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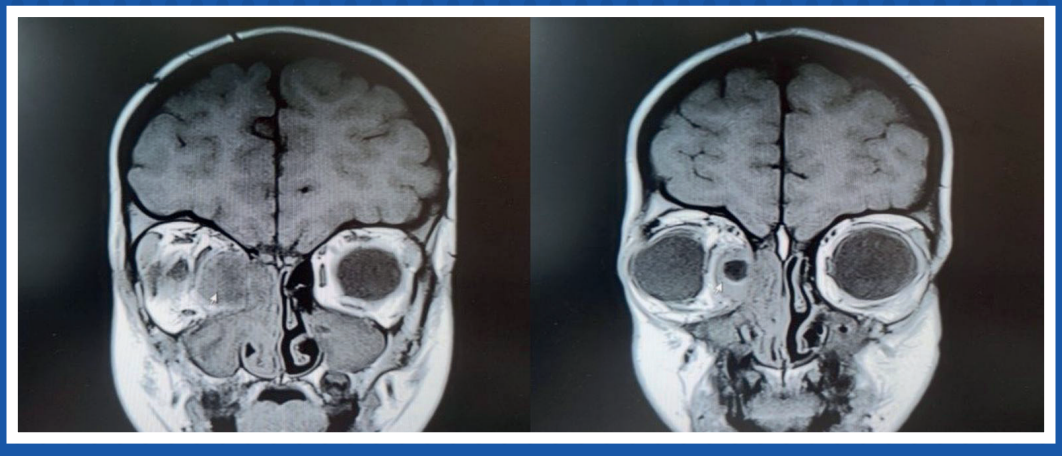

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Editorial

Welcome to the April 2026 issue of the Northwestern Medical Journal. The year 2026 stands out as a turning point where technology in medical practice has shifted from being merely "supportive" to becoming "integral." Remote patient monitoring, wearable devices, and AI-powered diagnostic tools are significantly accelerating routine clinical decision-making processes and enhancing their accuracy. Particularly in fields such as oncology, immunology, diabetes, and obesity, alongside next-generation treatments, "hyper-personalized" approaches based on individual genetic profiles are becoming increasingly integrated into daily practice. These advancements enable patients to receive earlier diagnoses, more effective treatments, and recover with fewer side effects.

However, this rapid transformation also brings significant responsibilities. Data privacy, algorithmic bias, ethical issues, and the preservation of the doctor-patient relationship are among today's most critical topics of discussion. AI's superior performance in diagnostic and treatment recommendations should remain a tool designed to enhance clinical judgment rather than replace physicians. As scientists and clinicians, we are responsible for ensuring that technology remains human-centered.

The original research articles and case reports featured in this issue highlight various aspects of this transformation. Turgut Semerci et al. share their experience on the efficacy of surgery for orbital complications of rhinosinusitis. Küçük et al. report the impacts of chalazion surgery on intraocular pressure. Üçer et al. eluciadte the systemic effects of pseudoexfoliation syndrome. Dilek et al. investigated the relationship between the cognitive functions and age in Sjögren Syndrome. Baykal Şahin et al. studied the quality of life, functionality, and psychological status of fibromyalgia patients. Uygun et al. reported the utility of pentoxifylline in neonates. Uluç et al. assesed the potential of homeobox protein-3 in multiple sclerosis. Kurtboğan et al. evaluated the effects of morphology of vertebra on Cobb Angle in adolescents with idiopathic scoliosis. Odabaşı Tezer et al. evaluated the preclinical education of endodontics in a retrospective model.

As the Northwestern Medical Journal, our mission is to make quality science accessible and to highlight research that contributes to clinical practice. In 2026 and beyond, we will continue to serve as a platform where evidence-based medicine meets innovative technologies.

We thank all our readers, authors, and reviewers. Drawing strength from your scientific curiosity and contributions, let us move forward together toward a healthier future.

Sincerely,
Prof. Ahmet Ural, M.D.
Editor-in-chief

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RESEARCH ARTICLE

Quality of life, psychological status, and functionality in patients with fibromyalgia

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ABSTRACT

Aim: This single-center cross-sectional study aimed to investigate the clinical, demographic, and psychological characteristics of patients with fibromyalgia (FM) and assess the impact of these parameters on quality of life, daily functioning, and psychological well-being.

Materials and Methods: Eighty-six women diagnosed with FM according to the 1990 ACR criteria were included. Socio-demographic, clinical, and psychometric characteristics were recorded. The severity of pain was assessed with the Visual Analog Scale (VAS), while the Fibromyalgia Impact Questionnaire (FIQ), Nottingham Health Profile (NHP), Hamilton Anxiety (HAM-A), and Depression (HAM-D) scales, Symptom Checklist-90-R (SCL90-R), and Modified Fatigue Impact Scale were used to evaluate disease severity, quality of life, and psychological symptoms, respectively. Physical activity level, hand grip strength, 100-meter walking time, and tender point counts were also recorded.

Results: Major anxiety was detected in 61.6% and moderate-to-severe depression in 38.4% of participants. Pain levels (VAS) showed a significant positive correlation with both functional disability (FIQ) and depression (HAM-D). Physical activity was inversely associated with fatigue scores (p=0.039). No significant associations were found between BMI and most clinical parameters, except for walking time. SCL90-R scores indicated elevated somatization and psychological distress in a substantial subgroup.

Conclusion: FM adversely affects quality of life and is commonly accompanied by psychological symptoms. Comprehensive assessment strategies addressing both physical and psychological aspects are essential for effective management.

Keywords: Fibromyalgia, depression, anxiety, quality of life

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INTRODUCTION

Fibromyalgia (FM) is a chronic, non-inflammatory rheumatic condition characterized by widespread musculoskeletal pain, fatigue, sleep disturbance, and cognitive impairment. Although its exact etiology remains unclear, several mechanisms, such as central sensitization, neuroendocrine dysfunction, and psychological factors, have been implicated (1).

Fibromyalgia is more common among women and affects 2-8% of the general population (2). A study applying the 2010 American College of Rheumatology (ACR) criteria reported a prevalence of 2.1%, while regional studies in Turkey revealed rates as high as 10.1% among women aged 50–59 (3,4). In addition to chronic pain, psychological symptoms like depression and anxiety frequently co-occur with FM, contributing to reduced quality of life and functional disability (5).

The prevalence of depression and anxiety in FM ranges widely, influenced by variations in study design and diagnostic tools (6-8). Depressive symptoms may exacerbate functional limitations, whereas anxiety disorders, particularly Post-traumatic stress disorder (PTSD), are notably more prevalent in FM populations (9,10). Patients with FM report a considerable impact on their quality of life. They experience a lower quality of life compared to the general population. The quality of life of FM patients seem to be associated with their FM related disability level and is influenced by their pain problem (11).

Given FM's multifactorial nature and its broad impact on physical and psychological health, this study aimed to comprehensively assess demographic, clinical, and psychological characteristics in FM patients and evaluate their associations with quality of life and functionality.

MATERIALS AND METHODS

Study design and participants

This cross-sectional study was conducted with patients who presented to the Physical Medicine and Rehabilitation outpatient clinic of Karadeniz Technical University Hospital between January 2014 and December 2015. The study was conducted in accordance with the Declaration of Helsinki and received approval from the institutional ethics committee (Protocol No: 2012-78). All participants provided written informed consent.

Inclusion criteria were female sex, age between 18–65 years, a diagnosis of FM based on the ACR 1990 criteria, and the ability to understand and complete questionnaires. Exclusion criteria included the presence of systemic inflammatory or autoimmune diseases (e.g., rheumatoid arthritis, lupus), neurological or severe psychiatric disorders (e.g., psychosis, bipolar disorder), use of centrally acting drugs such as pregabalin, duloxetine, opioids, corticosteroids (>10 mg/day prednisone or equivalent), pregnancy, malignancy, or cognitive impairment affecting the ability to comply with the study.

Data collection

Demographic (age, marital and menopausal status, education, BMI), clinical (disease duration, surgical history, family history), and lifestyle (physical activity level, smoking) information were recorded. Physical assessments included bilateral hand grip strength (dynamometer), 100-meter walking time (in seconds), and the number of tender points.

Outcome measures

The severity of pain was assessed using the Visual Analog Scale (VAS), a widely accepted tool in which patients rate their pain intensity on a 0–10 scale. The Fibromyalgia Impact Questionnaire (FIQ) was used to assess the functional impact of FM across domains such as physical functioning, absenteeism, and symptom severity. To evaluate psychological status, the Hamilton Anxiety Scale (HAM-A) and Hamilton Depression Scale (HAM-D) were administered by trained professionals. These scales measure the severity of anxiety and depressive symptoms, respectively. Fatigue was assessed with the Modified Fatigue Impact Scale, which captures physical, cognitive, and psychosocial dimensions of fatigue. The Nottingham Health Profile (NHP), a general health-related quality of life instrument, was used to evaluate pain, sleep, physical mobility, emotional reactions, and social isolation. Finally, the Symptom Checklist-

90-R (SCL90-R), a comprehensive instrument for psychological symptomatology, provided insights into somatization, obsessive-compulsive traits, depression, anxiety, and other psychiatric features. All scales used in this study have been validated and shown to be reliable in previous psychometric studies (12-16).

Statistical analysis

Statistical evaluation was performed using SPSS (Statistical Package for the Social Sciences) version 13 for Windows. Data are shown as mean ± standard deviation or percentage (%). When comparing measurement data between three groups, if the data were normally distributed, ANOVA was used; if not, the Kruskal-Wallis test was used. When comparing measurement data between two groups, the Student's-t test was used if the data were normally distributed; if not, the Mann-Whitney-U test was used. When examining the relationship between two measurement data, Pearson correlation tests were used if the data were normally distributed; if not, Spearman correlation tests were used. Statistical significance level was accepted as $p < 0.05$. A priori sample size calculation targeted detection of at least a moderate correlation ($r = 0.30$) with a two-sided $\alpha = 0.05$ and 80% power. Using Fisher's z transformation, the required sample size was n = 85 for the primary outcome measure.

RESULTS

A total of 86 female patients were included in this study, with a mean age of 43.20±10.04 years and an average symptom duration of 7.53±7.16 years. Demographic and clinical characteristics of the patients are shown in Table 1.

Table 1. Baseline characteristics of the patients. Data are presented as n (%) or mean ± standard deviation

Parameter	
Menopause status	
premenopause	45 (52.3)
postmenopause	41 (47.7)
Marital status	
married	72 (83.7)
single/widow	14 (16.3)
Education Status	
none	19 (22.1)
primary school	35 (40.7)
middle school and beyond	32 (37.2)
Disease duration	
0-5 yr	45 (52.3)
> 5 yr	41 (47.7)
Former or current smoker, n (%)	24 (27.9)
BMI	
<25	16 (18.6)
25-29.99	40 (46.5)
≥30	30 (34.9)
Physical activity level	
Sedentary	22 (25,6)
Mildly active	40 (46,5)
Moderately/highly active	24 (27,9)
Hand grip strengths	
Right	23.6±8.3
Left	21.4±5.6
100-meter walking time	88.2±15.3
Number of tender points	15.7±2.3
Surgical history	60 (69.8)
Family history	24 (27.9)

BMI: body mass index.

According to the HAM-A results, 32 (37.2%) patients had minor anxiety, 53 (61.6%) patients had major anxiety, and 1 (1.2%) patient had no anxiety. According to the HAM-D results, 35 (40.7%) patients had mild depression, 32 (37.2%) patients had moderate depression, 1 (1.2%) patient had severe depression, and 18 (20.9%) patients had no depression. According to the SCL90-R scale, 73 (84.9%) patients were normal, 12 (14%) patients had a high psychological symptom level, and 1 (1.2%) patient had a very high psychological symptom level. Mean scores for pain, quality of life, and fatigue are also presented in Table 2.

Table 2. Scale results. Data are presented as mean ± standard deviation

Parameter	
VAS	7.93±1.75
FIQ	64.71±12.27
HAM-A	16.54±5.76
HAM-D	13.89±6.15
Modified fatigue impact score	34.63±15.01
NHP – Pain	77.24±24.61
Fatigue	44.37±17.25
Sleep	89.01±23.98
Social isolation	65.23±28.35
Emotional reaction	28.24±30.60
SCL90-R	1.16±0.40

*VAS: Visual Analog Scale, FIQ: Fibromyalgia impact questionnaire, HAM-A: Hamilton anxiety rating scale, HAM-D: Hamilton depression rating scale, NHP: Nottingham Health Profile, SCL90-R: The Symptom Checklist-90-Revised.

Patients were stratified by disease duration (≤5 years vs. >5 years). Those with longer disease duration showed higher mean scores in pain (VAS), fatigue, depression, anxiety, and psychological distress, as well as decreased grip strength and increased walking time, although none reached statistical significance (Table 3).

BMI was significantly associated only with walking performance: patients with BMI ≥30 had significantly slower walking times than those with BMI <25 ($p<0.01$), but other clinical parameters and psychometric scores did not differ significantly by BMI (Table 4).

Moderate/high activity was associated with an approximately10.6-point lower MFIS than sedentary (95% CI 1.7 to 19.5, $p = 0.039$, Table 5).

Correlation analyses revealed that VAS scores were positively correlated with FIQ and HAM-D scores.

Table 3. Comparison of results according to disease duration

	Hand grip strength		100 m walking time	VAS	FIQ	mFIC	Tender point count	HAM-A	HAM-D	Scl90R
	Right	Left								
0-5 year	23.4	21.7	87.6	7.8	62.6	34.1	15.6	15.9	13.1	1.15
>5 year	22.4	21.7	90.7	8	66.9	35.1	15.8	17.1	14.7	1.17
p value	.356	.997	.263	.474	.103	.762	.747	.230	.217	.945

VAS: Visual Analog Scale, FIQ: Fibromyalgia impact questionnaire, mFIC: Modified fatigue impact score, HAM-A: Hamilton anxiety rating scale, HAM-D: Hamilton depression rating scale, SCL90-R: The Symptom Checklist-90-Revised.

Table 4. Comparison of results according to body mass index

	Hand grip strength		100 m walking time	VAS	FIQ	mFIC	Tender point count	HAM-A	HAM-D	Scl90R
	Right	Left								
BMI < 25	25.3	23.3	80.5	7.6	64.8	35.3	15.8	17	13	1.25
BMI = 25-29.99	22.5	21.8	87.6	7.8	64.3	32.7	16	15.2	13.2	1.12
BMI ≥ 30	22.2	20.7	95.6	8.2	65	36.7	15.2	18	15.2	1.16
p value	.085	.292	**<.001***	.565	.973	.530	.486	.131	.339	.387

* <25 - (25-29.99) p=0.124 ; <25 - ≥30 p<0.01 ; (25-29.99) - ≥30 p=0.15

VAS: Visual Analog Scale, FIQ: Fibromyalgia impact questionnaire, mFIC: Modified fatigue impact score, HAM-A: Hamilton anxiety rating scale, HAM-D: Hamilton depression rating scale, SCL90-R: The Symptom Checklist-90-Revised.

Table 5. Comparison of results according to physical activity level

	Hand grip strength		100 m walking time	VAS	FIQ	mFIC	Tender point count	HAM-A	HAM-D	Scl90R
	Right	Left								
Sedentary	22.7	21.3	92.1	8.3	67.8	38.9	15.8	17	13	1.25
Mildly active	22.3	21	89.3	7.7	63.5	36	15.9	15.2	13.2	1.12
Moderately/highly active	26.7	22.3	85.9	7.8	63.8	28.3	15.3	18	15.2	1.16
p value	.107	.671	.243	.472	.385	**.039***	.632	.131	.339	.387

*sedentary-mildly active p=1.00; sedentary-moderately/highly active p=0.04; mildly active- moderately/highly active p=0.13

VAS: Visual Analog Scale, FIQ: Fibromyalgia impact questionnaire, mFIC: Modified fatigue impact score.

Table 6. Correlations between scores

	Tender point count	VAS	FIQ	Modified fatigue impact score	HAM-A	HAM-D	Scl90-R
Tender point count	1	.053	.118	.119	-.096	-.025	-.037
VAS		1	.597*	.142	.195	.302*	.112
FIQ			1	.452*	.472*	.580*	.304*
Modified fatigue impact score				1	.543*	.526*	.384*
HAM-A					1	.764*	.385*
HAM-D						1	.350*
Scl90-R							1

The r values are shown. *; p<0,05 VAS: Visual Analog Scale, FIQ: Fibromyalgia impact questionnaire, HAM-A: Hamilton anxiety rating scale, HAM-D: Hamilton depression rating scale, SCL90-R: The Symptom Checklist-90-Revised.

FIQ scores showed strong positive correlations with VAS, HAM-A, HAM-D, and SCL90-R. Similarly, both anxiety (HAM-A) and depression (HAM-D) scores were significantly correlated with fatigue and psychological distress (Table 6).

DISCUSSION

The findings of this study support the notion that FM is a complex syndrome involving both physical and psychological dimensions. The high mean VAS pain score (7.93) confirms the intense pain experienced by patients, consistent with previous studies (17,18). The FIQ is a widely used tool to assess quality of life in FM patients and has been shown to be more sensitive than the SF-36 (19). In this study, the mean FIQ score was 64.7, with 37.2% of patients scoring ≥70, indicating severe impact. These findings are consistent with previous literature reporting similar average scores across large FM cohorts (20,21).

Anxiety and depression are prevalent and often severe in FM patients. In this study, 61.6% had major anxiety and 37.2% had moderate depression based on HAM-A and HAM-D scores. Although higher than some previous reports, differences may be due to the assessment tools used (22,23). Consistent with previous literature, anxiety did not correlate with pain intensity, suggesting that anxiety in FM may operate independently of pain perception (8). These findings highlight the importance of incorporating psychological evaluation into FM management, as focusing solely on physical symptoms would be insufficient.

SCL90-R scores highlighted prominent somatization tendencies. The relationship between FM and somatization has been previously investigated in the literature, and it has been determined that somatization is more common in patients with FM compared to other chronic pain syndromes and inflammatory diseases (24,25). Multiple symptoms of FM can be expressed as somatization, which can cause the person to focus on

their health. Conversely, focusing on their health can lead to somatization. This preoccupation with internal somatic states can ultimately lead to an increase in depression and obsessive-compulsive symptoms as the individual attempts to cope with FM symptoms, and cognitive and behavioral adaptation to pain becomes impaired (24). However, the pathophysiological basis of FM pain and the role of central sensitization should not be ignored.

In this study, higher pain levels (VAS) were associated with worse quality of life (FIQ) and greater depressive symptoms, aligning with some prior research (17,26). It should be kept in mind that chronic pain may be caused by a psychiatric disorder, but pain itself may also negatively affect quality of life and cause psychiatric disorder. FIQ scores also correlated with fatigue, anxiety, depression, and psychological distress, emphasizing the interplay between pain, psychological factors, and functional impairment in FM.

The mean disease duration was 7.5 years, but longer duration was not associated with increased pain, fatigue, or psychological symptoms. This aligns with previous research and suggests that FM symptoms do not necessarily worsen over time (27).

Encouragingly, patients with higher physical activity levels reported lower fatigue scores, suggesting the potential benefit of physical activity on fatigue. This observation is consistent with existing literature demonstrating that regular physical activity improves central pain modulation, enhances mitochondrial efficiency, and reduces pro-inflammatory cytokines, all of which contribute to reduced fatigue in fibromyalgia (21,28). Moreover, exercise has been shown to improve sleep quality, autonomic balance, and psychological well-being, which in turn further decreases fatigue perception. Taken together, these findings reinforce the role of physical activity as a non-pharmacological cornerstone in FM management, particularly for alleviating fatigue symptoms (11,29,30).

The prevalence of chronic pain is high in overweight and obese patients, and functional capacity and quality of life are negatively affected in these patients. Obesity is also common in patients with FM (30-45%), but the relationship between them has not yet been clearly understood (31). In this study, BMI was not significantly associated with pain, psychological symptoms, or quality of life. Despite high rates of overweight and obesity, BMI was only significantly associated with longer walking time. This indicates that while obesity may impact physical performance, it does not necessarily intensify subjective symptom burden. Prior studies have produced conflicting evidence, with some reporting increased FM symptomatology in obese patients (32,33). There are also studies (34,35) in the literature showing that the prevalence of depression and anxiety is significantly higher in obese FM patients than in non-obese patients. Although the increase in BMI is not directly related to FM, it should be kept in mind that it will negatively affect treatment results. In addition, the fact that weight loss has been shown to significantly reduce FM symptoms and provide a significant decrease in tender point count suggests that it would be appropriate to include obesity treatment among FM treatment targets (36,37).

Limitations: The number of patients included in the study was smaller compared to some studies in the literature. At the same time, all of the patients included in our study were women. This situation should be taken into account when evaluating the results of our study. In addition, our study was conducted only on patients with FM; a control group was not included.

Conclusion

It was determined that psychological symptoms are also prominent along with widespread pain in FMS and that quality of life is negatively affected. The fact that psychological symptoms are prominent suggests that stress plays a role in the pathogenesis of this disease and reveals the necessity of psychosocial support in these patients.

Ethical approval

The study protocol was approved by the Karadeniz Technical University School of Medicine Ethics Committee (protocol number: 2012-78).

Author contribution

Concept: MK; Design: MK, EÇ; Data Collection or Processing: HBŞ; Analysis or Interpretation: HBŞ, MK; Literature Search: HBŞ, MK, EÇ; Writing: HBŞ. All authors reviewed the results and approved the final version of the article.

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Conflict of interest

The authors declare that there is no conflict of interest.

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RESEARCH ARTICLES

Evaluation of the effectiveness of pentoxifylline use in neonatal sepsis

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ABSTRACT

Aim: Neonatal sepsis is an infection of the bloodstream in infants under 28 days old. It remains a leading cause of morbidity and mortality among infants. For this reason, it is important to closely monitor patients and initiate early and effective treatment when sepsis is suspected. In some cases, supportive treatments are needed in addition to appropriate antibiotic therapy to ensure clinical stability. This study aims to evaluate the effectiveness of pentoxifylline (PTX) use as a supportive treatment for neonatal sepsis.

Materials and Methods: Patients who were followed up in our clinic with a diagnosis of sepsis between January 2020 and December 2024 and who had pentoxifylline added to their treatment were included in the study. Patient data were obtained from patient files, the hospital patient record, and the follow-up system, and evaluated retrospectively.

Results: All patients who were followed up for sepsis and treated with pentoxifylline were evaluated. A total of 45 infants were included in the study. Nine patients died due to sepsis in the early period. Therefore, early morbidity outcomes were evaluated based on the remaining 36 patients. Another patient died on the 67th day of life, bringing the total mortality count to 10. Demographic, clinical and laboratory data of the patients were shown in tables. It was observed that the frequency of mortality, bronchopulmonary dysplasia, and necrotizing enterocolitis (NEC) in our patients was higher than the reported national/international averages.

Conclusion: In our study, the mortality and short-term morbidity rates, including necrotizing enterocolitis and bronchopulmonary dysplasia, were found to be higher than those reported in the literature. This may be due to pentoxifylline being administered to patients with impaired circulation and added late to the treatment. Randomized controlled studies with larger patient samples and more homogeneous clinical conditions are needed to more accurately reveal the effect of pentoxifylline on neonatal mortality and morbidity.

Keywords: NICU, pentoxifylline, sepsis, supportive treatment

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INTRODUCTION

Neonatal sepsis is an infection of the bloodstream in infants younger than 28 days old (1,2). Despite advances in neonatology, sepsis remains an important cause of infant mortality and morbidity (3). Therefore, close monitoring of infants and the prompt initiation of effective treatment are crucial when sepsis is suspected.

