagetoid epidermal involvement, lichen planus-like keratosis, solar lentigo, compound melanocytic nevus, angioleiomyoma, and ruptured epidermal inclusion cyst. We conducted a sub-analysis to compare participants based on their self-reported skin cancer knowledge. Patients who identified as informed or very informed (n=117) were categorized as the "informed" group, while those who reported little or no knowledge (n=150) were categorized as the "non-informed" group. Notably, informed participants demonstrated greater engagement in sun protective behaviors. Regular sun protection use more than three times per week was reported by 45% of informed participants compared to 25% of uninformed participants, whereas never using sun protection was reported by 15% and 35%, respectively. Sunscreen was the most common method in both groups, used by 71% of informed participants and 50% of uninformed participants. Avoidance of sun exposure was also more common among informed participants, reported by 38% compared with 22% of uninformed participants. These findings are consistent with previous studies conducted in the Puerto Rican population, where significantly higher levels of sun-protective behaviors were observed among individuals with greater skin cancer knowledge [2]. Remarkably, 40% of the non-informed group reported using no sun protection, compared to 17% of the informed group. This study is limited by a small sample size and self-reported data, which may introduce bias and limit generalizability to the broader Puerto Rican population. The underrepresentation of men may reflect gender differences in healthcare utilization, with men less likely to seek preventive and specialty care [3].

Our findings provide new insights into the barriers Puerto Ricans face in accessing dermatologic care. Despite most participants reporting a history of dermatologic conditions, most patients had never seen a dermatologist due to long wait times and limited availability. Like the broader U.S., Puerto Rico faces a physician shortage, with just 9,000 doctors serving 3.2 million

residents, barely surpassing the WHO's minimum recommended provider-to-population ratio, amid a trend of physician workforce decline on the island over the past decades [4]. The combination of high rates of dermatologic disease and limited access to care raises concerns about potential underdiagnosis, delayed treatment, and poorer health outcomes for patients on the island. Most patients cited the free services of the SRFC as a key factor in improving their access to dermatologic care, underscoring the island's socioeconomic challenges, where over half the population lives below the poverty line and nearly 50% are enrolled in Medicaid, factors associated with longer wait times and reduced access to specialty care [5]. Our findings suggest the level of knowledge about skin cancer plays a central role in shaping sun-protective behaviors, which raises concerns, as most of our cohort was not well informed. This is consistent with literature showing that lower levels of sun protection knowledge are associated with higher sun exposure and an increased risk of developing skin cancer [3]. These findings highlight the critical role that SRFCs focused on dermatologic care can play in expanding access to services in Puerto Rico, particularly for underserved populations. Besides improving access, the involvement of MS may ease the burden placed on dermatologists, who face high patient volumes due to the ongoing physician shortage on the island. MS can also contribute meaningfully to public education efforts, promoting greater awareness and prevention of skin conditions. Ultimately, SRFCs may improve dermatologic access and positively impact patient outcomes across the island.

Table 1. Severe Sunburn History, Sun Protection Behaviors, and Skin Cancer Knowledge.

Severe sunburn history	**N (%)**
1-2	102 (38.2)
Never	70 (26.2)
≥3	40 (16)
Sun protection behaviors	**N (%)**
Type	
Sunscreen SPF ≥30	158 (59.2)
No sun protection	80 (30)
Hats	79 (29.6)
Avoid sun exposure between 10am and 4pm	28 (10.5)
Sun-protective clothing with UPF	28 (10.5)
Frequency	
>3 times per week	90 (33.7)
Never used sun protection	71 (26.6)
2-3 times per week	52 (19.5)
<1 time per week	48 (18)

Skin cancer knowledge	N (%)
Little informed	115 (43.3)
Informed	100 (37.5)
Not informed	31 (11.6)
Very informed	17 (6.4)

Table 1. *Participant history of severe sunburn, sun protection behaviors, and skin cancer knowledge. Data are presented as number and percentage of respondents. Severe sunburn history is categorized as never, 1–2 episodes, or ≥3 episodes. Sun protection behaviors are detailed by type (e.g., sunscreen use, hats, protective clothing, avoidance of midday sun) and frequency of use. Skin cancer knowledge is self-rated as very informed, informed, little informed, or not informed. Percentages may not total 100% due to multiple responses.*

Table 2. Patient-Reported Barriers, Motivations, and Impact of Enlace Dermatology Clinic.