According to the timing and route of infection, neonatal sepsis is classified into two main categories. Early-onset sepsis (EOS) typically caused by vertical transmission of invasive pathogens from the mother during labor or delivery. It is diagnosed when microbiological cultures are positive within the first seven days of life. In contrast, late-onset sepsis (LOS), also referred to as nosocomial sepsis, occurs after the first week of life and is usually attributed to the postnatal acquisition of pathogens, either from hospital (nosocomial) or community sources. Empirical antibiotic therapy should be selected according to these classifications, while also considering the local microbial flora and resistance patterns specific to the clinical setting (4).

In some cases, supportive treatments are needed in addition to appropriate antibiotic therapy to ensure clinical stability (5). Therapies such as granulocyte colony-stimulating factor, granulocyte-macrophage colony-stimulating factor, and immunoglobulin do not significantly improve outcomes in preterm neonates with sepsis (6,7). Pentoxifylline (PTX), a derivative of methylxanthine, works as a phosphodiesterase inhibitor and shows anti-hemorrhagic, anti-proliferative, and immunomodulatory effects. As a result, it leads to improved microcirculation and tissue perfusion. Pentoxifylline also has an anti-inflammatory effect against Toll-like receptor –mediated production of cytokines (8,9).

This study aims to evaluate the effectiveness of pentoxifylline using as a supportive treatment for neonatal sepsis.

MATERIALS AND METHODS

This study was designed as a single-center, retrospective analysis carried out in the NICU of our tertiary-level hospital. The study included patients who were hospitalized and treated in the NICU between January 2020 and December 2024 and were diagnosed with proven, clinical, or suspected sepsis. The EMA Sepsis Scoring System was employed to support early recognition and management, in accordance with the Turkish Neonatology Society's Guideline on the Diagnosis and Treatment of Neonatal Infections (10). Clinical criteria included temperature instability and respiratory findings such as apnea, tachypnea, and an increased need for respiratory support; cardiovascular signs such as bradycardia, tachycardia, and hypotension; and signs of impaired peripheral perfusion. Laboratory findings that were considered supportive of sepsis included leukopenia or leukocytosis (white blood cell count >20,000/mm^3), an elevated immature-to-total neutrophil ratio (≥0.2), thrombocytopenia (<100,000/mm^3), CRP >15 mg/L (1.5 mg/dL), procalcitonin >2 ng/mL, hypoglycemia or hyperglycemia (<45 or >180 mg/dL), and metabolic acidosis on blood gas analysis (base excess >–10 mEq/L or serum lactate >2 mmol/L).

Infants with congenital heart disease, syndromic features, or known neurometabolic disorders were excluded from the study.

PTX was added to the treatment for cases of sepsis with impaired tissue perfusion. PTX was used at a dosage of 6 mg/kg/h infused over 6-h daily for six days. All demographic, clinical, and laboratory data of the participants were obtained retrospectively from their medical records. Patient data were accessed from patient files and the Enlil Hospital Information System database, which is the hospital's patient registration and tracking system.

Demographic and clinical data of the patients, including gender, gestational age, birth weight, mode of delivery, and maternal age, were recorded.

Laboratory parameters, blood culture results, sepsis classification, pentoxifylline treatment status, and the timing of its initiation were also documented. Sepsis was classified based on the time of onset (early vs. late-onset). Laboratory evaluations included C-reactive protein (CRP) levels and hematological indices such as white blood cell (WBC) and platelet (PLT) counts, as well as the presence or absence of microbial growth in blood cultures. Clinical outcomes assessed during the follow-up period included mortality and short-term morbidities, particularly necrotizing enterocolitis (NEC), bronchopulmonary dysplasia (BPD), and retinopathy of prematurity (ROP).

The statistical analysis was performed using IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize the data. Continuous variables were presented as the mean ± standard deviation for normally distributed data or as the median (minimum–maximum) for skewed distributions. Categorical variables were expressed as numbers and percentages. Since this was a descriptive study without group comparisons, no inferential statistical tests were applied.

RESULTS

Patients diagnosed with sepsis and treated with pentoxifylline were included in the analysis. A total of 45 infants were included in the study. Nine patients died due to sepsis in the early stage. Therefore, early morbidity outcomes were evaluated based on the remaining 36 patients. Another patient died on the 67th day of life, bringing the total mortality count to 10.

Table 1 shows the demographic features. As expected, the majority of the infants were born prematurely and had low birth weights. The majority of the infants were appropriate for gestational age and were delivered via cesarean section. The number of male and female infants was approximately equal.

Sepsis-related laboratory parameters are summarized in Table 2. PTX treatment was administered to 45 patients due to nosocomial sepsis (80%). In 64% of our patients, pathogens were isolated by culture antibiogram, and most of them were gram (-) bacteria.

Table 1. Demographic characteristics of the patients

Characteristic	PTX group (N=45)
Gestational week (week)	28.8 ± 5.2
mean ± SD (min-max)	(22 - 40)
Birth weight (gram)	1320 ± 858
mean ± SD (min-max)	(560 - 3950)
SGA	11 (24%)
AGA	27 (60%)
LGA	7 (16%)
Female	21 (47%)
Maternal Age	26.9
mean (min-max)	(18 - 39)
Cesarean Section delivery (C/S)	33 (73%)
Spontan vaginal delivery	12 (27%)

*SGA: Small for gestational age; AGA: Appropriate for gestational age; LGA: Large for gestational age.

The choice of antibiotic was made in collaboration with the pediatric infectious diseases department.

Data on mortality and short-term morbidities such as BPD, NEC, and ROP are summarized in Table 3. Ten patients died in the early period of the septic attack. For this reason, BPD and ROP evaluations were made on 35 patients. In our study, the mortality rate was found to be 46 percent.

DISCUSSION

The incidence of neonatal sepsis is generally reported as 1 to 5 cases per 1,000 live births, with higher frequencies observed in infants with lower gestational age and birth weight (11). Consistent with the literature, similar findings were observed in our study.

The primary method of preventing neonatal infections should be to protect the newborn against infections. The main subjects emphasized here are hand hygiene, umbilical cord care, eye prophylaxis, skin care, breastfeeding, protection against central vascular catheter-related infections and ventilator-associated pneumonia, avoidance of prolonged and broad-spectrum antibiotics, and protection against invasive Candida infections (12).

Table 2. Laboratory parameters of patients	
Parameter	**PTX group (n=45)**
Early-onset sepsis (+)	9 (20%)
Nosocomial sepsis	36 (80%)
Blood culture (+)	29 (64%)
WBC count at diagnosis (K/µL) Mean ± SD Median (min–max)	 18,670 ± 19,057 13,300 (1,050–85,800)
Platelet count at diagnosis (K/µL) Mean ± SD Median (min–max)	 173,200 ± 140,366 136,000 (10,000–654,000)
CRP at diagnosis (mg/L) Mean ± SD Median (min–max)	 61.8 ± 57 36 (17–159)
WBC count after pentoxifylline (K/µL) Mean ± SD Median (min–max)	 18,491 ± 12,371 16,200 (400–54,100)
Platelet count after pentoxifylline (K/µL) Mean ± SD Median (min–max)	 148,142 ± 155,166 84,000 (7,000–616,000)

Table 3. Short-Term Morbidity and Mortality Rates and Hospitalization stay	
Parameter	**PTX group (n=45)**
Bronchopulmonary dysplasia (BPD)	13 (37%)
Necrotizing enterocolitis (NEC) stage ≥2	11 (24%)
Retinopathy of prematurity (ROP), treatment-requiring	3 (8.5%)
Length of hospital stay (days)	
Mean ± SD	59.6 ± 65.9
Median (min–max)	35 (6–262)
Sepsis-related early mortality	10 (22%)
All-cause mortality	21 (46%)

BPD: Bronchopulmonary dysplasia; NEC: Necrotizing enterocolitis; ROP: Retinopathy of prematurity.

For infants showing signs and symptoms of infection, an empirical antibiotic treatment should be started as soon as culture samples are obtained, based on the time of onset, the environment in which the agent was acquired, and the focus of the infection, and according to possible agents and antibiotic sensitivity, and the treatment process should be planned in light of culture results, clinical follow-up, and repeated laboratory tests if necessary (13). The majority of the infants included in our study experienced clinical deterioration after the seventh day of hospitalization. The selection of empirical antibiotics for these infants, who were considered to have nosocomial sepsis, was guided by the recommendations of the Turkish Neonatal Society and tailored to the pathogens commonly isolated in our clinic (14).

In cases of sepsis, intensive supportive treatment should be started together with antibiotic therapy. Electrolyte and glucose levels should be kept within normal limits, appropriate fluid-electrolyte therapy should be applied, acidosis and hypovolemia should be prevented, shock should be recognized early, and inotropic drugs should be used in addition to fluid therapy when necessary. Nutritional support should also be maintained. Hypoxia should be corrected (10). We continued to apply the necessary supportive treatment modalities along with antibiotic therapy during our follow-ups. In addition to standard supportive strategies, pentoxifylline was administered to neonates with circulatory dysfunction due to its anti-inflammatory properties and beneficial effects

on microcirculation (15). Despite implementing of all supportive treatments, selecting appropriate antibiotic therapy, and using pentoxifylline as an adjuvant treatment, the mortality rate in our cohort (sepsis-related early mortality 22%, all-cause mortality 46%) was higher than the mortality rates reported in the literature for neonatal sepsis. In a meta-analysis conducted by Carolin et al., studies from 14 countries were evaluated, and the incidence of neonatal sepsis was reported as 2,824 per 100,000 live births and 17.6% died (16). This may be attributed to the fact that pentoxifylline was administered to patients with already impaired circulation and was introduced relatively late in the course of treatment in our study. BPD developed in 13 of our patients who could be evaluated for BPD (37 %), 11 of whom were premature. As expected, the incidence of bronchopulmonary dysplasia (BPD) was high among preterm infants (17). Our literature review revealed no studies evaluating the use of systemic pentoxifylline for the prevention of BPD. Further randomized controlled trials are needed in this field. Eleven (24%) of our patients developed stage 2 or higher NEC according to the Modified Bell Criteria. In our literature review, we found no studies specifically investigating the use and effects of pentoxifylline in neonates diagnosed with necrotizing enterocolitis. Similar to the mortality findings, we believe that the higher incidence of NEC compared to the rate reported in the Turkish Neonatal Society Necrotizing Enterocolitis Guideline may be related to the fact that pentoxifylline treatment being added at a later stage, after the development of circulatory compromise in the patients included in our study (18). Only three of our cases developed retinopathy of prematurity requiring intervention (laser photocoagulation). The gestational ages of these infants at birth were 23, 26, and 28 weeks, respectively. In the study conducted by Erbaş et al., the rate of Stage 3 or higher ROP in patients receiving high-dose pentoxifylline was reported as 10.3% (9). However, in our cohort, the incidence of treatment-requiring ROP was lower (8.5%). The lower incidence observed in our study may be explained by the fact that infants who died in the early postnatal period were excluded from ROP evaluation, and the analysis was therefore limited to 35 surviving neonates.

Limitations

An important limitation of this study is the absence of a control group consisting of patients who did not receive pentoxifylline. Since the study was conducted exclusively on neonates treated with pentoxifylline for sepsis, no internal comparison could be made between users and non-users. As a result, while the findings were interpreted in light of existing literature, direct conclusions about the efficacy of pentoxifylline in our clinical are limited. This limitation has been recognized as a methodological shortcoming and should be taken into account in future prospective, controlled studies.

CONCLUSION

In this study, we were unable to demonstrate a statistically significant benefit of adjuvant pentoxifylline therapy in treating neonatal sepsis. The lack of observed efficacy may be attributed to factors such as the severity of the illness in the study population and the delayed initiation of pentoxifylline treatment. These limitations underscore the importance of further research.

To accurately evaluate the therapeutic potential of pentoxifylline in neonatal sepsis, well-designed, randomized controlled trials should be conducted in larger and more homogeneous patient populations, using standardized protocols and clearly defined timing for drug administration.

Ethical approval

This study has been approved by the Selcuk University Rectorate Local Ethics Committee (approval date 11.02.2025, number 2025/66).

Author contribution

Surgical and Medical Practices: SSU; Concept: SSU; Design: SSU; Data Collection or Processing: SSU; Analysis or Interpretation: SSU; Literature Search: SSU; Writing: SSU. The author reviewed the results and approved the final version of the article.

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Conflict of interest

The author declare that there is no conflict of interest.

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RESEARCH ARTICLES

Analysis of ductus nasolacrimalis and infraorbital foramen diameter measurements in patients operated on for antrochoanal polyps

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ABSTRACT

Aim: This study aimed to radiographically evaluate the diameters of the nasolacrimal duct (NLC) and infraorbital foramen (IOF) in patients operated on for antrochoanal polyps (ACP) and to investigate the association of these structures with the location of the polyp.

Materials and Methods: The transverse and anteroposterior diameters of NLC and IOF were measured from paranasal CT images of 40 patients who underwent functional endoscopic sinus surgery with a diagnosis of ACP between January 1, 2020, and January 15, 2025. Patients were classified according to the location of the polyp, its origin, and the status of sinus ventilation.

Results: While there was generally no significant difference in NLC diameters, in some subgroups the transverse diameters were found to be significantly larger on the normal side than on the pathological side. On the pathological side, a clear and significant narrowing of the IOF diameter was observed in all groups.

Conclusion: ACP causes morphological changes, particularly at the IOF, and the narrowing of this structure suggests bone remodeling. The effect on the NLC is more limited. A preliminary assessment of these anatomical structures during surgery planning is important to prevent possible complications.

Keywords: antrochoanal polyp, infraorbital foramen, nasolacrimal duct

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INTRODUCTION

Antrochoanal polyps (ACP) are benign masses that arise from the paranasal sinuses, particularly the maxillary sinus, and develop posteriorly, extending into the choana and nasopharynx (1). The literature reports that they account for 4–6% of patients with nasal polyps. They occur more frequently in children and young adults (2). ACP is usually unilateral, isolated, and spreads toward the nasal cavity (3).

Nasal obstruction causes symptoms such as unilateral nasal discharge, postnasal drip, and, rarely, headaches (4). A preliminary diagnosis can be made through a routine physical examination and a nasal endoscopy. Additionally, the use of imaging techniques provides more detailed information about the location and extent of the lesion (5). In particular, it is known that computed tomography (CT) provides more detailed information about the lesion (6). Furthermore, the etiology and pathogenesis of ACP have not yet been clearly established in the literature (7-9).

The nasolacrimal canal (NLC) is a duct system that facilitates tear drainage and must be taken into account during surgery (10). The infraorbital foramen (IOF) is a bony structure through which the infraorbital nerve passes. Any variation in this anatomical structure may lead to complications during surgery (11).

It is thought that the pressure created by ACP within the maxillary sinus may cause various changes in the NLC and IOF regions, which contain delicate bony structures (12). The effects on the NLC and IOF may, in turn, cause tear drainage disorders and neurological disorders (13). Therefore, a detailed preoperative evaluation of these structures can help prevent complications (14).

The aim of this study is to radiologically examine the diameters of the NLC and IOF in patients diagnosed with ACP and to evaluate the effect of ACP on these structures.

MATERIALS AND METHODS

The NLC and IOF diameters were measured from preoperative CT images of the paranasal sinuses in patients diagnosed with ACP who underwent functional endoscopic sinus surgery at the Ear, Nose, and Throat Clinic of Bolu Abant İzzet Baysal Training and Research Hospital between January 1, 2020, and January 15, 2025.

Patients were categorized according to age, sex, right-left position of the maxillary sinus, whether the lesion completely filled the maxillary sinus, and whether the lesion originated from the maxillary sinus ostium or accessory ostium.

Inclusion criteria for the study: Patients who underwent surgery with a diagnosis of ACP between 2020 and 2025, who had complete preoperative CT images, and who were over the age of 7 years.

Exclusion criteria: Patients who had previous sinus surgery, those with a history of maxillofacial trauma, and those with additional pathologies such as sinus tumors were excluded from the study.

Statistical analysis

Data analysis was performed using IBM SPSS Statistics for Windows (version 21.0; IBM Corp., Armonk, NY, USA). Data are expressed as mean ± standard deviation (SD) and n (%). The Mann-Whitney U test, Wilcoxon signed-rank test, and Pearson chi-square test were used for statistical comparison. For statistical significance, a p-value <0.05 was considered significant.

RESULTS

The study included 40 patients aged between 7 and 72 years (mean age 35.5 ± 17.3 years); 67.5% of the patients were male. When comparing the age and gender distribution regarding the location of the polyp (right/left), the exit site (native/accessory ostium), the status of sinus ventilation (partial/complete),

and the patency of the frontal recess, it was found that the average age was significantly higher only in patients with an obliterated frontal recess. In men, the proportion of polyps arising from the native maxillary ostium was significantly higher (Table 1). When evaluating the NLC diameters, no significant difference was found between the pathologic and normal sides in terms of transverse and anteroposterior (AP) measurements.

However, in some subgroups, such as right sinus location, native ostial origin, and complete loss of ventilation, transverse diameters were found to be significantly larger on the normal side than on the pathologic side (Table 2 and Table 3).

Significant differences were observed regarding IOF diameter. The IOF diameter on the pathological side was significantly smaller than on the normal side, and this was consistent across all groups. This difference remained independent of parameters such as sinus position, location of polyp exit, loss of ventilation, and patency of the frontal recess (Table 4).

These results show that the antrochoanal polyp has significant morphological effects, particularly on the IOF, while its effect on the NLC is more limited.

Table 1. Comparison of features of antrochoanal polyps according to demographic characteristics

Polyps	**Mean age**	**p**	**Male %**	**Female %**	**p**
Sinus Cavity Placement					
Right	36.9	0.494	69.6	30.4	0.746
Left	33.6		64.7	35.3	
Place of Origin/Origin					
Native Ostium	38.7	0.297	52.6	47.4	0.050
Accessory Ostium	32.6		81.0	19.0	
Loss of Sinus Aeration					
Partial	35.9	0.988	76.9	23.1	0.484
Total	35.3		63.0	37.0	
Frontal Recess					
Open	30.3	**0.004**	75.0	25.0	0.154
Obliterated	47.7		50.0	50.0	

Table 2. NLC and IOF measurements

Diameter (mm)	**Mean**	**SD**	**p**
Pathological side NLC transverse diameter	4,2	1,0	0.078
Normal side NLC transverse diameter	4,4	1,0	
Pathological side NLC AP diameter	6,4	1,1	0.412
Normal side NLC AP diameter	6,5	1,2	
Pathological side IOF diameter	2,6	0,4	0.001
Normal side IOF diameter	2,9	0,5	

NLC: Nasolacrimal duct; IOF: Infraorbital foramen; AP: Anteroposterior.

Table 3. Comparison of NLC transverse and AP diameters according to polyp characteristics

	Pathological side NLC transverse diameter	Normal side NLC transverse diameter	p	Pathological side NLC AP diameter	Normal side NLC AP diameter	p
Sinus Cavity Placement						
Right	4.1	4.5	**0.050**	6.4	6.4	0.107
Left	4.3	4.2	0.816	6.4	6.4	0.477
P	0.565	0.502		0.956	0.218	
Place of Origin/Origin						
Native Ostium	4.0	4.4	0.055	6.4	6.4	0.983
Accessory Ostium	4.4	4.4	0.601	6.4	6.4	0.262
P	0.132	0.578		0.626	0.766	
Loss of Sinus Aeration						
Partial	4.4	4.2	0.624	6.3	6.3	0.701
Total	4.1	4.5	**0.015**	6.4	6.4	0.103
P	0.241	0.772		0.840	0.102	
Frontal Recess						
Open	4.2	4.5	0.079	6.3	6.3	0.268
Obliterated	4.1	4.1	0.593	6.6	6.6	0.929
P	0.478	0.231		0.848	0.813	

NLC: Nasolacrimal duct; AP: Anteroposterior.

Table 4. Comparison of IOF diameters according to polyp characteristics

	Pathological side IOF diameter	Normal side IOF diameter	p
Sinus Cavity Placement			
Right	2.5	2.8	**0.001**
Left	2.8	3.0	**0.006**
P	0.123	0.118	
Place of Origin/Origin			
Native Ostium	2.7	3.0	**0.001**
Accessory Ostium	2.6	2.8	**0.006**
P	0.703	0.139	
Loss of Sinus Aeration			
Partial	2.7	2.9	**0.039**
Total	2.6	2.9	**0.001**
P	0.931	0.885	
Frontal Recess			
Open	2.7	2.9	**0.001**
Obliterated	2.6	3.0	**0.005**
P	0.964	0.225	

IOF: Infraorbital foramen.

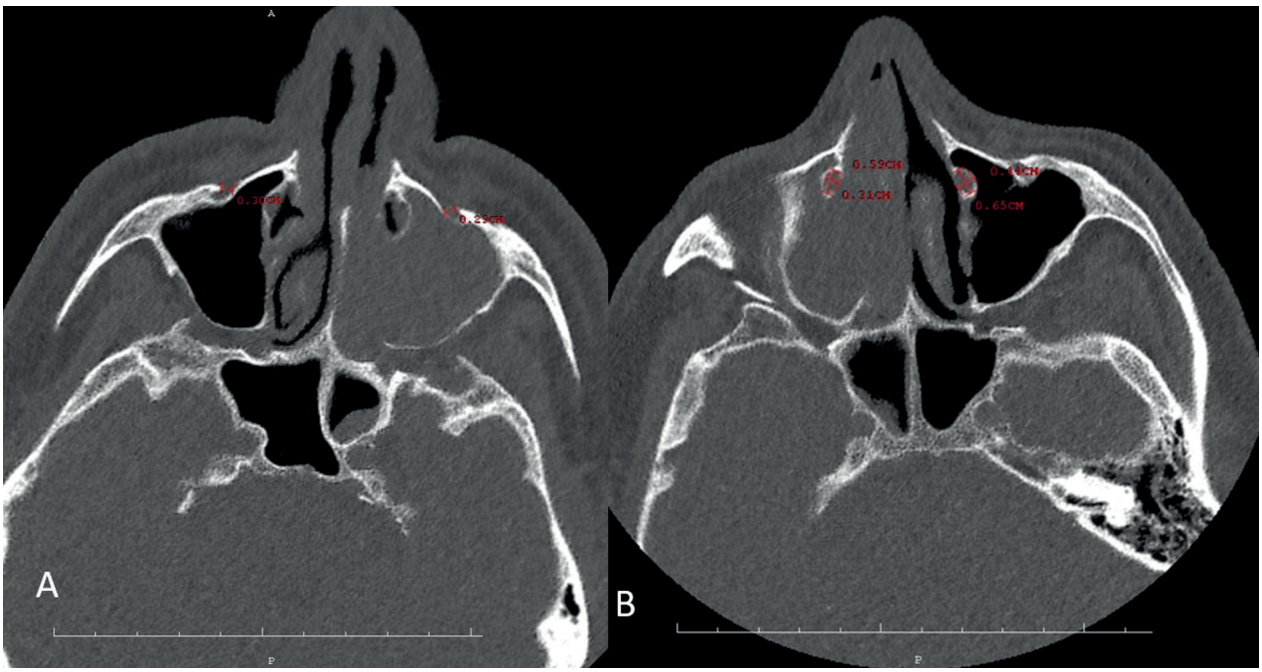

Figure 1. In axial paranasal sinus CT examination, the measurement method of the infraorbital canal at the level of the inferior orbital rim (A) and the nasolacrimal canal at the level of the middle turbinate (B) are shown.

The measurement method of the infraorbital canal and nasolacrimal canal in axial paranasal sinus CT examination is shown in Figure 1.

DISCUSSION

In this study, NLC and IOF diameters in patients operated on for antrochoanal polyp (ACP) were radiologically evaluated, and morphological differences between the pathological side and the normal side were examined.

The study has highlighted the fact that ACP alters major anatomical structures. ACP may result from obstruction induced by inflammatory stress in the sinus ostium (8,15), as reported in the literature. This obstruction results in increased pressure within the maxillary sinus (16) and compresses adjacent tissues. This significant reduction in IOF diameter is in agreement with previous studies. Moreover, in this study, we also evaluated NLC diameters. Injury to the NLC during surgery may cause various symptoms (17). In both the pathological and normal sides of the NLC evaluated in this research, no significant difference in the size of the NLC was found. This may indicate that ACP is less effective than IOF in altering the NLC. However, the limited number of patients prevents generalization of the outcome. A further key theme in the results was that the difference was most pronounced in polyps located in the right sinus or polyps derived from the natural maxillary sinus ostium. We assume that the location and origin of the polyp are important parameters regarding its influence on the NLC. However, this, along with the limited number of patients, limits generalization.

Likewise, the older average age of patients with an obliterated frontal recess suggests that the inflammatory process lasts longer in these patients, and therefore the polyp may cause more anatomical changes in the surrounding structures. These results suggest that age and patency of the frontal recess may be important predictors in assessing the anatomical impact of ACP.

The IOF is a bone canal through which the infraorbital nerve passes and is located very close to the maxillary sinus wall. Therefore, the inflammatory or mechanical

pressure generated by ACP can lead to a reduction in the diameter of this foramen and indirectly cause symptoms such as paresthesia in the postoperative period (18,19). In fact, our study found a significant difference in IOF diameters between the pathological and normal sides in patients with polyps in both the right and left sinus areas. Similarly, it has been shown in the literature that diseases of the maxillary sinuses, particularly chronic inflammation, can lead to remodeling in the area of the IOF (20).

In our study, it was found that whether the exit site is a native maxillary ostium or an accessory ostium also has an impact on the IOF diameter. The IOF diameter on the pathological side decreased significantly in both groups. This shows that no matter which ostium the polyp originates from, it can affect the IOF adjacent to the maxillary sinus wall. Furthermore, the fact that the narrowing of the IOF diameter is significant even with complete loss of ventilation supports the effect of increased intrasinus pressure on the IOF. These results highlight the need for a systematic evaluation of the IOF in diseases of the maxillary sinuses (21).

Our study emphasizes the importance of radiological measurements in assessing anatomical changes due to ACP. Morphological assessment of critical structures such as the NLC and IOF is valuable not only for surgical planning but also for preventing potential complications. It has been shown that complications that may arise, particularly after sinus surgery, may be directly related to the spread of the polyp into the paranasal sinuses and its effects on neighboring structures (22).

Limitations of this study include the limited number of patients and its retrospective design. Furthermore, our study did not establish a correlation between postoperative symptoms and radiological findings but only assessed anatomical changes using objective measurements. Future prospective studies may be more informative regarding the association of changes in the diameter of these structures with clinical symptoms. In addition, simultaneous examination of the degree of inflammation with histopathological examinations can more clearly reveal the pathogenesis of these morphological changes. In conclusion, it has been shown that antrochoanal polyps cause significant morphological changes in the bony structures around the maxillary sinus, especially the IOF. These findings suggest that a detailed preoperative CT examination should evaluate not only the spread of the polyp but also its structural effects on the IOF and NLC. Surgeons should minimize the risk of neurological complications by considering that this structure may have narrowed during operations close to the IOF. The relationship between these morphological changes and symptoms should be evaluated in larger and prospective studies.

Ethical approval

This study has been approved by the Bolu Abant Izzet Baysal University Non-Interventional Clinical Research Ethics Committee (approval date 04.03.2025, number 2025/98).

Author contribution

Concept: AG, FA; Design: AG, FA; Data Collection or Processing: FA, AG, SH; Analysis or Interpretation: FA, EK, SH; Literature Search: AG, FA, EK, SH; Writing: AG, FA, EK, SH. All authors reviewed the results and approved the final version of the article.

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The authors declare that there is no conflict of interest.

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RESEARCH ARTICLES

The relationship between respiratory symptoms and psychological state: a perspective on kinesiophobia and cardiac anxiety

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ABSTRACT

Aim: This study investigated the relationship between kinesiophobia, cardiac anxiety, and dyspnea symptoms in patients undergoing coronary artery bypass graft (CABG) surgery.

Materials and Methods: A descriptive cross-sectional study was conducted with 84 patients at a tertiary care facility over a 15-month period from December 2023 to March 2025. The study population included adult patients (≥18 years) who underwent elective CABG and remained hospitalized for 3 to 5 days postoperatively. Data were collected using the Cardiac Anxiety Questionnaire (CAQ) and the Tampa Scale for Kinesiophobia (TSK), alongside demographic and clinical assessments of pain, fatigue, and dyspnea.

Results: Data analysis revealed a significant positive correlation between kinesiophobia and cardiac anxiety (r=0.602, p=0.01), suggesting that these psychological barriers frequently coexist post-surgery. Participants with higher levels of kinesiophobia exhibited significantly higher cardiac anxiety. However, kinesiophobia was not correlated with pain (r=0.161, p=0.142) or dyspnea (r=-0.010, p=0.924). Regression modeling demonstrated that cardiac anxiety was the sole independent predictor of kinesiophobia, accounting for 23% of the total variance (p=0.001). Other variables, including age, weight, smoking status, and dyspnea, were not significant predictors.

Conclusion: Our findings suggest that cardiac anxiety is a primary driver of kinesiophobia following cardiac surgery. These results underscore the necessity for healthcare providers to conduct multidisciplinary assessments of physical, mental, and respiratory status during cardiac rehabilitation to optimize patient outcomes.

Keywords: anxiety disorders, dyspnea, fear, pain, psychological distress

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INTRODUCTION

Coronary artery disease (CAD) remains a leading cause of morbidity and mortality globally (1). Coronary Artery Bypass Grafting (CABG) is one of the most common surgical interventions, aimed at enhancing cardiac output and improving survival rates (2). However, patients often face barriers to functional recovery due to postoperative physical and emotional effects. Symptoms such as fatigue, discomfort, and dyspnea may impede rehabilitation, often due to a fear of re-injury associated with physical movement (3).

Dyspnea is a complex perception influenced by both physiological and psychological variables (4). Although it may not always stem from a primary respiratory etiology, postoperative dyspnea in CAD patients remains a critical metric for pulmonary evaluation. Anxiety-related dyspnea may lead patients to misinterpret physical sensations, thereby exacerbating perceived respiratory distress (5). Consequently, differentiating between cardiac and pulmonary symptoms is essential in patients presenting with comorbid conditions.

Dyspnea is frequently associated with psychological distress and the avoidance of movement due to fear, known as kinesiophobia (6,7). Anticipation of symptoms or fear of breathlessness can trigger cardiac-related stress, which subsequently restricts daily activity and reduces overall physical capacity (8). This pattern is prevalent in cardiovascular patients and has also been observed in populations with COPD or interstitial lung diseases (9,10).

In this context, the correlation between patient-perceived dyspnea and physical inactivity necessitates a multidisciplinary approach. This study aimed to investigate the relationship between kinesiophobia, cardiac anxiety, and dyspnea in CAD patients. Our preliminary observations suggest a direct correlation between kinesiophobia and cardiac anxiety levels. Furthermore, the degree of anxiety appears to vary significantly based on the level of kinesiophobia. These data emphasize the importance of integrated assessments involving psychological, respiratory, and physical symptomatology, highlighting the integral role of pulmonologists in the postoperative recovery process.

METHODS

Study design and participants

This study utilized a descriptive cross-sectional design. The study population comprised 84 patients admitted to the Bolu Abant İzzet Baysal University, İzzet Baysal Training and Research Hospital between December 2023 and March 2025.

Inclusion criteria were:

- Age ≥18 years,
- Undergoing elective CABG surgery,
- Hospitalization for 3–5 days post-surgery,
- Provision of verbal and written informed consent.

Exclusion criteria included cognitive impairment, speech disorders, pre-existing psychiatric diagnoses, or a requirement for mechanical ventilation. Cognitive status was assessed by the attending physician through clinical evaluation of orientation, memory, and the ability to follow instructions.

Data collection tools

Data collection included demographic variables (age, height, weight, education, smoking status, comorbidities, and exercise habits), symptomatic conditions (pain, fatigue, and dyspnea), and psychological assessments.

The Cardiac Anxiety Questionnaire (CAQ) is a self-report instrument developed by Eifert et al. to evaluate heart-related fear, attention to symptoms, and avoidance behaviors (11). Items are scored from 0 (none) to 4 (very high), with higher total scores indicating greater cardiac anxiety. The Turkish version has demonstrated validity and reliability across various cardiac populations (12).

The Tampa Scale for Kinesiophobia (TSK) evaluates fear of movement or physical activity due to concerns regarding pain or injury. Originally developed by Kori et al., it is widely used in rehabilitation settings (13). The TSK consists of 17 items scored on a 4-point Likert scale (1=strongly disagree, 4=strongly agree). Total scores range from 17 to 68, where higher scores reflect greater kinesiophobia. The Turkish version is a validated tool for assessing activity-related avoidance behaviors (14).

Ethical approval

This study was approved by the Bolu Abant İzzet Baysal University Clinical Research Ethics Committee (Date: 05.12.2023; Decision No: 2023/416). Informed consent was obtained from all participants.

Statistical analysis

Data were analyzed using IBM SPSS Statistics v20.0 (IBM Corp., Armonk, NY, USA). Continuous variables are presented as mean±standard deviation (SD), and categorical variables as frequencies and percentages. Data normality was assessed using the Shapiro–Wilk test. Intergroup comparisons were conducted using independent samples t-tests or the Mann–Whitney U test as appropriate. Differences across kinesiophobia levels (low, medium, and high) were evaluated via the Kruskal–Wallis test with Dunn–Bonferroni post-hoc analysis. Pearson's correlation was used to assess relationships between variables, and multiple linear regression (enter method) was used to identify predictors of kinesiophobia. Significance was set at $p < 0.05$.

RESULTS

Eighty-four patients meeting the inclusion criteria were monitored during the early postoperative period. The mean age was 62.07±8.37 years. Physical characteristics included a mean height of 168.63±7.02 cm and a mean weight of 76.95±13.82 kg. Approximately 30% of participants were active smokers, and 25% reported chronic comorbidities such as diabetes mellitus or hypertension. Postoperative fatigue was the most prevalent symptom. Dyspnea was reported by over 50% of participants, while 30% experienced pain in the early recovery phase. Participants exhibited moderate levels of cardiac anxiety and kinesiophobia, as summarized in Table 1.

Cardiac anxiety demonstrated a significant positive correlation with kinesiophobia (r=0.602, p=0.01). Conversely, no significant correlation was found between kinesiophobia and pain (r=-0.161, p=0.142) or dyspnea (r=-0.010, p=0.924) (Table 2).

Participants were stratified into low, medium, and high kinesiophobia groups (Figure 1). Kruskal–Wallis analysis revealed significant differences in cardiac anxiety scores between groups (p=0.004). Post-hoc testing indicated that the high kinesiophobia group had significantly higher cardiac anxiety compared to other groups.

Table 1. Overview of the sociodemographic and clinical profiles of the participants (n=84)

	Mean	SD	Min	Max	Q1	Q3
Age (year)	62.07	8.37	37	77.0	58.011	68.0
Height (cm)	168.63	7.03	148	181.0	165.0	174.0
Weight (kg)	76.95	13.82	45	135.0	70.75	84.0
BMI (kg/m^2)	27.15	5.26	19.99	46.85	23.77	29.23
CAQ (0-4)	1.97	0.56	0.44	4.25	1.705	2.22
TSK (17-68)	44.79	6.59	32	62.0	40.0	49.0

SD: Standard Deviation, Min: Minimum, Max: Maximum, Q1: 1st Quartile, Q3: 3rd Quartile, BMI: Body Mass Index, CAQ: Cardiac Anxiety Questionnaire, TSK: Tampa Scale for Kinesiophobia.

Table 2. Correlations among key clinical and psychological variables

		CAQ	TSK	Presence of Pain	Presence of Dyspnea
CAQ	p	NA	0.01*	0.112	0.411
	r		0.602	-0.357	-0.189
TSK	p	0.01*	NA	0.142	0.924
	r	0.602		-0.161	-0.01
Presence of Pain	p	0.112	0.142	NA	0,01*
	r	-0.357	-0.161		0,338
Presence of Dyspnea	p	0.411	0.924	0.01*	NA
	r	-0.189	-0.01	0.338	

*p<0.05; r: Pearson correlation coefficient; NA: Not Applicable; CAQ: Cardiac Anxiety Questionnaire; TSK: Tampa Scale for Kinesiophobia.

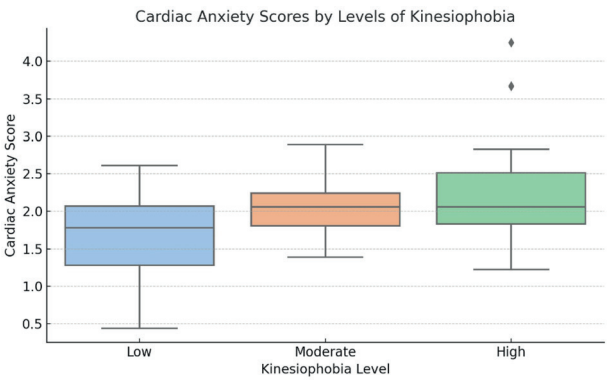

Figure 1. Descriptive statistics of cardiac anxiety scores according to kinesiophobia levels.

Multiple linear regression identified cardiac anxiety as the only significant predictor of kinesiophobia (β=5.37, p=0.001). Variables such as age, weight, smoking status, and dyspnea did not significantly contribute to the model (p>0.05). The model explained 23.1% of the variance in kinesiophobia (R^2=0.231).

DISCUSSION

This study explored the relationships between dyspnea, cardiac anxiety, and kinesiophobia in post-CABG patients. Our findings indicate a strong association between heart-related anxiety and fear of movement, with kinesiophobia levels increasing in tandem with cardiac anxiety.

These results align with previous research. Keessen et al. noted that patients often avoid exercise when they perceive heart-related symptoms as dangerous (15). Similarly, Hüzmeli et al. observed that patients with high cardiac anxiety engage in less physical activity due to fear-avoidance beliefs (16). Our study confirms that CABG patients are susceptible to these psychological mechanisms.

While dyspnea is a common clinical finding, its management in cardiac patients is complicated by emotional factors. Leupoldt and Dahme argued that dyspnea perception is mediated by cognitive and emotional processes (17). The lack of a strong correlation between dyspnea and kinesiophobia in our results suggests that the fear of movement may be more closely tied to perceived cardiovascular risk than to immediate respiratory distress during the early postoperative phase.

Regression analysis confirmed that cardiac anxiety is a major determinant of exercise avoidance. Traditional demographic factors such as age and smoking status did not significantly influence kinesiophobia, suggesting that psychological interventions may be more effective than addressing physical factors alone in reducing fear of movement. Clinicians should evaluate patients for anxiety and avoidance behaviors, as exercise intolerance often stems from a combination of physiological and psychological barriers.

This study has several limitations. The sample size of 84 may limit the generalizability of the findings. The single-center design further restricts the external validity of the results. Future multi-center studies with larger cohorts are needed to validate these findings. Additionally, reliance on self-report measures for psychological status and symptoms may introduce subjective bias, and the absence of objective functional indicators could result in an underestimation of symptom severity.

CONCLUSION

A clear relationship exists between cardiac anxiety and kinesiophobia following CABG surgery. Interestingly, kinesiophobia was not directly correlated with dyspnea or postoperative pain in this cohort, suggesting that psychosocial factors play a dominant role in activity avoidance. Therefore, postoperative care should incorporate psychological screening alongside physical rehabilitation. A multidisciplinary approach involving cardiac, pulmonary, and psychological specialists is essential to break the cycle of inactivity and improve patient recovery after CABG.

Ethical approval

This study has been approved by the Clinical Research Ethics Committee of Bolu Abant İzzet Baysal University (approval date 05.12.2023, number 2023/416). Written informed consent was obtained from the participants.

Author contribution

Concept and Design: SK, AÖ, ERU, UAU, EAÖ, TK; Data Collection or Processing: AÖ, EAÖ, TK, UAU; Analysis or Interpretation: AÖ, UAU; Literature Search: SK, ERU, AÖ; Writing: SK, ERU, AÖ, UAU, EAÖ, TK. All authors reviewed the results and approved the final version of the article.

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Conflict of interest

The authors declare that there is no conflict of interest.

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RESEARCH ARTICLES

The impact of intervertebral morphological structure on the cobb angle in patients with adolescent idiopathic scoliosis

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ABSTRACT

Objective: We aimed to investigate how the heights of the vertebral bodies on the concave and convex sides, as well as the differences between these heights, affect the Cobb angle in patients presenting with adolescent idiopathic scoliosis (AIS).

Materials and Methods: Radiographs and computed tomography (CT) images of 23 patients aged 13-18 years diagnosed with AIS were retrospectively analyzed. The heights of the vertebral bodies on the concave and convex sides were measured and compared with the curvatures determined using the Cobb method. The contributions of the vertebral body Cobb angle and the intervertebral disc Cobb angle to the total Cobb angle were also evaluated.

Results: The vertebral body Cobb angle contributed an average of 52% to the total Cobb angle, while the intervertebral disc Cobb angle contributed an average of 48%. A stronger correlation was observed between the intervertebral disc Cobb angle and the total angle than between the vertebral body Cobb angle and the total angle.

Conclusion: The reduced heights of both the intervertebral disc and the vertebral body on the concave side compared to the convex side indicate that as the difference between these values decreases, these components progressively move away from the apical vertebrae. This causes greater wedging at the apex and reduced wedging in adjacent segments, consequently increasing the total Cobb angle. Although the vertebral body Cobb angle contributes more numerically to the total Cobb angle, the relationship between the intervertebral disc Cobb angle and the total Cobb angle was found to be statistically stronger.

Keywords: scoliosis surgery, young adult idiopathic scoliosis, scoliosis, cobb angle, adolescent idiopathic scoliosis

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INTRODUCTION

Defined as a lateral spinal curvature of 10 degrees or more in the frontal plane on standing plain radiographs, scoliosis is the most common spinal deformity; it is a three-dimensional deformity comprising frontal, sagittal, and axial planes. In anomalies causing a lateral shift in the frontal plane, axial rotation and extension in the sagittal plane can be observed, which leads to lordosis (1). Adolescent idiopathic scoliosis (AIS) is observed in approximately 2-4% of healthy children on average and accounts for approximately 80% of structural scoliosis cases occurring at any age during the growth period. AIS can be diagnosed by excluding neurological causes, relevant pathologic findings (e.g., skin lesions in neurofibromatosis), and congenital anomalies through thorough physical and radiological examinations (1).

Although factors such as genetics, growth hormone secretion, connective tissue structure, muscle structure, vestibular dysfunction, melatonin secretion, and differences in platelet microstructure have been suggested as potential causes, the exact etiology of AIS remains unknown. Studies simplifying etiology to a single factor have been unsuccessful, indicating that the cause is multifactorial (2,3). While there are no widely accepted scientific theories for AIS etiology, studies focusing on pathogenesis have shown significant asymmetry in the pedicles of AIS individuals, which demonstrates clinical importance (4,5). In these studies, the concave side of the curve has been found to have reduced height and width periapically; the circumference of the pedicle on the convex side has been found to be sharper than that on the concave side around the apex (6). The identification of asymmetry between pedicles on the concave and convex sides in scoliosis patients minimizes the risk of screw placement complications and contributes greatly to understanding scoliosis etiology (6).

Scoliosis is assessed by the Cobb angle (a standard measurement method for determining the degree of curvature), which guides the decision between conservative approaches and surgical interventions in the management of AIS. The Cobb angle is obtained by drawing lines perpendicular to the upper and lower end vertebrae detected in the coronal plane of the X-ray (7,8). The Cobb angle is comprised of two basic components: the vertebral bodies and the intervertebral discs (7,9). The narrowing of the intervertebral disc space and wedging occurring in the vertebral bodies both influence the Cobb angle.

In this study, the researchers measured the heights of the concave and convex sides of vertebral bodies in patients with AIS and calculated the Cobb angle to investigate the impacts of the intervertebral disc and vertebral body heights on the overall Cobb angle.

MATERIAL AND METHODS

Ethical approval and study design

This study is retrospective and observational in nature. The researchers aimed to investigate the morphometric contribution of vertebral and discal wedging to the overall Cobb angle using radiographic and computed tomography (CT) data. The research was approved by the Bolu Abant Izzet Baysal University Clinical Researches Ethics Committee (Decision No: 2019/186). The medical records of patients diagnosed with AIS who received treatment at the Spine Clinic of Bolu Abant Izzet Baysal University Faculty of Medicine Training and Research Hospital between 2017 and 2020 were reviewed retrospectively.

Patient selection

Patients aged 13-18 years with a confirmed diagnosis of AIS whose available radiographs and CT images were suitable for accurate morphometric measurements (vertebral body and intervertebral disc heights on both the concave and convex sides of the spinal curve) were included in the study.

Patients who presented with congenital vertebral anomalies such as wedge or block vertebrae, lumbar disc herniation, or inflammatory back pain were excluded. Additional exclusion criteria included spinal conditions such as spondylolisthesis, rheumatologic or systemic disorders, and chronic pulmonary or cardiac diseases that might have affected spinal morphology. A total of 23 patients were found to be eligible for the study after these criteria were applied.

Radiographic and CT measurements

Demographic data (including age and sex) and radiological measurements (including Cobb angles, vertebral body heights, and intervertebral disc heights) were obtained for each patient. For quantitative evaluation, scoliosis radiographs in the anteroposterior plane and axial CT images were utilized.

Curvature assessment: In addition to the apical, neutral, and stable vertebrae, the upper and lower end vertebrae of the proximal thoracic, main thoracic, and lumbar curves were identified. The Cobb method on standing posteroanterior radiographs was utilized to calculate the magnitude of each curve.

Height measurements: On axial and sagittal CT images, the vertebral body and intervertebral disc heights on the concave and convex sides were measured. The narrowest and widest portions of the vertebral body and intervertebral disc were used to assess the degree of wedging. The respective contributions of these values to overall curvature were then identified by correlating the values with the Cobb angle values.

Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics version 21.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were calculated for all variables. Continuous variables were expressed as mean, standard deviation, median, and range (minimum-maximum), while categorical variables were presented as frequencies and percentages. The Shapiro-Wilk test was applied to test the normality assumption for numerical variables. For paired comparisons between the concave and convex sides, the paired samples t-test was used in cases where the data were normally distributed, and the Wilcoxon signed-rank test was used where the data were not.

Pearson's correlation coefficient was used to assess the strength and direction of linear relationships between the total Cobb angle and its components, including the vertebral body Cobb angle and the disc Cobb angle. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Of the 23 patients included in the study (aged 13-18 years), 82.6% were female and 17.4% were male; the mean age was 16.22 ± 1.59 years (Table 1).

Segment-level measurements of vertebral body heights and intervertebral disc heights between the upper and lower end vertebrae forming the Cobb angle are summarized in Table 2. Except for T4, the T4-T5 disc space, and T5, significant differences between concave and convex sides were observed for most vertebral levels (Table 2).

Descriptive statistics for the total Cobb angle, vertebral body (corpus), and disc components are presented in Table 3. The relationship between the corpus and disc components is illustrated in Figure 1. The associations of the total Cobb angle with the corpus and disc components are shown in Figures 2 and 3, respectively.

Correlation analysis demonstrated a moderate, statistically significant positive association between the total Cobb angle and the total vertebral body Cobb angle ($r = 0.698$, $p < 0.001$), and a strong, statistically significant positive correlation between the total Cobb angle and the total disc Cobb angle ($r = 0.894$, $p < 0.001$) (Table 4; see also Figures 2 and 3). In terms of variance explained, the corpus and disc components accounted for approximately 48.7% and 80.0% of the variability in the total angle, respectively (r^2 values derived from Table 4).