Barriers to Accessing Care	N (%)
Extended wait times for appointments	118 (44.2)
Limited available dermatologists	79 (29.6)
High cost of consultation	67 (25.1)
High cost of treatment	47 (17.6)
Lack of insurance coverage	47 (17.6)
Transportation issues	4 (1.5)
No difficulties	41 (15.4)
Reason for Attending Enlace Clinic	**N (%)**
Routine skin check	176 (65.9)
Skincare recommendations	107 (40.1)
Evaluation of new/concerning lesions	95 (35.6)
Second opinion	76 (28.5)
Skin cancer prevention counseling	52 (19.5)
Cosmetic dermatologic consultation	45 (16.9)
Medication prescriptions/renewals	42 (15.7)
Follow-up of previous procedure	9 (3.4)
Referral to another specialist	6 (2.2)
Other reasons	26 (9.7)

Patient-Reported Benefits and Impact of the SRFC on Access to Dermatologic Care	
Improved access to dermatologic services	180 (67.4)
Free-of-charge services	139 (52.1)
Convenient location	111 (41.6)
Convenient timing	105 (39.3)
Access regardless of insurance	90 (33.7)
Quality of care	88 (33.0)
Skincare education/resources	87 (32.6)
Friendly staff	86 (32.2)
Had not yet used clinic services	68 (25.5)
No significant impact on access	18 (6.7)
Multilingual services	16 (6.0)

Table 2. *Patient-reported barriers to accessing dermatologic care, reasons for attending the Enlace Clinic, and perceived benefits and impact of the Student-Run Free Clinic (SRFC) on access to dermatologic services. Data are presented as number and percentage of respondents. Barriers include cost, lack of insurance, transportation issues, and limited appointment availability. Reasons for attending the clinic reflect patient motivations, such as affordability and quality of care. Reported benefits and impact highlight improvements in access, reduced wait times, and enhanced continuity of dermatologic care. Percentages may not total 100% due to multiple responses.*

Figure 1. Dermatologic History

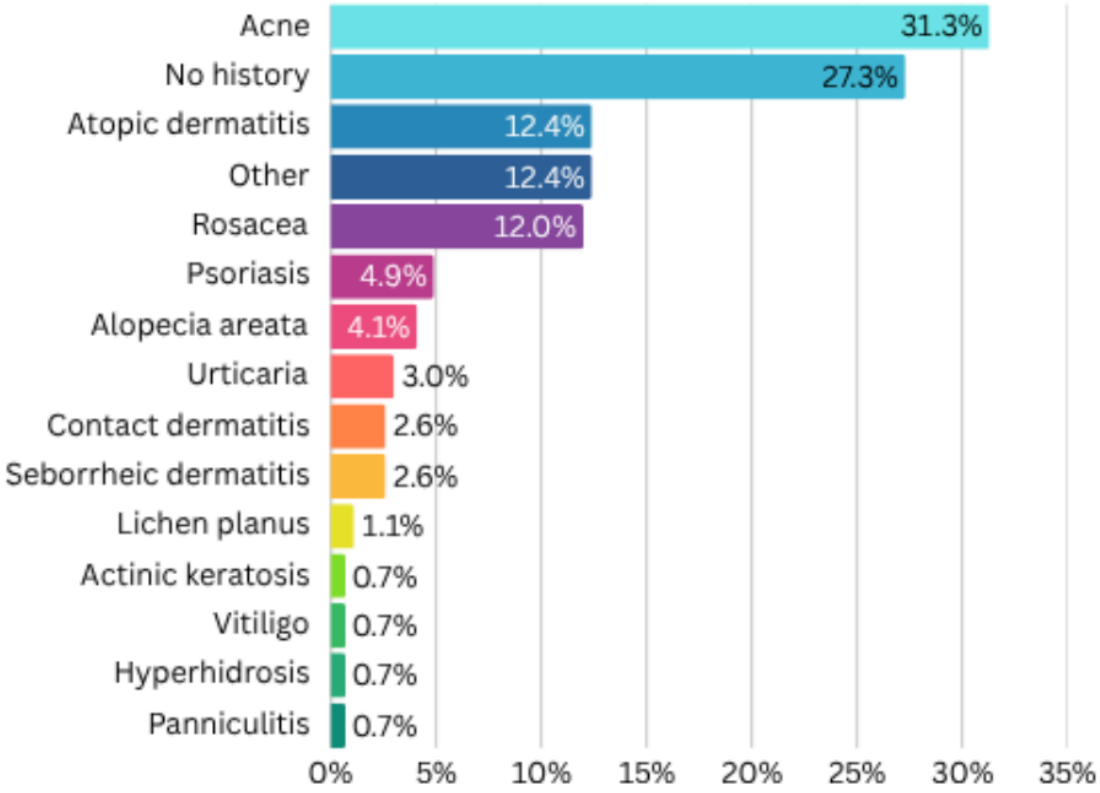

Figure 1. *Distribution of self-reported dermatologic conditions among participants. Acne (31.3%) and no history (27.3%) were most common, followed by atopic dermatitis (12.4%), other conditions (12.4%), and rosacea (12.0%). Less frequent conditions included psoriasis, alopecia areata, urticaria, contact dermatitis, seborrheic dermatitis, and rare disorders (<2%). Percentages may exceed 100% due to multiple responses.*

Supplementary Materials: To explore the barriers to dermatologic care and characterize the population served by our SRFC, we administered a non-validated 11-item structured questionnaire in Spanish **(Appendix A)**.