Table 1. Demographic characteristics of the participants (summary of participant characteristics including age and sex distribution (N = 23))

Variable	Category	Value
Sample size	N	23
Age	Mean ± SD	16.22 ± 1.59
	Range (min-max)	13 - 18
Sex	Female	19 (82.6%)
	Male	4 (17.4%)

Table 2. Descriptive statistics presenting mean, standard deviation, median [min - max] values are provided for the descriptive statistics

Level	n	Angle mean-SD	Angle median-min-max	Concave mean-SD	Concave median-min-max	Convex mean-SD	Convex median-min-max	p
T4	4	1.54 ± 1.83	1.73 [0.37-2.32]	1.78 ± 1.16	1.80 [1.60-1.92]	1.81 ± 1.19	1.83 [1.60-1.98]	0.180
T4-T5	4	2.39 ± 0.33	2.52 [1.90-2.60]	0.23 ± 0.06	0.23 [0.16-0.30]	0.25 ± 0.07	0.26 [0.20-0.35]	0.180
T5	9	2.04 ± 0.85	2.02 [0.93-3.88]	1.73 ± 0.13	0.72 [1.48-1.90]	1.75 ± 0.16	1.72 [1.48-2.02]	0.292
T5-T6	9	2.63 ± 0.88	2.45 [1.44-4.32]	0.23 ± 0.06	0.27 [0.10-0.29]	0.28 ± 0.07	0.28 [0.12-0.34]	0.002
T6	12	2.48 ± 0.77	2.58 [1.39-4.21]	1.75 ± 0.16	1.78 [1.38-2.00]	1.80 ± 0.16	1.81 [1.50-4.21]	0.035
T6-T7	12	2.85 ± 1.27	2.68 [0.79-5.74]	0.24 ± 0.08	0.25 [0.10-0.38]	0.31 ± 0.10	0.32 [0.11-0.49]	<0.001
T7	13	3.24 ± 1.08	3.45 [1.60-4.89]	1.77 ± 0.19	1.81 [1.38-2.06]	1.87 ± 0.17	0.89 [1.53-2.15]	<0.001
T7-T8	13	3.53 ± 2.98	2.98 [1.51-2.58]	0.26 ± 0.09	0.26 [0.11-0.42]	0.36 ± 0.14	0.37 [0.11-0.61]	0.003
T8	14	3.53 ± 1.06	3.41 [1.73-5.82]	1.82 ± 0.21	1.82 [1.43-2.12]	1.97 ± 0.18	2.03 [1.52-2.23]	<0.001
T8-T9	13	3.51 ± 2.02	3.21 [1.80-9.67]	0.27 ± 0.08	0.30 [0.13-0.38]	0.41 ± 0.14	0.42 [0.15-0.71]	0.001
T9	16	3.75 ± 1.87	3.09 [1.29-7.49]	1.89 ± 0.22	1.93 [1.46-2.22]	2.06 ± 0.21	2.13 [1.52-2.35]	0.001
T9-T10	16	3.31 ± 1.69	3.01 [1.78-8.90]	0.34 ± 0.11	0.36 [0.12-0.49]	0.46 ± 0.17	0.48 [0.21-0.87]	0.001
T10	17	3.44 ± 2.06	3.07 [1.02-0.39]	2.03 ± 0.19	2.05 [1.66-2.33]	2.19 ± 0.19	2.23 [1.79-2.48]	0.001
T10-T11	12	2.62 ± 0.60	2.56 [1.76-3.61]	0.38 ± 0.11	0.39 [0.20-0.55]	0.52 ± 0.18	0.49 [0.31-0.94]	0.002
T11	16	2.89 ± 0.99	2.87 [1.37-4.98]	2.18 ± 0.18	2.18 [1.72-2.50]	2.30 ± 0.17	2.33 [2.00-2.56]	0.001
T11-T12	15	2.97 ± 0.77	3.02 [1.64-4.12]	0.47 ± 0.12	0.50 [0.24-0.66]	0.65 ± 0.13	0.65 [0.43-0.86]	<0.001
T12	16	3.05 ± 1.16	2.73 [1.03-5.68]	2.29 ± 0.22	2.29 [1.78-2.70]	2.42 ± 0.18	2.41 [2.10-2.81]	<0.001
T12-L1	16	3.36 ± 1.21	3.41 [1.04-5.68]	0.50 ± 0.15	0.48 [0.20-0.94]	0.73 ± 0.18	0.75 [0.44-1.07]	<0.001
L1	16	3.24 ± 1.45	3.27 [1.19-6.09]	2.43 ± 0.23	2.45 [1.93-2.79]	2.56 ± 0.20	2.56 [2.22-2.89]	<0.001
L1-L2	15	4.12 ± 2.04	4.02 [1.90-9.73]	0.58 ± 0.15	0.55 [0.31-0.85]	0.87 ± 0.25	0.78 [0.56-1.49]	0.001
L2	15	3.08 ± 1.57	2.58 [0.71-6.16]	2.48 ± 0.22	2.47 [2.04-2.88]	2.61 ± 0.23	2.62 [2.27-3.00]	0.001
L2-L3	10	4.65 ± 2.62	3.48 [2.17-8.81]	0.64 ± 0.18	0.61 [0.35-0.93]	0.90 ± 0.21	0.91 [0.60-1.18]	0.001
L3	10	3.03 ± 1.23	2.67 [1.69-5.26]	2.55 ± 0.26	2.55 [2.23-2.93]	2.65 ± 0.26	2.69 [2.30-3.04]	0.005
L3-L4	8	3.58 ± 2.27	2.86 [1.66-8.96]	0.69 ± 0.22	0.70 [0.35-1.05]	0.86 ± 0.15	0.87 [0.57-1.10]	0.029
L4	8	2.07 ± 0.76	1.95 [1.00-3.26]	2.64 ± 0.26	0.64 [2.25-3.10]	2.76 ± 0.33	2.76 [2.24-3.30]	0.043

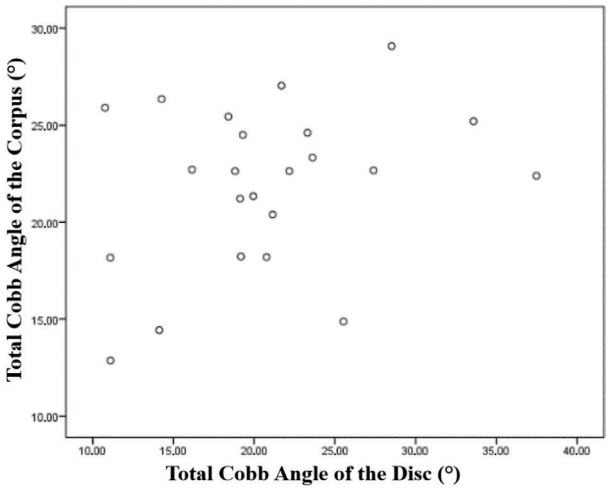

Figure 1. Scatter plot showing the relationship between the total vertebral body Cobb angle and the total disc Cobb angle.

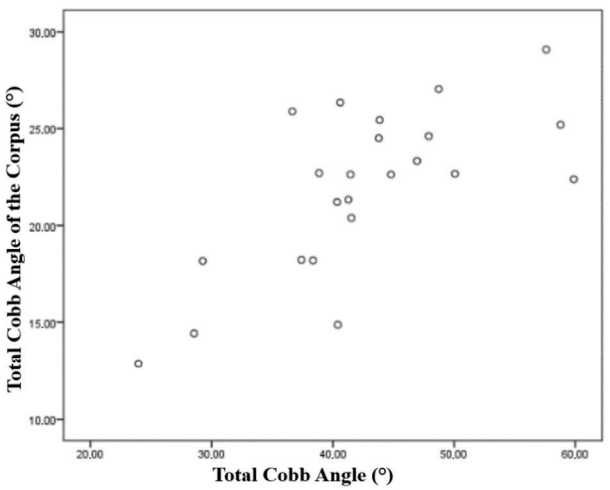

Figure 2. Scatter plot showing the relationship between the total vertebral body Cobb angle and the total Cobb angle.

Based on the decomposition of the total Cobb angle into its components, the mean proportional contributions were approximately 52% for the vertebral body component and 48% for the disc component; moreover, 65% of participants exhibited a larger corpus contribution to the total angle (visualized in Figure 4, with summary values in Table 3).

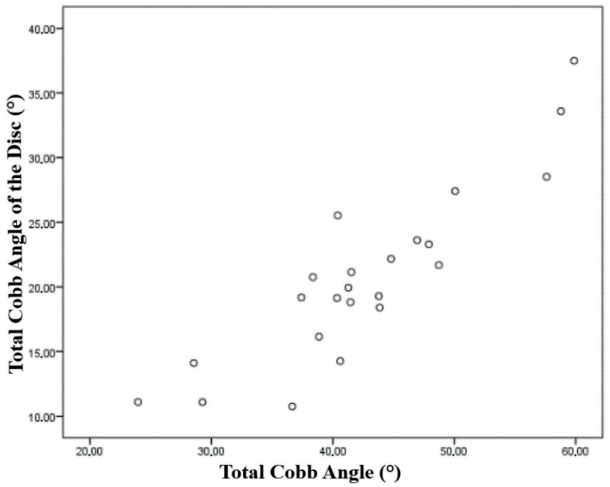

Figure 3. Scatter plot showing the relationship between the total disc Cobb angle and the total Cobb angle.

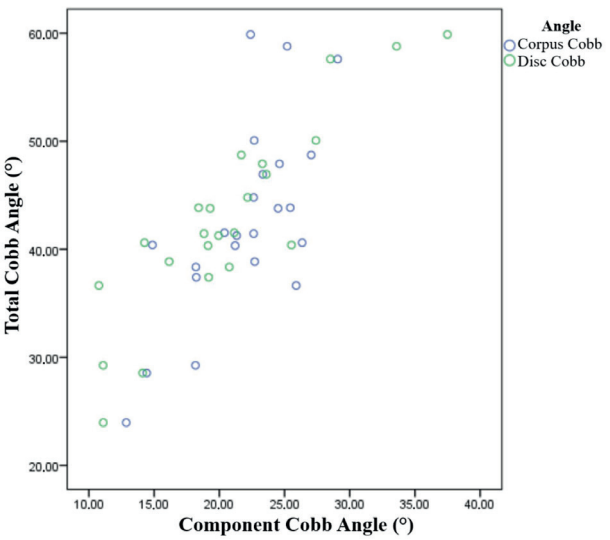

Figure 4. Scatter plot showing the distribution between vertebral body Cobb angle values and disc Cobb angle values.

Finally, the overall distributions and pairwise relationships among variables are depicted in Figures 1-4 and are consistent with the numerical results reported in Tables 1-4.

Table 3. Descriptive statistics of cobb angle values

Measurement	n	Mean	Standard Deviation	Median	Min - Max
Total Cobb Angle of the Corpus	23	21.92	4.19	22.63	12.86 - 29.08
Total Cobb Angle of the Disc	23	20.76	6.74	19.94	10.76 - 59.88
Cobb Angle	23	42.65	8.97	41.45	23.96 - 59.88

Table 4. Correlation between total cobb angle and vertebral/disc cobb angles

Comparison	r	p
Total Cobb Angle of the Corpus	0.698	<0.001
Total Cobb Angle of the Disc	0.894	<0.001

DISCUSSION

A major finding of this study was that vertebral body height on the concave side was consistently lower than on the convex side. Although the vertebral body component accounts for a slightly larger numerical share of the total Cobb angle, the intervertebral disc component demonstrates a stronger statistical correlation with the total angle. These findings suggest that disc wedging influences the pathogenesis and progression of spinal curvature in AIS more significantly (5-7,9). This concept is further corroborated by recent studies employing three-dimensional (3D) imaging and morphometric analyses, which argue that intervertebral disc deformation precedes vertebral structural remodeling, serving as an early biomechanical indicator of scoliosis progression (8,10,11). Studies conducted by Oba et al. (2025) and Labrom et al. (2020) demonstrated that higher discal asymmetry around the apical vertebra strongly correlates with a greater Cobb angle and more rapid curve progression. These findings underline the importance of disc wedging in the early stages of deformity formation (10,11).

Despite the critical importance of accurate morphometric characterization for surgical planning, morphometric studies on vertebral bodies and intervertebral discs in AIS remain relatively limited, with existing studies often involving small sample sizes.

To address this gap, Ramachandran et al. employed CT imaging to demonstrate significant vertebral and pedicle asymmetry in AIS patients, finding notable transverse plane deviations between the concave and convex sides (5). Qian et al.'s findings indicate that both vertebral height and width asymmetries contribute to rotational deformities and coronal curvature severity, aligning with more recent 3D CT-based investigations (8,12).

Huang et al. reported that disc wedging was the primary cause of curvature progression during the rapid growth phase, while vertebral body wedging became more prominent after skeletal maturation slowed (6). Shi et al. (2025) utilized automated SVD-based vertebral modeling to show that intervertebral disc compression dominates early deformity and subsequently transitions into bony remodeling as mechanical loading asymmetry persists (13). Our findings are consistent with these studies and suggest a dynamic anatomical shift in deformity contributors over time.

Shen et al. demonstrated that vertebral wedging tends to increase toward the apex of the scoliotic curve, particularly in the coronal plane, while sagittal wedging remains minimal (7). Recent imaging-based studies have corroborated this apex-centric distribution, indicating that maximal structural asymmetry occurs at the apical region and diminishes progressively toward the end vertebrae (14). The observation of decreased vertebral and disc height differences as the distance from the apex increases supports this progressive wedging gradient.

In addition, Qian et al. demonstrated anterior-posterior length disparities in the thoracic region of AIS patients, primarily attributed to soft tissue and discal alterations rather than bone morphology (8). Similarly, Wang et al.

(2025) observed that asymmetric disc loading induces significant shear stress at the endplates, predisposing vertebral wedging through altered growth plate pressure distribution (15).

In a study by Okuwaki et al., regional wedging patterns were differentiated, showing that vertebral body wedging is more prominent in thoracic curves, whereas disc wedging is more pronounced in lumbar deformities (9). These region-specific variations were confirmed in recent finite element modeling studies by Zhang et al. (2025), which demonstrated that lumbar disc wedging has a more substantial impact on spinal flexibility and curve reversibility compared to thoracic vertebral wedging (16).

Beyond osseous and discal morphology, neurodevelopmental and myofascial factors have gained attention as modulators in AIS progression. It is hypothesized that neuroanatomical asymmetries and proprioceptive dysfunctions may alter postural control and loading symmetry, contributing to progressive curvature (17,18). Zhang et al. (2025) further demonstrated via shear-wave elastography that asymmetry in paraspinal muscle stiffness correlates strongly with vertebral body wedging, emphasizing the interaction between muscle and bone in AIS biomechanics (19).

Our findings also parallel the MRI-based study by Labrom et al., which revealed that vertebral body wedging significantly contributes to coronal deformity during growth spurts (20). Similarly, Zhang et al. (2025) confirmed that "relative anterior spinal overgrowth" is a key structural phenomenon underlying curve progression, especially in moderate AIS (14). Collectively, these findings reinforce the idea that discal deformation likely initiates curvature, while vertebral wedging sustains and stabilizes it as growth progresses.

Standardized nomenclature for vertebral and disc geometry has been advocated to improve scoliosis research (21). Our CT-based quantification approach aligns with these recommendations and supports the transition toward multi-parametric, 3D diagnostic evaluation.

In summary, this study underscores that both vertebral and discal structures contribute significantly to the Cobb angle in AIS. While vertebral wedging quantifies cumulative deformity, disc wedging may better reflect active curve progression. Integrating 3D morphometric, biomechanical, and neuromuscular parameters can enhance diagnostic precision and guide individualized therapeutic strategies for AIS (10-22).

Limitations

The study was limited by: (i) the relatively small sample size (n = 23), which may affect statistical power and limit generalizability; (ii) its single-center design, which introduces potential selection bias; (iii) possible measurement errors or interobserver variability, despite the use of high-resolution CT; and (iv) its retrospective nature, which limits control over confounding variables such as growth status or prior treatments. Future multicenter, prospective studies with larger cohorts are required to validate these findings.

CONCLUSION

This study established that both vertebral body and intervertebral disc wedging contribute significantly to the Cobb angle in AIS. While vertebral body wedging shows a slightly higher numerical contribution, disc wedging exhibits a stronger correlation with overall curvature, indicating a predominant role in curve progression. The results suggest that the relative decrease in vertebral and disc heights on the concave side, particularly near the apex, is critical to the three-dimensional deformity in scoliosis.

Improved understanding of the morphometric dynamics of spinal curvature can enhance diagnostic precision and help identify progressive curves earlier. Quantifying the separate contributions of disc and vertebral wedging and incorporating detailed imaging metrics into clinical decision-making may: (i) aid in developing targeted conservative approaches; (ii) guide surgical strategies; and (iii) improve individualized treatment planning and long-term outcomes for patients with idiopathic scoliosis.

The researchers also suggest that future studies with larger sample sizes and longitudinal designs would both validate these morphometric patterns and help better understand their role in monitoring prognosis and therapeutic response thereafter.

Ethical approval

This study has been approved by the Bolu Abant Izzet Baysal University Clinical Researches Ethics Committee Approval (approval date 18/12/2019, number 2019/186).

Author contribution

Concept: MK, Cİ; Design: MK, CA; Data Collection or Processing: MMB, EA; Analysis or Interpretation: MÇ, MTT; Literature Search: MK; Writing: MK, CA. All authors reviewed the results and approved the final version of the article.

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Conflict of interest

The authors declare that there is no conflict of interest.

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RESEARCH ARTICLES

When should we perform surgery in orbital complication due to rhinosinusitis?

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ABSTRACT

Objective: In our study, we aimed to find out which factors the treatment method depends on in orbital complications and to shape the treatment scheme according to these factors.

Material and Methods: Patients who were treated and followed up for orbital complications of rhinosinusitis in the Karadeniz Technical University Faculty of Medicine, Department of Otorhinolaryngology, between 2007 and 2018 were retrospectively analyzed. A total of 64 patients were included in the study. Abscess volume and proptosis values of the patients with subperiosteal and orbital abscesses were calculated. The operative approach was recorded in patients treated surgically.

Results: It was determined that 48.4% of the patients were children and 51.6% were adults. The mean age was calculated as 26.3±20.5 years. Of these, 25% of the patients were female and 75% were male. Abscess was detected in 10 patients (15.6%). Subperiosteal abscesses were detected in 3 patients and orbital abscesses in 7 patients. The patients were classified as those with preseptal and orbital cellulitis (Group I), and those with subperiosteal abscess (SPA) and orbital abscess (Group II). Proptosis, restricted eye movements and fever were found to be significantly higher in Group II ($p < 0.05$). The mean abscess volume of the patients in Group II was found to be 3210±1614 mm^3, and the mean value of proptosis was found to be 4.24±1.7 mm. Surgery was performed on 24 patients. The mean abscess volumes in the surgical group and the non-surgical group were found to be 3800 mm^3 and 850 mm^3, respectively (p=0.034). The mean proptosis values in the surgical group and the non-surgical group were 4.91 mm and 1.55 mm, respectively (p=0,036).

Conclusion: Whether patients presenting with orbital complications should be treated conservatively or surgically remains a topic of debate in the current literature. In this discussion, it is important to predict which patients will progress to a subperiosteal or an orbital abscess. In our study, we found that proptosis, limited eye movements, and high fever (>37.5 °C) were associated with abscess development, and abscess volume and proptosis value were also important in terms of surgical necessity.

Keywords: orbital complication, sinusitis

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INTRODUCTION

Rhinosinusitis can be defined as an inflammatory response that occurs in the mucosa lining the nasal cavity and paranasal sinuses, and/or in the underlying bone (1). Although the use of antibiotics has reduced the prevalence of sinus infections and their complications, acute rhinosinusitis is still the leading cause of orbital inflammation and visual impairment. Although it can occur at any age, it is more common in children since upper respiratory system infections are more common at these ages and easily spread to the nose and sinuses. In addition, with the continuous development of treatment regimens, the number of patients living with suppressed immunity such as those with diabetes, kidney failure, organ transplants, or those receiving chemotherapy or radiotherapy is gradually increasing. These patients, in addition to being susceptible to other opportunistic infections, are at risk of developing sinusitis and its complications that will rapidly develop.

Therefore, medical treatment and surgical interventions for orbital complications of rhinosinusitis have gained importance. Our study aims to more effective intervention strategies for these complications through retrospective examination.

MATERIAL AND METHOD

After obtaining ethics committee approval, patients who were treated and followed up due to orbital complications of rhinosinusitis between 2007 and 2018 in the Karadeniz Technical University Faculty of Medicine, Department of Otorhinolaryngology, were retrospectively analyzed. A total of 770 patients with acute (J01.9) and chronic (J32.9) sinusitis diagnoses of ICD were analyzed, and 64 patients with the orbital complications of rhinosinusitis were included in the study. Since the patients in our study underwent intervention for complications, there were no exclusion criteria.

Demographic, clinical, radiological, and microbiological data were collected for each patient. The medical comorbidities, vital values at the time of admission, laboratory values, and medical and surgical treatment characteristics of the patients were examined. The operations were performed by the same surgical team with nearly 20 years of experience. The characteristics and duration of the antibiotherapy administered to the patients were evaluated.

Abscess volume and proptosis values were calculated by examining pre-operation scans of patients with subperiosteal and orbital abscesses. Proptosis values were evaluated by measuring the distance between the interzygomatic line and the anterior corneal edge at the midglob level in the axial computed tomography (CT) section (Figure 1). Abscess volumes were calculated using the GE Advantage Workstation (GE Healthcare Dharmacon, Chicago, Illinois, USA) software program. The abscess circumference of all patients was drawn manually by the same radiologist. The abscess volumes were calculated using the GE Advantage Workstation measurement tools. The surgical approach was recorded for all patients treated surgically.

Statistical analysis

SPSS (Statistical Package for the Social Science) 23.0 was used for statistical analyses. Descriptive statistics for categorical variables are presented as numbers and percentages. Mean, standard deviation, minimum and maximum values are reported for numerical variables. The Kolmogorov-Smirnov and Shapiro-Wilk tests were used to test the distribution normality. The Mann-Whitney U Test was used to compare the numerical variables non-normally distributed. The Fisher's Exact Test was used to compare categorical variables. A p-value of <0.05 was considered statistically significant in all analyses.

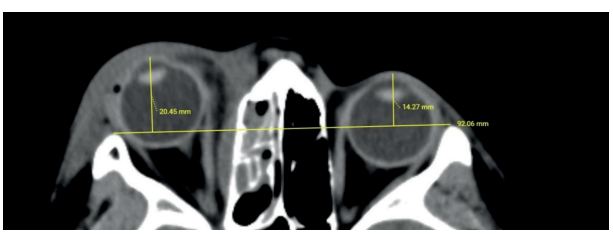

Figure 1. Proptosis measurement of the 13-year-old male patient in Figure 3.

RESULTS

The demographic information and medical history of the patients participating in the study are shown in Table 1. It was found that 31 patients (48.4%) were children (<18 years old), and 33 (51.6%) were adults. The mean age of all patients was 26.3±20.5 (2-90) years. The mean age of children was 9.84 years (2-17). In adults, the mean age was 41.7 (20-90). Of the total, 16 patients (25%) were females and 48 (75%) were male. It was observed that 89.1% of the patients had a history of sinusitis, 9.4% had a history of previous functional endoscopic sinus surgery (FESS), 4.7% had a history of diabetes mellitus, 14.1% had a history of dental infection, 1.6% had a history of maxillofacial trauma, and 1.6% had immunosuppression.

The comparison of the medical histories between the pediatric and adult patients participating in the study is shown in Table 2. Histories of sinusitis, FESS, diabetes mellitus, dental infection, trauma, and immunosuppression were found to be more common in adults. Of these, only FESS history was found to be significantly higher in adults compared to children (p <0.05).

The clinical complaints and examination findings of the patients participating in the study are shown in Table 3. Periorbital pain was observed in 73.4% of the patients, periorbital edema in 96.9%, periorbital erythema in 68.8%, proptosis in 12,5%, and limited eye movements in 4.7%. It was determined that 43.8% of the patients had a history of antibiotic use. The mean body temperature of the patients at admission was 36.8±0.8 °C, the mean C-reactive protein (CRP) level was 7.16 mg/L, and leukocytosis was observed in 67.2% of the patients.

Table 1. The demographical information and medical histories of the patients participating in the study.

Age	
Mean overall age(years)	26,3±20,5
Mean child age(years)	9,84
Mean adult age(years)	41,7
Range of ages(years)	2-90
Child(n)	31(%48.4)
Adult(n)	33(%51.6)
Sex	
Male	48(%75)
Female	16(%25)
Medical History	
Sinusitis	57(%89,1)
Prior FESS	6(%9,4)
Diabetes mellitus	3(%4,7)
Dental infection	9(%14,1)
Trauma	1(%1,6)
Immunosuppression	1(%1,6)

FESS: functional endoscopic sinus surgery.

Table 2. Comparison of medical histories of pediatric and adult patients participating in the study.

Medical History	Child	Adult	P
Sinusitis	29(%93,5)	28(%84.8)	0,428
Prior FESS	0(%0,0)	6(%18,2)	0,025
Diabetes mellitus	0(%0,0)	3(%9,1)	0,239
Dental infection	4(%12,9)	5(%15,2)	0,100
Trauma	0(%0,0)	1(%3)	0,100
Immunosuppression	0(%0,0)	1(%3)	0,100

FESS: functional endoscopic sinus surgery.

Table 3. Findings and laboratory values of the patients participating in the study.

Complaints and Findings	
Periorbital pain	47(%73,4)
Periorbital edema	62(%96,9)
Periorbital erythema	44(%68,8)
Proptosis	8(%12,5)
Limited eye movement	3(%4,7)
Body temperature(mean)(°C)	36,8±0,8
Leukocytosis (10^3/ µL)	43(%67,2)
CRP(mean) (mg/L)	7,1663
Prior antibiotic use	28(%43,8)

CRP: C Reactive Protein.

The presence of abscess based on the CT features of the patients participating in the study is shown in Table 4. An abscess was detected in 10 patients (15.6%), of whom 3 had subperiosteal abscesses and 7 had orbital abscesses. In 3 patients with subperiosteal abscess, the abscesses were found to be medial to the orbit. Among the orbital abscesses, 4 were located superiorly, 1 inferiorly, 1 laterally, and 1 superolaterally.

The treatment regimens administered to the patients participating in the study are shown in Table 5. 1.6% of the patients were treated with amoxicillin/clavulanic acid, 32.8% with ceftriaxone, 65.6% with ampicillin/sulbactam, 79.7% with clindamycin, 1.6% were given meropenem, 1.6% were given posacanosal, and 1.6% were given amphotericin B. The duration of antibiotherapy and hospitalization of the patients participating in the study is shown in Table 6. Accordingly, the mean duration of antibiotherapy and hospitalization were 13.4±2.8 (7-21) days and 9.1±4.6 (1-23) days, respectively.

Table 4. Presence and localization of abscesses according to CT features of the patients participating in the study.

ABSCESS	
Presence of abscess	10(%15,6)
Localization of abscesses	
medial	3(%4,7)
superior	5(%7,8)
lateral	1(%1,6)
inferior	1(%1,6)

Table 5. Treatment regimens applied to patients participating in the study.

Treatment regimens	
Amoxicillin/clavulanic acid	1(%1,6)
Ceftriaxone	21(%32,8)
Ampicillin/sulbactam	42(%65,6)
Clindamycin	51(%79,7)
Meropenem	1(%1,6)
Posacanosal	1(%1,6)
Amphotericin B	1(%1,6)

The number of surgical procedures performed on the patients participating in the study is shown in Table 7. Surgery was performed on 24 (37.5%) patients. Of these, 14 patients underwent an endonasal approach only, 9 underwent combined endonasal and external approaches, and 1 patient was treated with an external approach alone.

Patients participating in the study were classified according to Chandler's classification (2), and those with preseptal and orbital cellulitis were named Group I and those with subperiosteal abscess (SPA) and those with orbital abscess were named Group II. Group I and Group II were compared according to age, sex, medical history, complaints and findings, and laboratory results (Table 8). Proptosis, limited eye movements, and fever were found to be significantly higher in Group II ($p < 0.05$) than in Group I.

When the priorly antibiotic use, duration of antibiotherapy, hospitalization period, and type of surgery performed on both groups were compared (Table 9), it was found that the duration of antibiotic therapy and hospitalization were significantly longer in the abscess group ($p<0.05$). Among the surgical interventions, it was seen that the external approach was performed significantly more in the abscess group ($p < 0.05$).

The abscess volumes, proptosis measurements and type of surgery performed in patients with subperiosteal or orbital abscess are demonstrated in Table 10. The mean abscess volume and the mean proptosis value were found to be 3210±1614 mm^3, and

Table 6. Duration of antibiotherapy and hospitalization of the patients participating in the study.

Duration of antibiotics (day)	13,4±2,8 (7-21)
Duration of hospitalization (day)	9,1±4,6 (1-23)

Table 7. Surgical procedures performed on patients participating in the study.

Surgery type	**n**	**%**
endonasal	14	58,33
external	1	4,16
combined	9	37,5

Table 8. Comparison of preseptal-orbital cellulitis and subperiosteal-orbital abscess group

Age	**Grup I**	**Grup II**	**P**
Mean overall age (years)	27,6±21,3	19,2±14,3	0,300
Sex			
Male(%)	85,4	14,6	0,701
Female(%)	81,3	18,8	
Medical history			
Sinusitis	82,5	17,5	0,584
Prior FESS	66,7	33,3	0,234
Diabetes mellitus	100	0	0,1
Dental infection	100	0	0,333
Trauma	100	0	0,1
Immunosuppression	100	0	0,1
Complaints and Findings			
Periorbital pain	83,0	17,0	0,1
Periorbital edema	85,5	14,5	0,290
Periorbital erythema	79,5	20,5	0,152
Proptosis	0	100	0,000
Limited eye movement	0	100	0,003
Body temperature(mean)(°C)	36,7±0,7	37,5±0,9	0,007
Leukocytosis (10^3/ µL)	79,1	20,9	0,146
CRP(mean) (mg/L)	6,6±7,7	10,4±6,6	0,053

FESS: functional endoscopic sinus surgery; CRP: C Reactive Protein.

4.24±1.7 mm, respectively. The mean abscess volume was significantly greater in the surgical group than in the non-surgical group (3800 mm^3 versus 850 mm^3, P=0.034). The mean proptosis value was significantly greater in the surgical group than in the non-surgical group (4.91 mm versus 1.55 mm, P=0.036). The mean percentage of orbital volume occupied by the abscess was also greater in the surgical group than in the non-surgical group (%38.025 versus %9.8, P=0.036) (Table 11).

DISCUSSION

Acute rhinosinusitis is a self-limiting illness with medical treatment. In adults, acute bacterial rhinosinusitis is diagnosed when the sudden onset of nasal congestion or nasal flow is accompanied by facial pain/pressure sensation or a decreased/loss of smell. In children, acute bacterial rhinosinusitis is diagnosed based on the presence of two symptoms: nasal congestion and nasal flow or cough (day or night) lasting less than 1 week. It can often be cured completely with early diagnosis and treatment.

Sinusitis is the primary cause of orbital complications with a rate of 74-85% of the cases. Complications in children mostly occur due to ethmoid sinusitis. Defects in the lamina papyracea are the primary cause of the spread of paranasal sinus infection. Apart from sinusitis, orbital complications may also develop due to local skin trauma, penetrating injuries, and surgical interventions. Delay in diagnosis and treatment may lead to complications such as visual impairment or brain abscess. Even today, the incidence of visual

Table 9. Comparison of preseptal-orbital cellulitis and subperiosteal-orbital abscess groups in terms of duration of antibiotherapy duration, length of stay and the type of surgery performed.

	Grup I	Grup II	P
Prior antibiotic use (%)	38,9	70	0,090
Duration of antibiotics(day)	13,1±2,7	15,3±2,8	0,029
Duration of hospitalization(day)	8,5±4,4	11,8±5,1	0,033
Surgery (%)			
endonasal	29,6	60	0,080
external	7,4	60	0,000

Table 10. Abscess volumes and proptosis measurements of patients with subperiosteal or orbital abscess, and the surgery type performed.

Patient no	Abscess volumes (mm^3)	Proptosis (mm)	Surgery type
1	5900	3.9	combined
2	4500	3.5	combined
3	4000	6.1	combined
4	900	1.6	None
5	2000	6.1	combined
6	800	1.5	None
7	4000	5,3	combined
8	3000	4	combined
9	4000	6,2	combined
10	3000	4,2	external only
Mean	3210	4,24	

Table 11. Comparison of mean abscess volume, mean proptosis values of surgical and non-surgical patients with subperiosteal or orbital abscess.

	Surgical	Non-surgical	P
Mean abscess volume (mm^3)	3800	850	0,034
Mean proptosis values (mm)	4.91	1.55	0,036
Mean abscess volume (%)	38.025	9.8	0,036

impairment is reported to be 3-11%, while mortality rates range between 1-2.5% (3,4). Because of these complications, a multidisciplinary approach including otolaryngologists, ophthalmologists and pediatricians should be applied.

Chandler's classification (2) of orbital complications has been widely accepted because it provides a clinical summary of secondary orbital inflammations. According to Chandler, the first stage is preseptal cellulitis with inflammatory edema. At this stage, deterioration of visual acuity is not observed, but edema of the eyelid is present. The second stage is orbital cellulitis, resulting from inflammatory infiltration of the orbital adipose tissue. The third stage is subperiosteal abscess. It is characterized by the accumulation of pus between the periorbita and the bony wall and originates mostly from the ethmoid or

frontal sinus (5). The fourth stage is orbital abscess. It is characterized by the pus accumulation in the orbital tissues after cellulite. Exophthalmos, chemosis, and ophthalmoplegia are observed. The fifth stage is cavernous sinus thrombosis resulting from the further progression of ethmoid or orbital phlebitis. In this stage, exophthalmos, chemosis, ophthalmoplegia, and visual impairment occur in the opposite eye of the toxic-looking patient who had complaints in one eye previously. This situation is explained by the transmission of the infection to the opposite side through the intercavernous sinus. The mortality rate in cavernous sinus thrombosis is 50-80%.

Erickson et al. (6) found that the age distribution of patients with orbital cellulitis and subperiosteal abscess did not differ significantly between adults and children. According to the study of Gavriel et al. (7) found no significant relationship between age and the presence of superior subperiosteal abscess for children and adults. In alignment with these studies, 31 of 64 patients participated in our study treated for orbital complications were children, and 33 were adults. The patients were between the ages of 2-90 (26.3±20.5). When the literature was reviewed, limited data were found regarding the management of orbital complications in adults. In our study, adult patients were more likely to present with predisposing factors such as sinusitis, a history of previous sinus surgery, diabetes mellitus, dental infection, trauma, and immunosuppression, which may lead to orbital complications, similar to the findings of the study by Erickson et al. (6). However, among these predisposing factors, only a history of previous sinus surgery was showed a statistically significant difference between children and adults ($p<0.05$).

Orbital infections secondary to sinusitis have been reported as preseptal cellulitis at a rate of 85-95%, and as postseptal infections at a rate of 5-15% (8). In the study by Kinis et al., subperiosteal abscesses were found in 11 patients (42.3%), preseptal cellulitis in 13 patients (50%), and orbital cellulitis in 2 patients (7.7%) (9). In our study, preseptal cellulitis was found in 48 (75%) patients, orbital cellulitis in 6 (9.4%) patients, subperiosteal abscess in 3 (4.7%) patients, and orbital abscess in 7 (10.9%) patients.

Coronal and axial paranasal CT scans, supported by cranial CT in determining the treatment method, play a key role in the localization of sinusitis, differentiation of preseptal and postseptal involvement, as well as the decision of emergency surgery. The need for a CT scan remains controversial, however, there is consensus that CT is necessary in cases with diplopia, limited visual acuity, proptosis, impaired visual acuity, and postseptal orbital complications on a visual examination performed at the time of admission. CT is especially harmful to children, as it causes radiation exposure. In addition, it may be insufficient in the evaluation of small abscesses and may give false positive or false negative results for SPA. In our study, 58 patients underwent CT evaluation.

A subperiosteal abscess is defined as a collection of pus between the orbital wall (most commonly the cortex) and the orbital periosteum. It usually develops secondary to acute ethmoiditis. It can cause proptosis, chemosis, and limited eye movement. Although SPAs are most commonly located medially, they may also occur in superior or superomedial locations. In their study, Kinis et al. (9) found 5 medial, 5 superomedial, and 1 inferolateral subperiosteal abscesses. In our study, we found all 3 of the subperiosteal abscesses were medially located. In our study, superior orbital abscesses were observed in 4 patients. And inferior orbital abscesses were observed in 1 patient. A lateral orbital abscess was observed in 1 patient. A superolateral orbital abscess was observed in 1 patient.

The ideal treatment for sinusitis with orbital complications is controversial, however, the current consensus suggests that patients with preseptal cellulitis should receive parenteral antibiotherapy immediately after the initial examination. The most common pathogenic agents in sinusitis are Haemophilus influenzae, Streptococcus pneumoniae, Moraxella catarhalis, Staphylococcus aureus, and Streptococcus pyogenes (2). Therefore, ampicillin-sulbactam or ceftriaxone-metronidazole combination treatments are recommended for preseptal and orbital cellulitis (10). In our study, ampicillin/sulbactam-clindamycin combination was administered to 36 patients, and ceftriaxone-clindamycin combination was administered to 13 patients. All patients in the cellulite group recovered with antibiotherapy. The

mean duration of antibiotherapy for the patients in the cellulitis group and in the abscess group was 13.1 days and 15.3 days, respectively, and it was found that antibiotherapy was statistically longer in the abscess group ($p<0.005$).

Some studies have investigated which symptoms and signs predict abscess development and when surgery should be performed. Gavriel et al. (11) reported a strong relationship between limited eye movements and proptosis, and abscess formation. Erickson et al. (6) also found a significant correlation between limited eye movements and abscess formation. According to Oxford et al., surgery should be performed in the presence of limited eye movements in one or more gaze directions, intraocular pressure of 20 mm or more, proptosis of 5 mm or more, and an abscess collection of 4 mm or more on CT (12). In the study of Ryan et al., it was found that the patients who underwent surgery were older (8.3 vs. 6.2), had abscesses larger than 10 mm, required longer hospitalization (10.2 vs. 6.6 days), and had higher body temperature values at admission (38.0°C vs. 37.3°C) (13). In our study, proptosis, limited eye movements, and fever were found to be significantly higher in the abscess group ($p<0.05$). According to the study of Soon et al. (14), there is a significant relationship between the leukocyte count in the complete blood count of the patients and the development of an abscess; however, no significant relationship was found in our study ($p>0.05$).

According to the study of Tabarino et al., the larger the abscess volume, the greater the need for surgery (15). Tabarino et al. argued that surgery is necessary in 100% of cases with abscesses larger than 500 mm^3 or 5% of the orbital volume, while Ryan et al. (13) argued that surgery should be performed in patients with an abscess larger than 1 cm in diameter. Likewise, Rahbar et al. (16) and Todman et al. (17) argued that abscess volume is important in terms of surgical necessity. According to Rahbar et al. (16), the mean abscess volume of the surgical group was 1452 mm^3, while the abscess volume of the non-surgical group was 600 mm^3. According to Todman et al. (17), the mean abscess volume of the surgical group was 3446.3 mm^3, while the abscess volume of the non-surgical group was 420.5 mm^3. Todman et al. found that the threshold value for surgery was 1250 mm^3.

In our study, we found the mean volume of the abscess was significantly greater in the surgical group than in the non-surgical group (3800 mm^3 versus 850 mm^3, $P=0.034$). Similarly, the mean percentage of the of the orbital volume occupied by the abscess was also greater in the surgical group than in the non-surgical group (38.025% versus 9.8%, $P=0.036$). We believe that the larger abscess volumes reported in both Todman et al. (17) and our study may be attributable to differences in the calculation methods or formulas used. According to Tabarino et al. (15), proptosis measurement is also an important surgical indicator in patients with orbital complications: proptosis greater than 4 mm increases the likelihood of requiring surgery, while proptosis less than 2 mm suggests a lower likelihood. According to Oxford and McClay (12), the threshold value for proptosis is <5 mm for medical treatment. In our study, we found the mean proptosis value was significantly greater in the surgical group than in the non-surgical group (4.91 mm versus 1.55 mm, $p=0.036$).

Whether a subperiosteal abscess should be treated conservatively or surgically is still a matter of debate in the current literature. In the study of Eviatar et al., all 48 patients younger than 2 years of age who were diagnosed with preseptal cellulitis showed improvement with antibiotherapy (18). However, in the study of Harris et al., it was reported that surgery should be performed even if the patients presented with cellulitis to prevent orbital and intracranial complications in children over 9 years (19). Advocates of the conservative method argued that the orbital periosteum, which is a flexible barrier, contributes to the localization and resolution of the abscess (20). Harris et al., on the other hand, argued that surgery should be performed after abscess formation (19). Though we agree that conservative treatment may be appropriate for patients without visual impairment, provided that they are closely monitored by an ophthalmologist, and we also emphasize that surgical drainage is warranted at the slightest suspicion of vision or worsening clinical presentation. Therefore, in our study, surgical drainage was performed early in one patient with a subperiosteal abscess (Figure 2a–d) and seven patients with orbital abscesses, due to the following reasons: patients were referred from other healthcare institutions after initiating antibiotic therapy, radiological persistence of abscesses despite

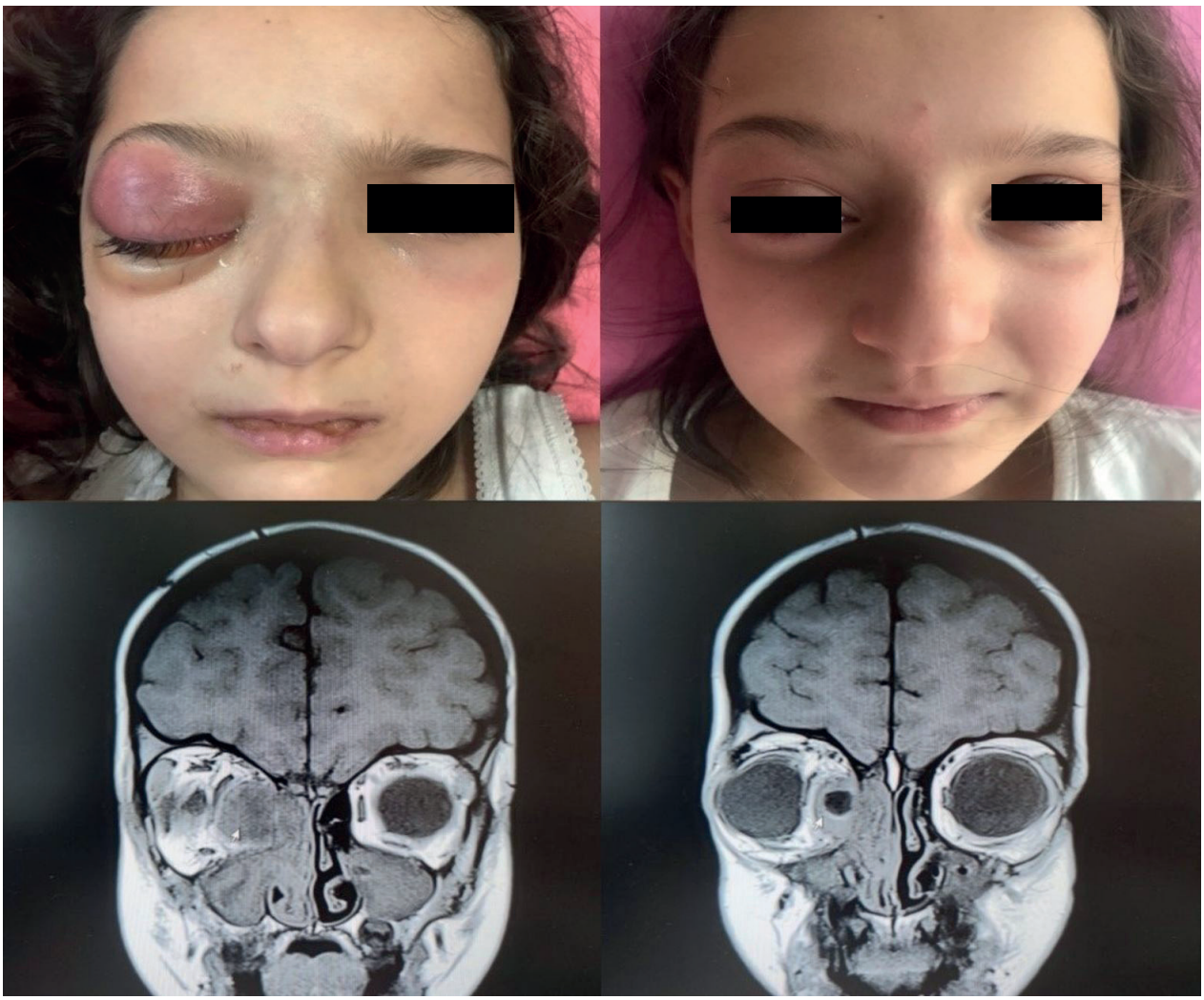

Figure 2. a: 10-year-old female patient, clinical status at admission, exophthalmos, chemosis, ophthalmoplegia are present; **b:** Clinical status on the 10th postoperative day; **c and d:** Orbital MRI at the time of admission: In the right retroorbital area, there is a hyperintense collection in the T1A of the abscess with the size of 15x19x35 mm, which is located extraconally, adjacent to the medial rectus muscle, and contains an air-fluid level.

broad-spectrum antibiotics, and presence of ocular findings at presentation. A combined approach was applied to 6 patients with orbital abscesses. External approach was applied to 1 patient with an orbital abscess. The other 2 patients with subperiosteal abscesses were followed up and treated with antibiotherapy (Figure 3a-d) (Figure 4a-d). Elective endoscopic sinus surgery was performed in 13 patients due to sinusitis findings after the recovery of the orbital complication in the acute period. Three patients were treated by including the external approach with the endoscopic approach due to the presence of frontal osteoma after the recovery from orbital complication in the acute period. As there were only 3 cases of subperiosteal abscess in our series, it is difficult to decide whether medical treatment is truly effective.