Author Contributions: Conceptualization, M.V-M., L.D-A., and C.C-C.; methodology, M.V-M., L.D-A., and C.C-C.; formal analysis, M.V-M., L.D-A., and C.C-C.; investigation, M.V-M., L.D-A., and C.C-C.; data curation, M.V-M., L.D-A., C.C-C., E.G., K.S-S., A.O-F., S.D., and D.C-L.; writing—original draft preparation, M.V-M., L.D-A., and C.C-C.; writing—review and editing, M.V-M., L.D-A., C.C-C., and M.B.; supervision, M.B.; project administration, M.B.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.
Data Availability Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Conflicts of Interest: The authors declare no conflicts of interest.

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INNOVATIVE IMAGING

Innovative Imaging

Artificial Intelligence–Enhanced 3D Reconstruction of Parapneumonic Effusion in a Pediatric Patient: A Novel Visualization Approach

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Keywords: pediatric pneumonia; pleural effusion; artificial intelligence; 3D lung reconstruction; computed tomography; lung segmentation; parapneumonic effusion; innovative imaging

1. Innovative Imaging

We present a case of a 3-year-old male who was admitted to the pediatric intensive care unit (PICU) with severe left-sided pneumonia and a large parapneumonic pleural effusion. The patient initially presented with epigastric abdominal pain and intermittent symptoms over the course of one week, eventually leading to progressive respiratory compromise and hypoxemia, with oxygen saturation levels declining to 90–92% on room air and evidence of intercostal retractions. Chest radiography demonstrated retrocardiac airspace consolidation, and a subsequent chest computed tomography (CT) confirmed multifocal left-sided airspace opacities with a significant associated pleural effusion. No evidence of loculation was found.

What sets this case apart is the integration of advanced post-processing imaging techniques to enhance visualization and understanding of the extent of pulmonary pathology. Using Lung CT Segmenter in 3D Slicer v5.8.1 [1], we performed an automated parenchymal segmentation to isolate and quantify affected lung regions. This was followed by a 3D reconstruction using Lung CT Analyzer [2], leveraging an artificial intelligence module that rendered a volumetric model of the pulmonary structures and pleural effusion (**Figure**).

These imaging innovations provided a comprehensive spatial understanding of the pneumonia's severity and distribution, facilitating multidisciplinary clinical decision-making. The AI-assisted 3D reconstruction helped delineate the extent of parenchymal involvement and confirmed the absence of loculated collections. While the patient was managed conservatively without invasive drainage, the advanced visualization supported close monitoring and contributed to the therapeutic strategy. The patient received intravenous therapy for 21 days during hospitalization, followed by an additional 7 days as an outpatient, completing a total of 28 days of treatment. Follow-up chest radiography at 30 days demonstrated complete resolution of the parapneumonic effusion, accompanied by clinical improvement.

By incorporating 3D AI-generated models into standard CT interpretation, we highlight the potential of emerging tools in improving pediatric respiratory diagnostics. This case illustrates how innovative imaging workflows can enhance diagnostic precision and communication in complex pediatric infections, especially when managing evolving conditions like parapneumonic effusions where early, informed decisions are critical [3,4]. In medical image interpretation, AI systems can refine diagnostic accuracy by highlighting subtle findings that might otherwise be overlooked [5]. AI-based 3D imaging may serve as a useful aid in evaluating disease severity, planning interventions, and educating future clinicians.

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2. Statements & Declarations

Image originality: The submitted images have not been previously published nor are they undergoing review for publication elsewhere.