The method of surgical drainage depends on the location of the abscess. Although external ethmoidectomy was preferred in the past, nowadays, endoscopic sinus surgery is the standard and immediate approach. Endoscopic sinus surgery is a safe method in the treatment of both subperiosteal and orbital abscesses. In addition to abscess drainage, endoscopic

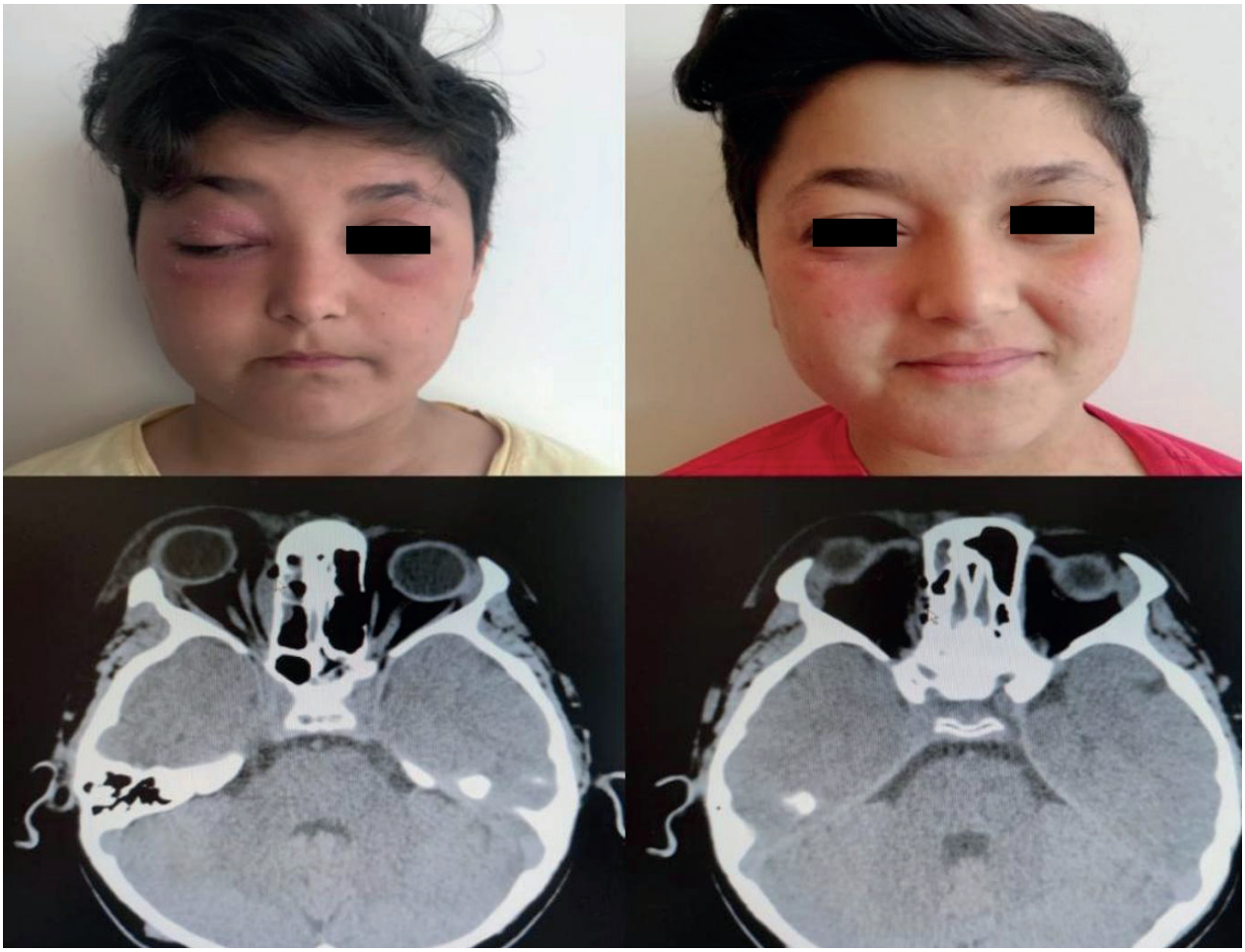

Figure 3. a: The clinical status of a 13-year-old male patient at the time of admission, periorbital edema and periorbital ecchymosis are present, ophthalmoplegia is not; **b:** Clinical status after 8 days of treatment; **c and d:** Orbital CT at the time of admission: Subperiosteal abscess with air values monitored within 25x5mm in the medial part of the right retrobulbar area, adjacent to the bone.

methods prevent facial scarring and reduces hospital stay duration.

The main problem encountered in endoscopy is mucosal hypertrophy, which can increase intraoperative bleeding mucosal hypertrophy, which can increase intraoperative bleeding and complicates the surgery. Therefore, it should be performed by experienced surgeons. The surgeries in our study were performed by the surgical team working in the same center for more than 20 years.

Many studies report that the use of endoscopic sinus surgery alone is suitable for medial abscesses, while a combined approach or external approach should be used in superomedial abscesses (21). Since it is difficult to approach superiorly located abscesses endoscopically, diseased sinuses should be treated endoscopically in addition to an external approach over the upper orbital rim (Figure 5 a-b). Of the 24 surgical interventions we performed in our study, 14 were endoscopic approaches, 9 were combined approaches, and only 1 was an external approach. After the surgeries, the patients recovered without any problems.

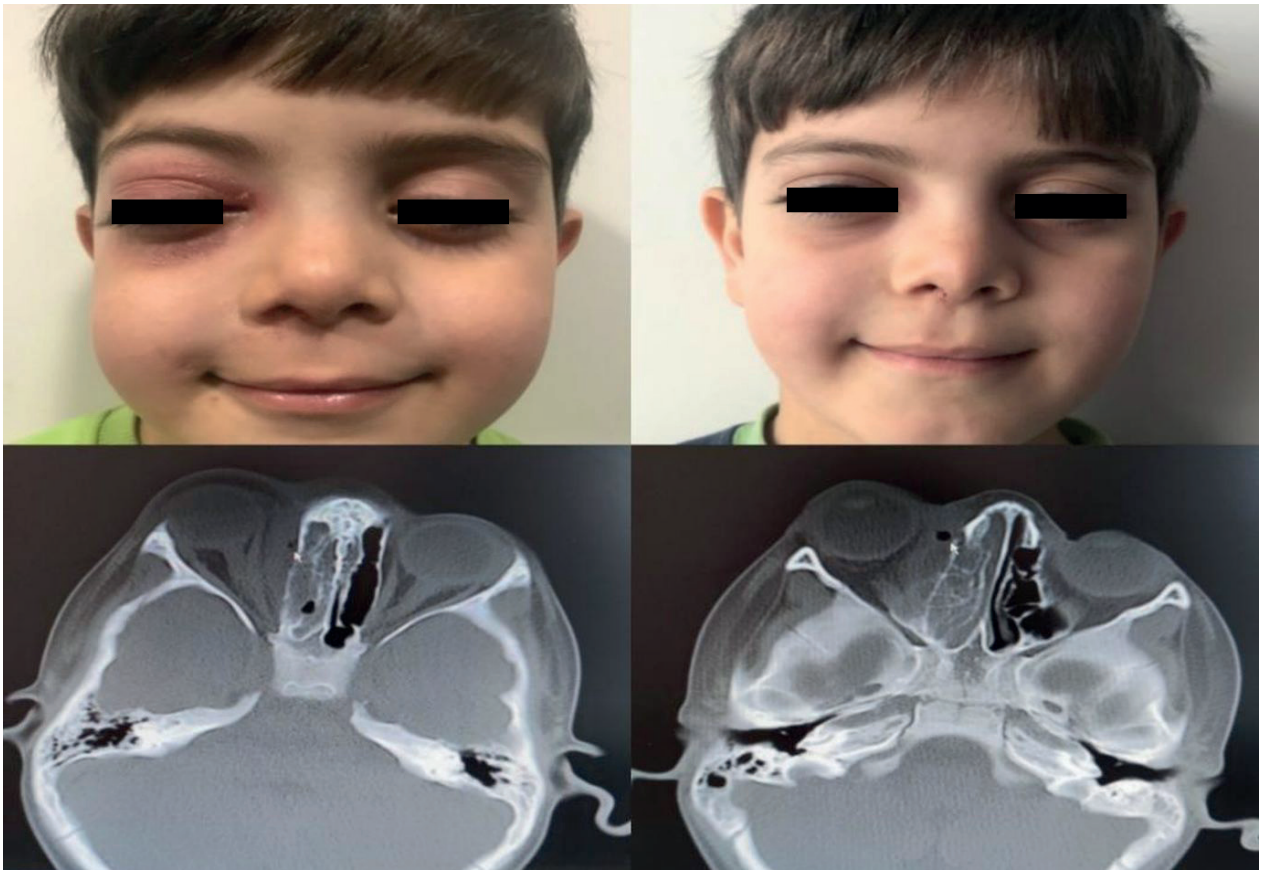

Figure 4. a: The clinical status of an 8-year-old male patient at the time of admission, periorbital edema and periorbital ecchymosis are present, ophthalmoplegia is not; **b:** Clinical status after 6 days of treatment; **c and d:** Orbital CT at the time of admission: Subperiosteal abscess with air values observed within 15x5mm, in the medial part of the right retrobulbar region, adjacent to the bone.

In the study of Tanna et al., the mean hospital stay was found to be 2.9 days (22). It was reported as 5 days in the study of Oxford et al. (12). In our study, the mean hospitalization time was 8.5 days for patients in the cellulitis group and 11.8 days for patients in the abscess group. A statistically longer hospital stay was observed in the abscess group ($p<0.05$).

CONCLUSION

In the treatment of orbital complications secondary to rhinosinusitis, early diagnosis and appropriate treatment are of vital importance. It is still a matter of debate whether patients presenting with orbital complications should be treated conservatively or surgically. In this discussion, it is important to predict which patients are at risk of progression to a subperiosteal or an orbital abscess. In our study, we found that proptosis, limited eye movements, and fever (>37.5°C) were associated with abscess development, and abscess volume and proptosis value were also important in terms of surgical necessity. We think that predicting the need for surgical treatment of the patient followed up may reduce morbidities, such as blindness, intracranial complications, and even mortality.

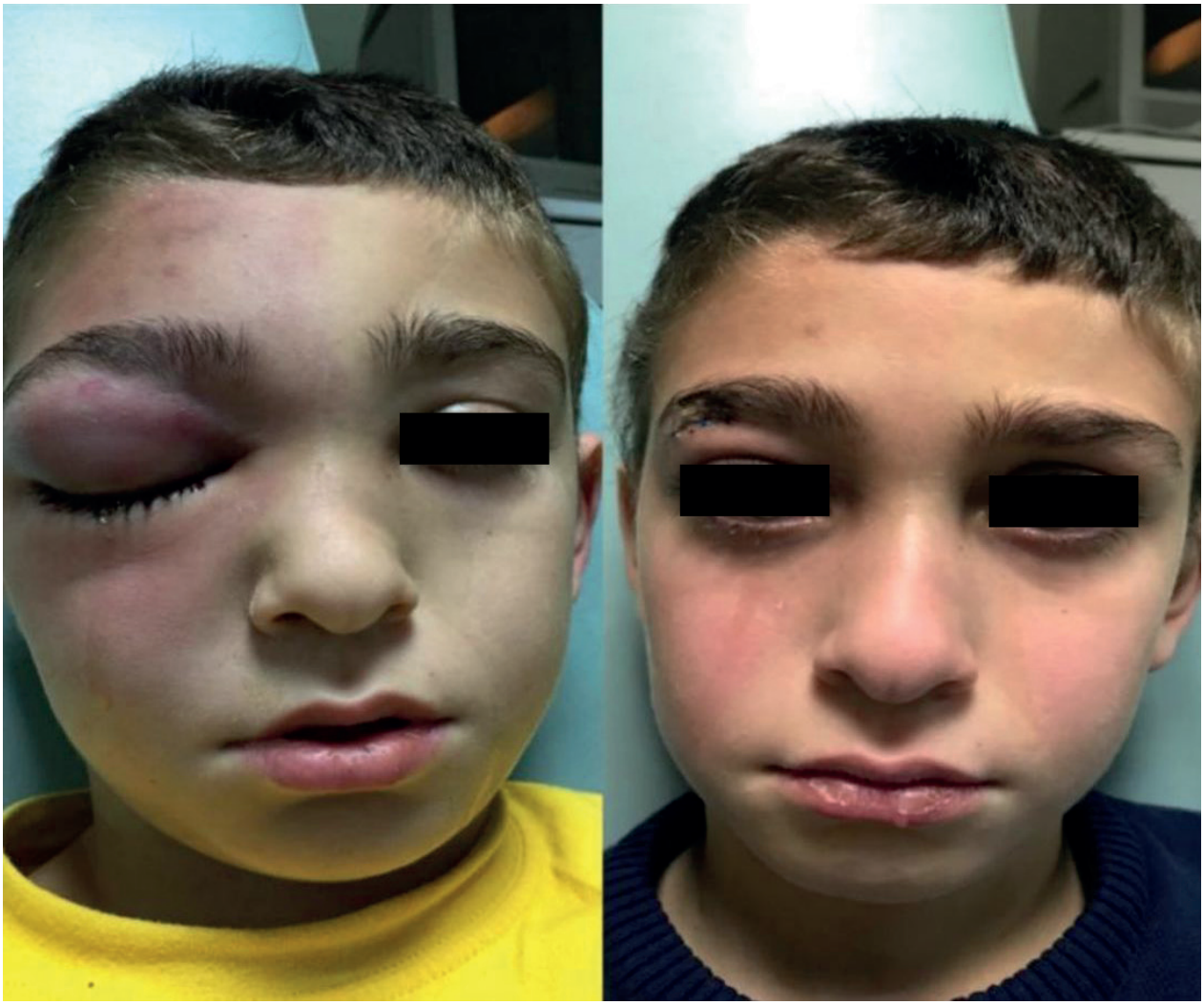

Figure 5. a: Clinical condition of a 9-year-old male patient at admission, exophthalmos, chemosis, and ophthalmoplegia are present; **b:** Clinical condition 7 days after the combined surgical approach for right superior orbital abscess.

Since rhinologists play a very important role in the surgical management of orbital complications, patients should initially be followed up by rhinologists and timely intervention should be made when necessary. However, a multidisciplinary approach should be followed by pediatrics, ophthalmology and radiology departments in terms of pediatric patient follow-up, eye findings, and imaging evaluation.

Ethical approval

This study has been approved by the Ethics Committee of Karadeniz Technical University, Faculty of Medicine (Approval date: 24/09/2018, Protocol number: 2018/191). Written informed consent was obtained from the participants.

Author contribution

Surgical and Medical Practices: OB, HTS, HBÇ; Concept: HTS; Design: HTS; Data Collection or Processing: HTS; Analysis or Interpretation: OB, HBÇ; Literature Search: HTS; Writing: HTS. All authors reviewed the results and approved the final version of the article.

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Conflict of interest

The authors declare that there is no conflict of interest.

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RESEARCH ARTICLES

Do age at disease diagnosis and age at symptom onset affect cognitive functions in Sjögren's syndrome?

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ABSTRACT

Objectives: In this study, we aimed to investigate the relationship between the age of onset of disease symptoms, the age at diagnosis, and cognitive function in patients with primary Sjögren's syndrome (pSS).

Methods: Sixty-two patients diagnosed with pSS who presented to the Sakarya Training and Research Hospital Internal Medicine Rheumatology outpatient clinic between November 2021 and November 2022 were included in the study. Parameters such as age at diagnosis, age at symptom onset, fibromyalgia status, Beck Depression Inventory (BDI) score, Beck Anxiety Inventory (BAI) score, insomnia, fatigue, learning disability, and number of comorbidities were recorded. The Montreal Cognitive Assessment (MoCA) score was used to evaluate cognitive function. The scale ranges from 0 to 30, with a threshold value set at 21. Scores of 21 and above were considered normal. Independent samples t-tests, Mann-Whitney U tests, and chi-square tests were used for data comparison.

Results: Patients with MoCA values less than 21 were significantly older. In the study, the age at symptom onset for patients with a MoCA score<21 was significantly higher than for those with a MoCA score ≥ 21 ($p<0.05$). Similarly, the age at diagnosis for patients with MoC<A values<21 was significantly higher than for those with MoCA values ≥ 21 ($p<0.05$). The impaired group (MoCA<21) comprised 20 individuals, representing 32.2%±3% of the cohort, while the non-impaired group consisted of 42 individuals, accounting for 67.7%±4% of the patients ($p<0.001$).

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A negative correlation was detected between age at the onset of symptoms (r=-0.376, p=0.003), disease diagnosis age (r=-0.297, p=0.019), and the MoCA value.

Conclusion: In our study, a negative correlation was found between age at the onset of symptoms, age at diagnosis, and MoCA values. Early diagnosis and treatment of SS can minimize cognitive dysfunction that may develop during the disease process. Maintaining high cognitive function will positively affect the quality of life.

Keywords: cognitive dysfunction, Sjögren's syndrome, disease age

INTRODUCTION

Sjögren's syndrome (SS) is an autoimmune disease characterized by symptoms of dry mouth and eyes resulting from lymphocytic infiltration of exocrine glands (1). Extraglandular involvement of various organs and systems can also be seen in SS. Neurological involvement has been reported in 8.5–70% of patients (2).

In primary Sjögren's syndrome (pSS), neurologic manifestations may be the first sign of the disease and are usually seen within the first two years after diagnosis. The most common neurologic complication is peripheral neuropathy with predominant sensory polyneuropathy. Central nervous system (CNS) involvement is less common. Cognitive dysfunction is one of the neurologic findings seen in patients. Mild to moderate cognitive difficulties are frequently reported in SS patients, a condition often referred to as "brain fog." It has been reported that cognitive impairment in pSS is associated with frontal-subcortical dysfunctions that control executive functions such as attention, memory, and information processing (3).

In patients with cognitive difficulties, symptoms such as forgetfulness, memory loss, mental confusion, decreased verbal fluency, and difficulty in concentration may be observed. Various neurological tests, including imaging techniques, are used to evaluate neurological involvement in pSS patients. However, these methods are expensive and may not always be suitable for daily practice (4). The Montreal Cognitive Assessment (MoCA) is an effective and easily applicable Turkish-validated test used in autoimmune diseases to evaluate cognitive functions (5).

SS can occur at any age, but its incidence increases in the 4th and 6th decades. SS is influenced by multifactorial factors, and age is a significant factor in demographic analyses (6).

Publications suggest that the clinical phenotypes of SS differ with patient age (7,8). Studies show that advanced age at disease onset is an independent predictor of neurologic involvement in SS (9). However, studies evaluating cognitive dysfunction in pSS patients and investigating related factors are limited. In this study, we aimed to investigate the relationship between age at onset of symptoms, age at diagnosis, and cognitive dysfunction in patients with pSS.

METHODS

This study included 62 patients over 18 years of age with pSS who met the 2016 ACR/EULAR criteria at the Sakarya Training and Research Hospital Internal Medicine Rheumatology Outpatient Clinic between November 2021 and November 2022. Parameters such as age at diagnosis, age at symptom onset, fibromyalgia, Beck Depression Inventory (BDI) score, Beck Anxiety Inventory (BAI), insomnia, fatigue, learning disability, and number of comorbidities were recorded. Patients were questioned and recorded regarding the presence of diagnosed fibromyalgia and symptoms such as fatigue, attention deficiency, and learning difficulties. MoCA was used to assess cognitive function. The MoCA is a screening tool used to assess early-stage cognitive impairment. The test takes approximately 10 minutes and covers 6 domains: memory, visuospatial ability, executive function, attention, concentration, language, and orientation. The lowest score is 0 and the highest is 30. The

threshold score was set at 21; scores of 21 and above were considered normal (Turkish version). Exclusion criteria included other neurodegenerative diseases affecting cognitive function, history of cerebrovascular disease, secondary Sjögren's disease, additional rheumatological diseases, mental retardation, and age under 18 years. Comparisons between groups were performed using the independent samples t-test for normally distributed continuous variables and the Mann-Whitney U test for non-normally distributed variables. Categorical variables were analyzed using the Chi-squared test.

RESULTS

The mean age of the patients was 53.08±11.7 years, with 59 (95.16%) being female and 3 (4.83%) male. Patients with a MoCA score less than 21 were significantly older. The age at symptom onset was significantly higher in patients with a MoCA score less than 21 compared to those with a score of 21 or higher ($p<0.05$). Similarly, the age at diagnosis was significantly higher in patients with a MoCA score less than 21 than in those with a score of 21 or higher ($p<0.05$).

The cohort comprised 20 individuals with a MoCA score<21 (32.2%±3%) and 42 individuals with a normal MoCA score (67.7%±4%), a difference that was statistically significant ($p<0.001$).

A negative correlation was found between the MoCA score and both the age at symptom onset ($r=-0.376$, $p=0.003$) and the age at diagnosis ($r=-0.297$, $p=0.019$).

Table 1. Relationship between the MoCA score and the age at diagnosis and the age at the onset of symptoms

	Montreal Cognitive Score (<21); n: 20	Montreal Cognitive Score (≥21); n: 42	P
Age at symptom onset (year)	50.6±12.0	40.8±11.0	**0.003***
Age at diagnosis (year)	53.7±12.0	44.3±11.1	**0.019***
Beck depression scale	11.6±9.4	12.4±8.1	0.728*
Beck anxiety scale	14 (18) IQR	12 (16.5) IQR	0.768**

*Independent samples t-test; **Mann-Whitney U.

IQR: Inter Quantile Range.

Table 2. Associations between MoCA and fibromyalgia, fatigue, forgetfulness, learning disability and attention problems

		Normal Montreal Cognitive Score; n: 42	Impaired Montreal Cognitive Score; n: 20	P*
Comorbidity	Non	15 (35.7)	7 (35)	0.956
	Yes	27 (64.3)	13 (65)	
Fibromyalgia	non	16 (38.1)	9 (45)	0.604
	Yes	26 (61.9)	11 (55)	
Attention deficiency	non	13 (33.3)	7 (48.3)	0.466
	Yes	26 (66.7)	9 (56.3)	
Learning disability	non	13 (33.3)	8 (47.1)	0.329
	Yes	26 (66.7)	9 (52.9)	
Forgetfulness	non	9 (23.1)	2 (11.8)	0.473
	Yes	30 (76.9)	15 (88.2)	
Fatigue	non	4 (9.5)	4 (20)	0.418
	Yes	38 (90.5)	16 (80)	

*Chi-squared tests.

MoCA: Montreal cognitive assessment score.

Conversely, no significant correlation was observed between the MoCA score and the BDI or BAI scores (Table 1). Furthermore, no significant correlation was identified between MoCA scores and patient-reported symptoms of fibromyalgia, fatigue, forgetfulness, learning disability, or attention disorder (Table 2).

DISCUSSION

Cognitive impairment in pSS has been associated with frontal-subcortical dysfunction affecting attention, memory, decision-making speed, and executive functions (10). Cognitive dysfunction may be the first clinical manifestation in some pSS patients. While studies have reported varying results regarding disease duration, age at diagnosis, and clinical manifestations (such as sicca symptoms, arthralgia, and fatigue), data evaluating the relationship between cognitive functions and age at disease onset are limited (6,11).

In our study, a negative correlation was found between MoCA values and age at symptom onset and age at diagnosis. Blanc et al. reported cognitive dysfunction in 60% of patients in a case-control study of 25 patients aged 30–75 years (12). In our study, cognitive dysfunction was identified in 32.2% of the patients. Dziadkowiak et al. reported that cognitive impairment was associated with disease duration and the severity of inflammatory changes in 30 pSS patients with a mean age of 51 years (13). In a controlled case-control study, the MoCA scores of pSS patients were compared with a healthy control group; no significant difference was found in the total score, though pSS patients showed worse results in visuospatial/executive subtests (14). That study, where the mean age was 56 years, did not provide information regarding the relationship between disease age, age at diagnosis, and MoCA scores (14).

Goulabchand et al. stated that cognitive complaints in pSS patients may be associated with accompanying disorders such as depression, anxiety, or sleep problems (15). In an article published in 2016, Tezcan et al. suggested that cognitive dysfunction might be protective against depression in pSS patients (16). In the present study, however, no significant relationship was found between depression, sleep disturbance, and cognitive functions.

Data in the literature suggest a strong association between cognitive impairment and fatigue in patients with pSS (16,17). In our study, no significant difference was found between cognitive dysfunction and fatigue.

Fibromyalgia is characterized by widespread pain, fatigue, sleep disturbance, and cognitive dysfunction. Studies show that fibromyalgia patients have more cognitive impairment than healthy controls (18). It is suggested that SS patients have a high risk profile for fibromyalgia. The coexistence of fibromyalgia and SS may affect cognitive functions (19). However, no significant relationship was found between cognitive dysfunction and fibromyalgia in this study.

Sleep disturbance is common in SS and affects the quality of life (2,20). Findings generally show that sleep disturbance is associated with cognitive dysfunction (20). In our study, no such relationship was found.

Limitations of our study include the lack of a control group and the absence of cranial MRI scans for patients with cognitive dysfunction. Our data suggest that older age at diagnosis and symptom onset are associated with cognitive dysfunction in pSS. Older age may increase the risk of cognitive dysfunction both independently and by influencing the inflammatory process.

We believe that the MoCA is an easily applicable test in pSS patients and can guide further investigation. Cognitive dysfunction in pSS is an area requiring more research. Larger, controlled studies will better elucidate the effects of age at diagnosis and disease onset on cognitive outcomes.

Ethical approval

This study has been approved by the Sakarya University Rectorate Faculty of Medicine Deanery Faculty Non-Interventional Ethics Committee (approval date 29.11.2023, number 352). Written informed consent was obtained from the participants.

Author contribution

Surgical and Medical Practices: GD, MKU, SMT; Concept: SBA, SÖ; Desing: AK, DK; Data Collection or Processing: EG, CGA; Analysis or İnterpretation: AK,

GD; Literatüre Search: TA, GY; Writing: GD, NE. All authors reviewed the results and approved the final version of the article.

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Conflict of interest

The authors declare that there is no conflict of interest.

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RESEARCH ARTICLES

Pseudoexfoliation syndrome in the Çorum region and its systemic associations: a population-based study

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ABSTRACT

Aim: Pseudoexfoliation syndrome (PEX) is a form of systemic elastic microfibrillopathy that affects multiple organs. The aim of this study was to investigate the prevalence of PEX in the Çorum province of Turkey and its relationship to various clinical manifestations.

Materials and Methods: A total of 1,013 patients underwent a comprehensive ophthalmic examination. Clinical diagnosis of PEX was established based on the presence of pseudoexfoliative material on the anterior lens capsule surface or the pupillary margin during slit-lamp biomicroscopy after pupillary dilation, or during surgery. Data were obtained from medical histories and patient records, including age, sex, history of ocular and systemic diseases, and systemic medication use. The systemic conditions evaluated included diabetes mellitus (DM), systemic hypertension (HT), ischemic heart disease (IHD), cerebrovascular disease (CVD), and chronic obstructive pulmonary disease (COPD). A p-value of less than 0.05 was considered statistically significant.

Results: PEX was identified in 154 of the 1,013 patients, yielding an overall prevalence of 15.2%. The prevalence of HT ($p = 0.009$), IHD ($p < 0.001$), and CVD ($p = 0.036$) was significantly higher in patients with PEX. Although the prevalence of DM was lower and COPD was slightly higher in the PEX group, these differences were not statistically significant ($p = 0.069$ and $p = 0.472$, respectively).

Conclusion: Our study demonstrates that even within geographically similar regions, the prevalence of pseudoexfoliation varies alongside different systemic comorbidities. These findings may be fundamental for identifying patients at an increased risk of systemic disease and for potentially tailoring follow-up protocols according to regional data, thereby improving public health and clinical outcomes.

Keywords: pseudoexfoliation, hypertension, cerebrovascular disease, ischemic heart disease

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INTRODUCTION

Pseudoexfoliation syndrome (PEX) is an age-related disorder characterized by the production and progressive accumulation of abnormal eosinophilic extracellular fibrillary material within various intraocular and extraocular tissues. Pseudoexfoliation fibrils may manifest in various ocular structures, including the ciliary processes, zonules, anterior lens surface, iris, corneal endothelium, trabecular meshwork, and conjunctiva (1). The condition may present unilaterally or bilaterally with lateral asymmetry. It is hypothesized that these fibrils are produced multifocally by various intraocular cell types, such as the pre-equatorial lens epithelium, non-pigmented ciliary epithelium, trabecular endothelium, corneal endothelium, vascular endothelial cells, and nearly all cell types of the iris (2). Consequently, ocular manifestations of PEX can involve all structures of the anterior segment.

PEX deposits in the anterior segment are associated with nuclear cataract formation, zonular instability, phacodonesis, lens subluxation, pigment dispersion, open-angle glaucoma, and angle-closure glaucoma resulting from pupillary or ciliary block. Additional manifestations include peripupillary atrophy, sphincter region transillumination, poor pupillary dilation, iris rigidity, asymmetric pupil size, blood-aqueous barrier defects, pseudo-uveitis, and atypical cornea guttata (1,3). Furthermore, PEX is a significant risk factor during cataract surgery. These pathological alterations explain the increased risk of intraoperative and postoperative complications, including posterior capsule or zonular rupture, vitreous loss, anterior capsule fibrosis, intraoperative miosis, hyphema, postoperative inflammation, postoperative intraocular pressure (IOP) elevation, and corneal endothelial decompensation (1-3).

Currently, PEX is recognized as a systemic disease. PEX material has been identified in extraocular muscles, cerebral meninges, the lungs, heart, liver, kidneys, gallbladder, vessel walls, and skin. Focal accumulations have been detected in these organs, particularly within the interstitial fibrovascular portions and septa. In the heart, deposits have been localized specifically on the muscle cell surfaces (4). Previous studies have reported associations between PEX and numerous systemic conditions, including hypertension, coronary heart disease, cerebrovascular events, abdominal aortic aneurysm, Alzheimer's disease, asymptomatic myocardial dysfunction, and diabetes (5,6).

The aim of this study is to investigate the prevalence of PEX syndrome in the Çorum province of Turkey and its relationship with several clinical parameters.

MATERIALS AND METHODS

Ethics committee approval for the study was obtained from Hitit University Non-Interventional Research Ethics Committee (approval number: 2023-19, date: 01.12.2023). The study was conducted in accordance with the principles of the Declaration of Helsinki. The study cohort included 1,013 patients who underwent cataract surgery performed by a single surgeon (MBÜ) between March 2019 and July 2023 at the Hitit University Hospital Department of Ophthalmology, the primary state hospital in the region. All participants underwent a comprehensive ophthalmic examination, including best-corrected visual acuity (BCVA) measured using the Snellen chart, intraocular pressure (IOP) assessment via air-puff tonometry, slit-lamp biomicroscopy, and dilated fundoscopy. Mydriasis was induced with 1% tropicamide and 10% phenylephrine hydrochloride.

The clinical diagnosis of PEX was based on the presence of exfoliative material on the anterior capsule surface or the pupillary margin observed during slit-lamp examination after dilation or detected intraoperatively with or without the use of trypan blue. Exclusion criteria included secondary cataracts related to trauma, uveitis, or steroid use; congenital cataracts; a history of vitrectomy; age under 50 years; and cases where cataract surgery was combined with vitreoretinal surgery. Only one eye per patient (the first eye to undergo surgery in bilateral cases) was included. Cataracts were classified as nuclear, cortical, subcapsular, mixed (combinations of nuclear, cortical, and/or subcapsular), or mature/white based on slit-lamp biomicroscopy.

Data were collected from patient medical histories and electronic medical records. The variables recorded included age, sex, ocular and systemic disease history, and use of systemic medications. Specific systemic conditions assessed were diabetes mellitus, systemic hypertension, ischemic heart disease, cerebrovascular disease, and chronic obstructive pulmonary disease.

Statistical analyses

Statistical analyses were performed using SPSS software (Version 22, IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as mean ± standard deviation. Categorical variables were expressed as frequencies and percentages. The independent samples t-test was used for group comparisons of continuous data. Categorical variables were compared using the chi-square test. Multivariate analysis was conducted using binary logistic regression to identify factors independently associated with PEX. Age was included as a continuous variable, while sex was treated as a dichotomous variable. Systemic comorbidities, including diabetes mellitus, hypertension, coronary artery disease, cerebrovascular disease, and chronic obstructive pulmonary disease, were included as binary covariates. Adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. A p-value of less than 0.05 was considered statistically significant.

RESULTS

PEX was detected in 154 of the 1,013 patients, representing an overall prevalence of 15.2%. The prevalence of PEX was 14.94% in males and 15.52% in females, showing no statistically significant difference between sexes (p = 0.798). Patients with PEX (mean age: 75.94 ± 7.39 years) were significantly older than those without PEX (mean age: 69.03 ± 8.69 years) (p < 0.001). The prevalence of PEX increased with age, ranging from 2.23% in the sixth decade to 27.01% in the ninth decade. In the fully adjusted multivariate logistic regression model, age was independently associated with PEX, with a 10% increase in odds per year (adjusted OR: 1.10, 95% CI: 1.08–1.13; p < 0.001). Sex was not associated with PEX after adjustment (adjusted OR: 1.01, 95% CI: 0.69–1.47; p = 0.98). Age-specific prevalence rates are detailed in Table 1.

IOP was significantly higher in eyes with PEX (16.02 ± 2.67 mmHg) compared to eyes without it (14.77 ± 2.44 mmHg) (p < 0.001). The BCVA of patients with PEX (0.18 ± 0.15) was significantly lower than that of patients without PEX (0.21 ± 0.15) (p = 0.006). The most common cataract type in patients with PEX was nuclear (53.2%), followed by mixed (37.7%). In patients without PEX, the most frequent types were nuclear (42.1%) and mixed (41%). Demographic characteristics are presented in Table 2.

The prevalence of hypertension (p = 0.009), ischemic heart disease (p < 0.001), and cerebrovascular disease (p = 0.036) was significantly higher in patients with PEX. The prevalence of diabetes mellitus was lower and COPD was slightly higher in the PEX group, though these differences lacked statistical significance (p = 0.069 and p = 0.472, respectively). In the multivariate model, coronary artery disease remained independently associated with PEX (adjusted OR: 1.97, 95% CI: 1.33–2.92; p < 0.001). Hypertension, cerebrovascular disease, and COPD were not significantly associated with PEX in the adjusted model (p = 0.19, p = 0.09, and p = 0.99, respectively). Systemic associations are summarized in Table 3.

Table 1. Prevalence of pseudoexfoliation syndrome according to different age groups

Age (years)	PEX (n=154)	No-PEX(n=859)	Total (n= 1013)	% of PEX
50-59	3	128	131	2.23
60-69	34	285	319	10.65
70-79	77	335	412	18.69
80-89	37	100	137	27.01
≥ 90	3	11	14	21.42

PEX: Pseudoexfoliation syndrome.

Table 2. Demographic characteristics of patients with senile cataract and distribution of cataract types

	PEX + (n = 154)	PEX - (n = 859)	Total (n = 1013)	P
Age	75.94±7.39	69.03±8.69	70.08±8.86	<0.001[a]
Gender				
Male	82 (53.2%)	467 (54.4%)	549 (54.2%)	
Female	72 (46.8%)	392 (45.6%)	464 (45.8%)	0.798[b]
BCVA	0.18±0.15	0.21±0.15	0.21±0.15	0.006[a]
IOP	16.02±2.67	14.77±2.44	14.96±2.52	<0.001[a]
Type of cataract				
Nuclear	82 (53.2%)	362 (42.1%)	444 (43.8%)	
Cortical	2 (1.3%)	33 (3.8%)	35 (3.5%)	
Posterior subcapsular	0 (0%)	50 (5.8%)	50 (4.9%)	
Mixed	58 (37.7%)	352 (41%)	410 (40.5%)	
Mature/white	12 (7.8%)	62 (7.2%)	74 (7.3%)	
Total	154 (100%)	859 (100%)	1013 (100%)	

PEX: Pseudoexfoliation syndrome, BCVA: Best corrected visual acuity, IOP: Intraocular pressure, [a]: Independent samples t-test, [b]: Chi-square test

Table 3. Associated systemic diseases in patients with pseudoexfoliation syndrome

Systemic disease	PEX	No-PEX	Total	p[a]
Diabetes mellitus	38 (24.7%)	274 (31.9%)	312 (30.8%)	0.069
Hypertension	99 (64.3%)	455 (53%)	554 (54.7%)	0.009
Ischemic heart disease	62 (40.3%)	210 (24.4%)	272 (26.9%)	<0.001
Cerebrovascular disease	13 (8.4%)	36 (4.2%)	49 (4.8%)	0.036
Chronic obstructive pulmonary disease	24 (15.6%)	115 (13.4%)	139 (13.7%)	0.472

PEX: Pseudoexfoliation syndrome, [a]: Chi-square test.

DISCUSSION

Pseudoexfoliation syndrome is a systemic elastic microfibrillopathy affecting multiple systems, including the ocular, cardiovascular, and musculoskeletal systems. Its prevalence is influenced by ethnicity and geography, with reported rates ranging from 3.6% to 34.2% in Europe, 1.5% to 22.1% in Asia, and 1.5% to 40% in Africa (7-9). Identification of PEX is crucial for the prevention of associated complications.

Previous Turkish studies conducted in Northwest Central Anatolia (Eskişehir), the Eastern Mediterranean (Adana), the Middle Black Sea (Tokat), Central Anatolia (Sivas), and Marmara (Istanbul) reported PEX frequencies of 5%, 7.2%, 12.2%, 10.1%, and 11%, respectively (8,10-13). In the present study from Çorum province, also located in the Middle Black Sea region, the prevalence was 15.2%. While environmental factors such as solar/ultraviolet exposure and low temperatures have been implicated in PEX pathogenesis (14), the higher prevalence in Çorum—despite its milder climate relative to Sivas and lower UV exposure compared to Adana—suggests more complex regional factors.

This study confirmed that PEX frequency increases significantly with age, consistent with previous literature (12,15). No significant sex-based differences were found, which contrasts with the male dominance reported by Kılıç et al. in a nearby province (12). This discrepancy might stem from regional variations or the

higher sample size in our study. However, our findings align with the majority of studies that found no significant correlation between sex and PEX (16-18).

Intraocular pressure was elevated in PEX eyes, an established clinical pattern (19-21). Furthermore, the association between cataracts and PEX was confirmed (22). Nuclear cataracts were the predominant type in our PEX cohort, supporting prior research indicating a strong association between nuclear opacities and exfoliative deposits (23,24).

This study demonstrated that hypertension, ischemic heart disease, and cerebrovascular diseases are significantly more prevalent in patients with PEX, which is consistent with existing literature. PEX deposits have been proposed as a substrate for atherosclerosis and thrombus formation. Polymorphisms in the lysyl oxidase-like 1 (LOXL1) gene, which is responsible for elastin cross-linking, have been identified as a major genetic risk factor (25,26,27).

Elevated levels of apolipoprotein A, homocysteine, and other cardiovascular risk factors have also been observed in PEX patients (4). It is hypothesized that an imbalance in the matrix metalloproteinase cycle leads to fibrotic matrix dysfunction and fibrillary deposition (28). A review by Bora et al. found that PEX is substantially associated with hypertension, angina, myocardial infarction, and stroke (28). This may be related to vessel wall elastosis caused by elastin cross-linking malformations. Furthermore, PEX deposits can induce vascular endothelial defects, associated with increased proinflammatory molecules and apoptotic endothelial matrix metalloproteinases (29).

Patil et al. reported coronary artery disease in 7.9% of PEX patients, cerebrovascular events in 2.6%, and hypertension in 47.4%, with cardiac anomalies correlating with PEX severity (30). Imaz Aristimuño et al. found coronary artery disease in 3.7% and stroke in 4.6% of PEX subjects (31). Citirik et al. demonstrated a significant link between PEX and coronary artery disease in patients undergoing angiography (32). Interestingly, Kılıç et al. found a significant association in a hospital-based setting but not in a population-based study within the same region (12).

A meta-analysis by Chung et al. confirmed the association between PEX and cerebrovascular events (33). Specifically, Bora et al. noted that PEX glaucoma patients had higher rates of senile dementia, cerebral atrophy, and chronic cerebral ischemia compared to patients with primary open-angle glaucoma (POAG) (28). Akarsu et al. demonstrated that pseudoexfoliation glaucoma is associated with reduced blood flow velocity and higher resistance in the middle cerebral arteries (34).

The link between PEX and systemic arterial disease involves several mechanisms. PEX is associated with a hypercoagulable state (27). Deposits in the adventitial and subendothelial connective tissues of the aortic wall lead to vessel damage and hardening (29). Intravascular aggregation of PEX material may contribute to increased vascular resistance, impaired flow, and altered parasympathetic modulation (35). Increased stiffness in the common carotid artery has also been reported (36). In a large study of 3,546 subjects, PEX was associated with increased vascular risk, including angina, hypertension, and myocardial infarction (37).

This study has limitations. Diagnosis was based on clinical findings without histopathologic confirmation, potentially leading to underdiagnosis in early cases. Systemic comorbidities were self-reported or retrieved from records, meaning disease duration and severity were not analyzed.

In conclusion, these findings underscore the importance of comprehensive systemic evaluation in PEX patients. Our study shows that even in similar regions, PEX prevalence and systemic comorbidities vary. These differences are vital for identifying high-risk individuals and tailoring follow-up care to regional needs, ultimately improving public health outcomes.

Ethical approval

This study has been approved by the Hitit University Non-Interventional Research Ethics Committee (approval date 01.12.2023, number 2023-19). Written informed consent was obtained from the participants.

Author contribution

Surgical and Medical Practices: MBÜ; Concept: MBÜ, ZEE, SC; Design: MBÜ, ZEE, SC; Data Collection or Processing: MBÜ, ZEE, SC; Analysis or Interpretation: MBÜ, ZEE, SC; Literature Search: MBÜ, ZEE; Writing: MBÜ, ZEE. All authors reviewed the results and approved the final version of the article.

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Conflict of interest

The authors declare that there is no conflict of interest.

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RESEARCH ARTICLES

Perceived adequacy of preclinical endodontic training and self-reported clinical competence among undergraduate dental students

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ABSTRACT

Aim: To evaluate undergraduate dental students' perceived adequacy of preclinical endodontic training and its association with their perceived competence to perform endodontic treatment according to clinical protocols.

Materials and Methods: This cross-sectional questionnaire-based study included 265 fourth- and fifth-year undergraduate dental students from dental schools in Ankara, Türkiye, who had completed their clinical endodontic training. The questionnaire comprised demographic items and questions with responses recorded on a 3-point Likert scale (1 = Disagree, 2 = Neutral, 3 = Agree) to assess clinical self-competence and the perceived adequacy of preclinical training. Data were analysed using descriptive statistics. Associations between students' perceived clinical competence and the perceived adequacy of preclinical endodontic training were analysed using Pearson's chi-square test, with effect sizes assessed by Cramér's V. A linear-by-linear chi-square test was applied to evaluate ordinal trends. Statistical significance was set at $p < 0.05$.

Results: A total of 265 students participated in the study, comprising 188 (70.9%) females, 72 (27.2%) males, and 5 (1.9%) students who preferred not to disclose their gender. Among them, 115 (43.4%) were fourth-year and 150 (56.6%) were fifth-year students. Students' self-reported clinical competence was significantly associated with the perceived adequacy of preclinical training across all assessed endodontic procedures (Pearson's chi-square test, $p < 0.05$). Effect sizes were predominantly small to moderate. The linear-by-linear chi-square test showed a positive linear trend for most procedures, whereas no significant trend was observed for irrigation or the use of magnification.

Conclusion: Students generally consider their endodontic preclinical education and clinical competence to be adequate. The perceived adequacy of preclinical training was significantly associated with perceived clinical competence and demonstrated a consistent directional trend across the majority of the assessed endodontic procedures.

Keywords: clinical competence, endodontic education, preclinical training, self-efficacy

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INTRODUCTION

Dental education is a complex and dynamic process that integrates theoretical knowledge, practical skills, and professional attitudes to prepare students for clinical practice (1,2). Among the stages of dental training, the transition from preclinical to clinical education is a critical milestone in students' professional development (3). During this period, students move from simulated environments, where they perform procedures on training models or extracted human teeth, to patient-based care. This transition often challenges their technical proficiency, confidence, and communication skills (4). As a result, their level of preparedness for clinical work is a major determinant of the quality and effectiveness of dental education programmes (5).

Preclinical training aims to develop the foundational psychomotor skills and cognitive understanding necessary for clinical competence (6,7). It allows students to become familiar with dental instruments, materials, and procedures before they are exposed to patient care. However, despite the importance of preclinical education, the extent to which it adequately prepares students for clinical situations remains a subject of debate (7,8). Many students experience anxiety and uncertainty when entering clinical courses, suggesting a potential gap between preclinical instruction and real-world clinical demands (9). Understanding how students perceive their preparedness may, therefore, provide valuable insights into the strengths and weaknesses of the educational process.

In contemporary dental education, students' perceptions are increasingly recognised as significant indicators of the quality of the learning experience (3,10). Student-centred approaches value learners' experiences, attitudes, and reflections as important components of meaningful learning (11). By analysing students' self-assessment of their preparedness and self-efficacy, educators can identify potential barriers to learning, optimise teaching methodologies, and improve the overall educational experience.

Self-efficacy, defined as one's belief in their ability to perform specific tasks successfully, plays a significant role in clinical performance, motivation, and persistence (12,13). Consequently, assessing students' self-efficacy and perceived preparedness can serve as an indirect measure of how effectively the curriculum supports the development of clinical competence. Previous studies have explored dental students' perceptions of their preclinical and clinical experiences (14-16). Some have reported that students feel adequately prepared for clinical practice following comprehensive preclinical training (2), whereas others have found that students struggle to adapt to patient treatment due to a lack of confidence or insufficient practice in simulated settings (4). These differences highlight the influence of contextual factors, such as curriculum structure, teaching methods, and institutional resources, on students' educational experiences (10).

Despite this growing body of research, there remains limited evidence regarding how dental students in specific educational settings perceive their transition from preclinical to clinical training (2). In line with this, the preparedness of dental students for clinical procedures has been investigated by several studies using qualitative and various other methodological approaches (5,14-18). However, to the best of our knowledge, the existing literature lacks a study that investigates students' perceptions of their preclinical education retrospectively following the completion of their endodontic training. Retrospective evaluations obtained following clinical experience may provide a more realistic and comprehensive understanding of students' preparedness.

Therefore, this study aimed to assess students' clinical self-competence and the perceived adequacy of preclinical training in endodontic procedures. The null hypothesis of this study (H0) is that there is no significant difference between students' levels of clinical self-competence and their perceptions of the adequacy of preclinical training in endodontic procedures.

MATERIALS AND METHODS

Ethical approval and sample size calculation

This study was conducted with the approval of the Ethics Committee for Non-Clinical Scientific Studies, Faculty of Dentistry, Ankara University (Approval No: 53/2024, dated 06 May 2024). The sample size was calculated based on a type I error (α) of 0.05, an effect size (d) of 0.2, and a statistical power (1–α) of 0.90. According to these parameters, the minimum required sample size to achieve 90% power was determined to be 265 participants.

Participants and administration of the questionnaire

A total of 265 fourth- and fifth-year undergraduate students from dental schools in Ankara who had completed their clinical endodontic training participated in the study during the 2024–2025 academic year. The original questionnaire developed by Baaij and Özok (14) was utilised as a framework, with its main structure preserved to allow comparisons with future studies. The questions related to root canal treatment were subsequently revised to align with the specific aims of the present study, resulting in a questionnaire utilising a Likert scale to cover different stages of endodontic treatment. This draft was comprehensively reviewed by faculty members with prior experience in questionnaire-based research and finalised according to their feedback.