3. Figure

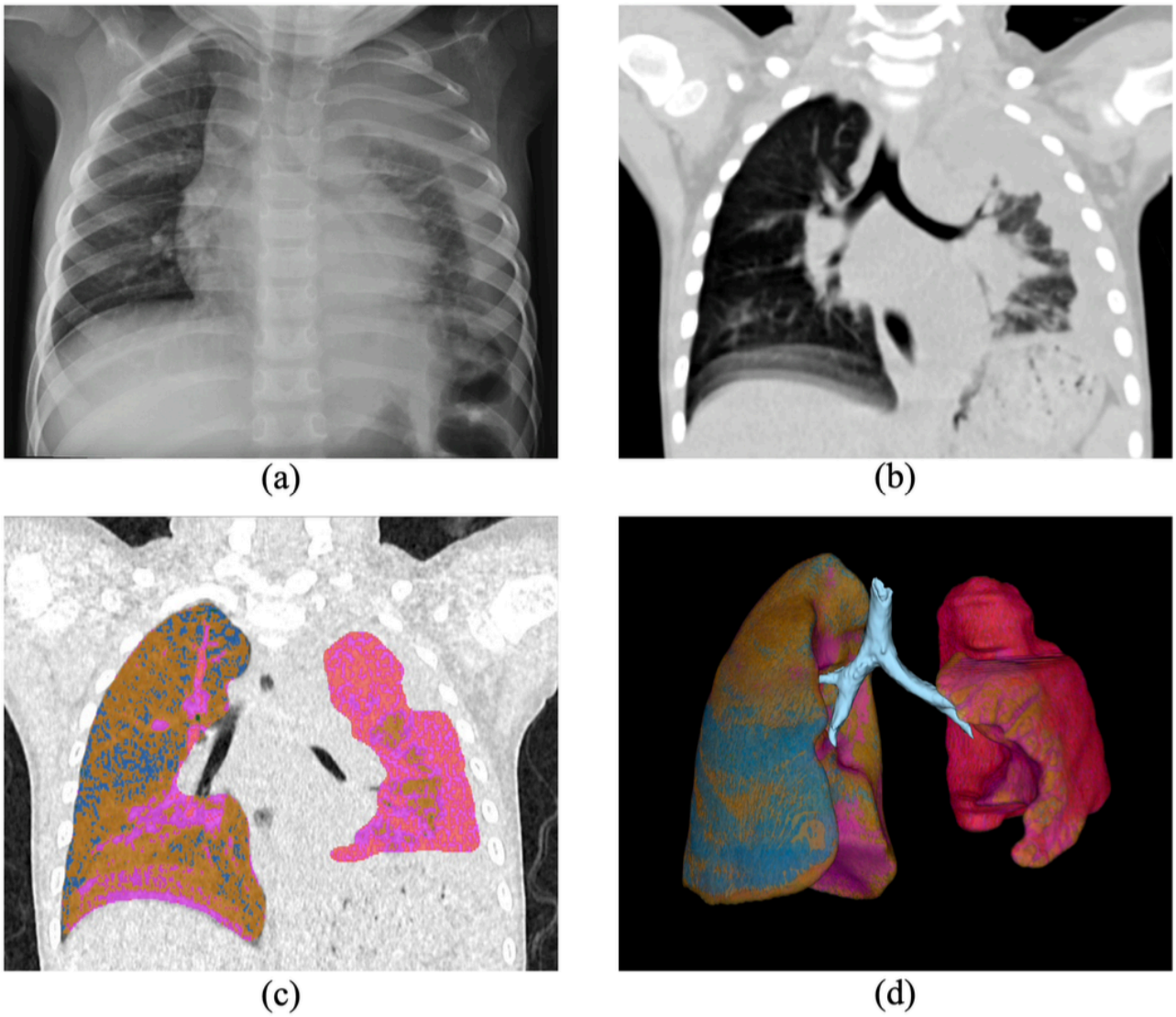

Figure. Multimodal imaging evaluation and AI-enhanced 3D reconstruction in a pediatric patient with pneumonia and parapneumonic effusion. (a) Chest radiograph showing retrocardiac airspace consolidation, concerning for left lower lobe pneumonia. (b) Coronal CT view of the thorax demonstrating multifocal left-sided airspace opacities with associated large parapneumonic pleural effusion. (c) Lung parenchyma segmentation using Lung CT Segmenter module in 3D Slicer (v5.8.1), highlighting affected lung zones. (d) AI-assisted 3D lung reconstruction using Lung CT Analyzer, showing volumetric distribution of aerated versus consolidated lung regions and pleural effusion. Light blue denotes the airway; dark blue represents normally aerated parenchyma; orange indicates areas of infiltration or inflammation; and pink represents regions of lung collapse.

Author Contributions: Conceptualization, G.R.-R. and W.D.J.-R.; clinical investigation and data acquisition, G.R.-R. and A.S.-L.; imaging analysis and visualization, G.R.-R. and W.D.J.-R; methodology and software utilization, G.R.-R. and W.D.J.-R; writing—original draft preparation, G.R.-R. and W.D.J.-R.; writing—review and editing, A.S.-L. and W.D.J.-R.; supervision, W.D.J.-R. All authors have read and agreed to the published version of the manuscript.

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