The final version of the questionnaire was converted into an online format using Google Forms (Google LLC, Mountain View, CA, USA) and disseminated via WhatsApp groups routinely used by students for communication. The questionnaire link was shared repeatedly throughout the data collection period to ensure that all eligible students had the opportunity to participate. At the beginning of the questionnaire, detailed information was provided regarding the study's purpose, structure, and participation requirements. Anonymity was ensured, and no identifying information was recorded. Participation was voluntary, and students could proceed only after confirming their informed consent.

The questionnaire consisted of two sections: (1) demographic information and (2) a three-point Likert scale (1 = Disagree, 2 = Neutral, 3 = Agree) designed to assess students' clinical self-competence and their perceived adequacy of preclinical training in endodontic procedures.

Statistical analysis

The data were analysed using the SPSS 22.0 statistical software package (IBM Corp., Armonk, NY, USA). Descriptive statistical methods were employed for data evaluation, with results presented as frequencies and percentages. Associations between categorical variables were examined using the Pearson's chi-square test, with effect sizes assessed by Cramér's V. Given the ordinal structure of the Likert-scale data, the association between perceived clinical competence and the perceived adequacy of preclinical training was analysed using linear-by-linear chi-square tests in 3 × 3 contingency tables. The level of significance was set at $p < 0.05$.

RESULTS

Demographic characteristics

Table 1 presents the demographic characteristics and self-reported endodontic treatment experience of the participants. A total of 265 undergraduate dental students participated in the study. Of these, 188 (70.9%) were female, 72 (27.2%) were male, and 5 (1.9%) preferred not to disclose their gender. Regarding academic year, 115 (43.4%) participants were fourth-year students and 150 (56.6%) were fifth-year students.

During preclinical training, most students reported performing 0–5 root canal treatments on anterior teeth (34.7%), followed by 5–10 (32.8%), 10–15 (20.4%), 15–20 (9.1%), and >20 (3.0%). Similarly, for posterior teeth, 33.2% of students performed 0–5 root canal treatments, followed by 31.3% (5–10), 26.0% (10–15), 5.0% (15–20), and 4.5% (>20).

Table 1. Demographic characteristics and self-reported endodontic treatment experience of the participants

Characteristics	Category	n	%
Gender	Female	188	70.9
	Male	72	27.2
	Prefer not to say	5	1.9
	Total	265	100.0
Academic year	Fourth Year	115	43.4
	Fifth Year	150	56.6
	Total	265	100.0
Number of Root Canal Treatments in Anterior Teeth	0–5	92	34.7
	5–10	87	32.8
	10–15	54	20.4
	15–20	24	9.1
	>20	8	3.0
	Total	265	100.0
Number of Root Canal Treatments in Posterior Teeth	0–5	88	33.2
	5–10	83	31.3
	10–15	69	26.0
	15–20	13	5.0
	>20	12	4.5
	Total	265	100.0

Association between perceptions of the adequacy of preclinical training and perceived clinical competence

Table 2 presents the associations between students' self-reported clinical competence and the perceived adequacy of preclinical training across endodontic procedures. Across all assessed endodontic procedures, students' self-reported clinical competence showed statistically significant associations with their perceived adequacy of preclinical training (Pearson's chi-square tests, $p < 0.05$). The strength of the associations was predominantly in the small-to-moderate range, based on Cramér's V effect size values. Linear-by-linear chi-square tests demonstrated a significant positive linear trend for most procedures. In contrast, no significant linear trend was identified for either irrigation or magnification ($p > 0.05$).

DISCUSSION

According to the guidelines published by the European Society of Endodontology (ESE) and the Association for Dental Education in Europe (ADEE), dental students are expected to graduate with the skills required to perform root canal treatment on uncomplicated anterior and posterior teeth (1,2). Achieving this graduation outcome may be particularly challenging in endodontics (19), as procedures in this field are often perceived by students as more difficult than those in periodontology and restorative dentistry (20). This perception arises from the variable and intricate structure of the root canal system and the clinically demanding, high-precision stages of endodontic treatment (21,22).

Furthermore, stress experienced by students during undergraduate endodontic education is a significant concern (23). Students' levels of stress and confidence are shaped by various factors, including the patient, the type of clinical procedure, the instructor, the teaching method, the clinical organisation, and the individual characteristics of the student (24). These factors may directly influence self-confidence, motivation, and clinical performance (25). Therefore, it is crucial to regularly evaluate whether the endodontic curriculum adequately meets students' educational needs in this area.

Within the educational process, both a supportive learning environment and the student's sense of confidence are of great importance (26,27). This context highlights that performing root canal treatment on a patient is a key experience that elevates a student from merely being skilful to becoming a confident clinician (15). Experience can enhance an individual's perception of confidence, while confidence may, in turn, facilitate the acquisition of further experience (28). Confidence is not a trait that can be directly measured; however, students' reported perceived competence in a specific area can serve as an indicator of their level of preparedness in that domain (29). Although actual ability does not always match perceived ability (9), the results of this study suggest that students' perceived competence may support the quality of the clinical experiences they acquire in the future.

Table 2. Association between students' self-reported clinical competence and perceived adequacy of preclinical training across endodontic procedures

Perceived preclinical training adequacy statement		**Clinical competence statement**								**p†**	**p‡**
		I feel competent at performing access cavity preparation according to the clinical protocol.									
		Disagree		Neutral		Agree		Total			
		n	%	n	%	n	%	n	%		
I believe that access cavity preparation was adequately taught during my preclinical training.	Disagree	20	37	11	20,8	23	14,6	54	20,4	< 0.001	< 0.001
	Neutral	15	27,8	26	49,1	42	26,5	83	31,3		
	Agree	19	35,2	16	30,1	93	58,9	128	48,3		
	Total	54	100	53	100	158	100	265	100		
		I feel competent at performing rubber dam isolation according to the clinical protocol.									
		Disagree		Neutral		Agree		Total			
		n	%	n	%	n	%	n	%		
I believe that rubber dam isolation was adequately taught during my preclinical training.	Disagree	14	51,9	17	27	55	31,4	86	32,5	< 0.001	0.017
	Neutral	5	18,5	29	46	36	20,6	70	26,4		
	Agree	8	29,6	17	27	84	48	109	41,1		
	Total	27	100	63	100	175	100	265	100		
		I feel competent at determining the working length according to the clinical protocol.									
		Disagree		Neutral		Agree		Total			
		n	%	n	%	n	%	n	%		
I believe that working length determination was adequately taught during my preclinical training.	Disagree	5	35,7	9	13,8	20	10,8	34	12,8	< 0.001	< 0.001
	Neutral	2	14,3	38	58,5	35	18,8	75	28,3		
	Agree	7	50	18	27,7	131	70,4	156	58,9		
	Total	14	100	65	100	186	100	265	100		

†: Pearson's chi-square test. ‡: Linear-by-linear chi-square test.
p values < 0.001 are reported as p < 0.001.
Values are presented as n (%). Each statement was rated on a 3-point Likert scale (1 = Disagree, 2 = Neutral, 3 = Agree)

Table 2. Continued

Perceived preclinical training adequacy statement		Clinical competence statement								p†	p‡
		I feel competent at preparing root canals according to the clinical protocol.									
		Disagree		Neutral		Agree		Total			
		n	%	n	%	n	%	n	%		
I believe that root canal preparation was adequately taught during my preclinical training.	Disagree	4	36,4	10	16,7	20	10,3	34	12,8	< 0.001	< 0.001
	Neutral	3	27,2	40	66,6	41	21,1	84	31,7		
	Agree	4	36,4	10	16,7	133	68,6	147	55,5		
	Total	11	100	60	100	194	100	265	100		
		I feel competent at performing irrigation according to the clinical protocol.									
		Disagree		Neutral		Agree		Total			
		n	%	n	%	n	%	n	%		
I believe that irrigation procedures were adequately taught during my preclinical training.	Disagree	3	25	11	21,6	42	20,8	56	21,1	0.005	0.068
	Neutral	4	33,3	29	56,8	62	30,7	95	35,8		
	Agree	5	41,7	11	21,6	98	48,5	114	43,1		
	Total	12	100	51	100	202	100	265	100		
		I feel competent at placing calcium hydroxide according to the clinical protocol.									
		Disagree		Neutral		Agree		Total			
		n	%	n	%	n	%	n	%		
I believe that the placement of calcium hydroxide was adequately taught during my preclinical training.	Disagree	21	65,6	27	30	36	25,2	84	31,7	< 0.001	< 0.001
	Neutral	4	12,5	50	55,6	28	19,6	82	30,9		
	Agree	7	21,9	13	14,4	79	55,2	99	37,4		
	Total	32	100	90	100	143	100	265	100		

†: Pearson's chi-square test. ‡: Linear-by-linear chi-square test.
p values < 0.001 are reported as p < 0.001.
Values are presented as n (%). Each statement was rated on a 3-point Likert scale (1 = Disagree, 2 = Neutral, 3 = Agree)

Table 2. Continued

Perceived preclinical training adequacy statement		**Clinical competence statement**								**p†**	**p‡**
		I feel competent at performing root canal obturation according to the clinical protocol.									
		Disagree		Neutral		Agree		Total			
		n	%	n	%	n	%	n	%		
I believe that obturation techniques were adequately taught during my preclinical training.	Disagree	37	78,7	37	36,3	25	21,6	99	37,4	< 0.001	< 0.001
	Neutral	7	14,9	49	48	28	24,1	84	31,7		
	Agree	3	6,4	16	15,7	63	54,3	82	30,9		
	Total	47	100	102	100	116	100	265	100		
		I feel competent at managing intraoperative complications according to the clinical protocol.									
		Disagree		Neutral		Agree		Total			
		n	%	n	%	n	%	n	%		
I believe that the management of procedural complications was adequately taught during my preclinical training.	Disagree	40	80	39	38,6	35	30,7	114	43	< 0.001	< 0.001
	Neutral	6	12	46	45,6	23	20,2	75	28,3		
	Agree	4	8	16	15,8	56	49,1	76	28,7		
	Total	50	100	101	100	114	100	265	100		
		I feel competent at using dental loupes according to the clinical protocol.									
		Disagree		Neutral		Agree		Total			
		n	%	n	%	n	%	n	%		
I believe that the use of dental loupes was adequately taught during my preclinical training.	Disagree	5	35,7	17	25,8	66	35,7	88	33,2	< 0.001	0.113
	Neutral	6	42,9	36	54,5	34	18,4	76	28,7		
	Agree	3	21,4	13	19,7	85	45,9	101	38,1		
	Total	14	100	66	100	185	100	265	100		

†: Pearson's chi-square test. ‡: Linear-by-linear chi-square test.
p values < 0.001 are reported as p < 0.001.
Values are presented as n (%). Each statement was rated on a 3-point Likert scale (1 = Disagree, 2 = Neutral, 3 = Agree)

Feedback is an essential component of the educational assessment and evaluation process. When used effectively, it can enhance the quality of the course and support student development (19,30), as well as help identify which aspects of the educational experience students value most (31). Previous research indicates that regularly gathering students' evaluations and feedback is highly important for identifying issues and implementing changes to improve the educational programmes (10,22). These evaluations may help identify strategies to enhance endodontic education and may also contribute to improving other related courses (30). Nevertheless, students' perspectives are often not sufficiently considered when planning the future of dental education (32).

In the present study, students generally considered themselves clinically competent in most endodontic procedures and perceived their preclinical education as adequate for clinical practice. A lack of confidence in new graduates may lead to excessive dependence on supervision, thereby slowing their professional development. Conversely, an inflated sense of confidence may compromise patient safety by encouraging attempts at procedures that exceed their capabilities (1). Therefore, it is essential that individuals recognise their actual level of competence realistically and develop a level of confidence that is aligned with it (9).

Baaij et al. reported that students with low self-efficacy before graduation showed a more pronounced improvement thereafter, whereas those with higher self-efficacy referred patients for endodontic surgery more frequently (16). Therefore, self-efficacy appears to be a dynamic concept that markedly influences both clinical decision-making and post-graduation development (16). Although the students in this study reported high levels of perceived competence, their evaluations were largely based on simple and uncomplicated cases. When they encounter more challenging real-life patient scenarios after graduation, their perceptions of their own competence may, therefore, change (33). In addition, levels of self-confidence may be influenced by individual personality traits and personal views and may not always accurately reflect true competence. This situation may even, at times, be interpreted as an indication of unconscious incompetence (3). Even in the presence of these limitations, the results of this study provide a meaningful contribution to understanding how their education influences the way students assess their own abilities.

According to the ESE guidelines, no recommendation is made regarding the number of root canal treatments an undergraduate dental student should perform before graduation (2). Self-efficacy has been defined as a feeling of competence and confidence, expressed as self-assurance in one's ability to perform specific tasks successfully (15). Students' self-efficacy was influenced mostly by their clinical experience when performing root canal treatment. It seems that the more root canal treatments students perform on patients, the greater their self-efficacy is at graduation (15). Baaij et al. further reported that, to increase self-efficacy, students should perform as many root canal treatments as possible, and that the number of treatments performed under the supervision of an endodontist influences students' self-efficacy and perceived level of competence (14). On this basis, it might be recommended that, before graduation, students should perform at least three root canal treatments on patients, preferably under the supervision of an endodontist (14). In the present study, more than half of the students had performed at least five root canal treatments. This suggests that their high perceived competence may be linked to having gained sufficient practical experience through an adequate number of clinical cases.

An association was observed between perceived clinical competence and perceived adequacy of preclinical education, with a consistent directional trend across most procedures. Accordingly, students who perceive preclinical education as more adequate also tend to perceive higher levels of clinical competence. However, these findings should not be interpreted as evidence of a cause-and-effect relationship whereby preclinical education directly enhances clinical competence. Rather, the results reflect a consistent and directional covariation in students' self-reported perceptions, indicating that preclinical and clinical educational experiences are evaluated within a holistic framework. In this context, students appear to view preclinical education and clinical competence not as separate

domains, but as interrelated components of a coherent learning experience. According to the most recently published guidelines of the British Endodontic Society Teachers of Endodontology Group, it is recommended that the use of dental loupes should be integrated into endodontic clinical skills training and the performance of endodontic treatment within the undergraduate curriculum (34). In this study, no linear trend was identified for dental loupes. These results suggest that the use of dental loupes may be closely associated not only with technical proficiency but also with factors such as individual habits, ergonomic comfort, visual adaptation, and instructor encouragement. Students may have perceived the use of dental loupes not as a natural extension of their clinical competence, but rather as an auxiliary tool dependent on personal preference or external conditions. This inconsistency may also be explained by the fact that preclinical exercises do not fully reflect real clinical conditions, where patient positioning and dynamic movement make magnification more difficult to master than on a mannequin. In addition, this result highlights the importance of not only emphasising basic teaching steps but also incorporating modern endodontic approaches and technologies into undergraduate endodontic education more effectively. Similarly, for irrigation, the absence of a significant linear trend may be related to the fact that this procedure is generally performed in a more standardised and protocol-based manner in the clinical setting. Students may perceive irrigation as a routine procedure in which the selected irrigant is applied at a predetermined volume and duration, rather than as an individual technical skill. Therefore, even if the overall perception of clinical competence increases, self-evaluations related to irrigation may not reflect this increase in a linear manner. In addition, the fact that the clinical success of irrigation is not directly observable in the short term may have led students to rate their perceived competence at this stage at similar levels. These findings indicate that some endodontic procedures are perceived as being shaped by experiences influenced by individual preferences and contextual factors, rather than by a linear progression of learning or competence.

A primary limitation of this study is that the data are based on students' self-reports, which are inherently subjective and may not fully represent actual clinical competence. Consequently, it is not possible to establish a causal relationship between preclinical training and clinical performance. The findings may also have been influenced by contextual factors such as the timing of data collection, assessment-related pressure, or variations in teaching approaches. Moreover, although the study was conducted across dental schools in Ankara, its restriction to a single city limits the generalizability of the results to other educational contexts. Although the quantitative survey data provide useful insights, they may not capture the deeper factors shaping students' perceptions. Future research would therefore benefit from incorporating qualitative interviews and more objective and structured competence assessment tools, such as Objective Structured Clinical Examinations (OSCEs), to provide a more reliable evaluation of students' clinical preparedness.

CONCLUSION

Based on descriptive statistics, the findings indicate that students reported moderate-to-high levels of perceived competence across most endodontic procedures and generally viewed their preclinical education as supportive of clinical practice. Perceived adequacy of preclinical training was associated with perceived clinical competence across all assessed endodontic procedures, and a significant linear trend was additionally observed for most procedures, except for irrigation and magnification. However, these perceptions may be influenced by individual personality traits, and self-perceived competence may not always accurately reflect true clinical ability. Further studies are needed to determine the extent to which students' perceived levels of competence genuinely reflect their actual clinical performance.

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Ethical approval

This study has been approved by the Ethics Committee for Non-Clinical Scientific Studies, Faculty of Dentistry, Ankara University (approval date 06/05/2024, number 53/2024). Written informed consent was obtained from the participants.

Author contribution

Concept: EOT; Design: EOT; Data Collection or Processing: ŞY, FNC, ZT, SU; Analysis or Interpretation: EOT; Literature Search: EOT, CY; Writing: EOT, CY; Critical Review and Supervision: EOT, CY. All authors reviewed the results and approved the final version of the article.

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Conflict of interest

The authors declare that there is no conflict of interest.

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RESEARCH ARTICLES

Cerebrospinal fluid HOXB3 does not differentiate relapsing–remitting multiple sclerosis from idiopathic intracranial hypertension: a pilot study

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ABSTRACT

Aim: Multiple sclerosis (MS) is a complex disease in terms of diagnosis and differential diagnosis due to the variety of clinical and radiological findings. Many diseases have similar characteristics and mimic MS. Thus, potential differential biomarkers have an importance for diagnosis of MS. Homeobox protein-3 (HOXB3) is a homeobox transcription factor implicated in immune cell regulation and neurodevelopment, and recent cerebrospinal fluid proteomic studies have suggested its potential role in neuroinflammatory processes, making it a plausible candidate biomarker for differential diagnosis in MS. The aim of this study was to investigate whether cerebrospinal fluid levels of HOXB3 differ between treatment-naïve patients with relapsing–remitting multiple sclerosis (RRMS) during relapse and patients with idiopathic intracranial hypertension (IIH).

Methods: Forty-one pwMS diagnosed with McDonald criteria were enrolled for the case groups. Thirty-four patients with IIH diagnosed with Dandy criteria were enrolled for control group. We measured cerebrospinal fluid level of HOXB3 (CSF HOXB3) by Enzyme-Linked Immunosorbent Assay (ELISA) method.

Results: No significant difference was observed in CSF HOXB3 levels between pwMS and control group. The ROC curve for HOXB3 was not statistically significant with the AUC at 0.573.

Conclusion: HOXB3 does not differentiate RRMS from IIH under the studied conditions.

Keywords: multiple sclerosis, human homeobox protein-3, cerebrospinal fluid, biomarker

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INTRODUCTION

Multiple sclerosis (MS) is a chronic and inflammatory disease that affects the central nervous system (CNS). The main characteristics of the disease are axonal loss and neuronal damage caused by the degeneration and demyelination of neurons (1). This disease is known to cause various symptoms that can affect the autonomic, motor, visual, and sensory systems. The underlying causes of the disease remain not yet fully understood, however, the incidence and prevalence of MS are increasing worldwide (2). MS is an inherently complex disease, and various disorders can easily mimic its clinical symptoms and paraclinical findings. This makes the diagnosis of MS particularly challenging due to the variability in clinical features and the lack of specific tests. Currently, there are no exclusive markers for diagnosing MS. Magnetic Resonance Imaging (MRI) is an essential tool in this diagnostic process. Although white matter lesions on brain MRIs are widely recognized as a hallmark of MS, they are also prevalent in other CNS inflammatory diseases, leading to potential diagnostic confusion. The growing availability of effective treatments for MS, coupled with the significant advantages of early intervention, underscores the critical need for accurate and timely diagnosis. Over the past decade, the landscape of cerebrospinal fluid (CSF) and blood biomarkers has significantly evolved, emerging as crucial tools for the diagnosis, prognosis, and treatment monitoring of MS (3).

Homeobox (HOX) genes are a family of homeodomain-containing transcription factors mainly involved in development (4). HOX genes regulate cell shape, migration, motility, proliferation and programmed cell death as well as conferring a differentiated cell identity. HOX genes are more highly expressed in haematopoietic stem cells, endothelial cells during vascular remodelling, endometrial cells of the uterus, fibroblast cells and skeletal stem cells, compared to less frequently dividing cells (5,6). Some HOX family members can cause inflammation in various disease states. As a result of these studies, HOX transcription factors may affect the inflammatory process and may be modulated by inflammation in many pathological conditions (7). Based on proteomic and ELISA studies, it has recently been reported that CSF levels of HOXB3 may serve to monitor the conversion from clinically isolated syndrome (CIS), the initial form of MS, to MS (8,9). Although the function of HOXB3 in the CNS is not fully understood, its growth regulatory effect and high expression in lymphocytes and leukaemia cells suggest that HOXB3 may be a potential marker of immune cell activation (4,10,11).

Considering the role of HOXB3 in the pathology of MS, in this pilot study, we aimed to investigate whether HOXB3 may confer a function as a differential biomarker in a cohort of pwMS during relapse period.

MATERIAL AND METHODS

Subjects and study procedure

41 newly diagnosed patients fulfilling the criteria for MS (12) were enrolled. Since CSF samples could not be obtained from healthy controls due to the disapproval of the ethics committee, 34 patients fulfilling the criteria for idiopathic intracranial hypertension (IIH) (13) were included as control group. Patients with other autoimmune diseases and other coexisting neurological or systemic disorders were excluded to avoid cross-reactivity. The study protocol was approved by Bolu Abant İzzet Baysal University Local Ethical Committee under decision number 2024/29 on March 3rd, 2024, and followed the guidelines outlined in the Helsinki Declaration. All the subjects gave written informed consent. CSF samples were collected from all participants during the first clinical episode, and patients were not under any immunosuppressive or immunomodulating treatment All the patients underwent the Lumbar Puncture (LP) for CSF sampling. The samples were divided into aliquots and stored at -80°C until assay.

Study of CSF samples

The human ELISA kit (Sunred Biological Technology Co., Ltd in Shanghai, China) was used for HOXB3 assay. The sensitivity is 0.033 ng/mL. Before testing, all the CSF samples were carefully thawed at 2-8°C and allowed to reach room temperature for 30 minutes. The assay was performed according to the manufacturer's instructions.

Statistical analysis

Statistical analysis was performed by using GraphPad Prism 8.0.2 (GraphPad Software, La Jolla, CA, USA). Frequency and percentage were used for categorical-demographic data of the groups. The Kolmogorov-Smirnov test was used to determine the distributional characteristics of continuous variables. In descriptive statistics, mean ± standard deviation values were provided for normally distributed characteristics, while median (minimum-maximum) values were given for non-normally distributed characteristics. Comparisons between two independent groups were assessed through the Student T-test and Mann–Whitney test, as appropriate. The linear association between the variables was examined through the Pearson correlation coefficient. Receiver Operating Characteristic (ROC) curve was fitted to estimate the ability of CSF HOXB3 concentration in distinguishing groups. The best cut-off value for this variable was determined with the Youden test. The statistical significance level was accepted as $p < 0.05$.

RESULTS

Demographic and clinical features of the study cohort

The relapsing-remitting MS (RRMS) subtype was selected for the pwMS. The primary IIH subtype was chosen for the IIH. Upon analyzing the gender distribution of participants, 87.8% of the pwMS were female and 12.2% were male. In the IIH group, 82.4% of the patients were female and 17.6% were male. The average age for the pwMS and IIH was 32.4 and 41.4, respectively. The age of onset was lower in pwMS than IIH. The median value for EDSS was 2.00 for pwMS. The average IgG index was higher in pwMS than IIH. Table 1 shows the demographic and clinical characteristics of the groups.

Quantification of CSF HOXB3 level

The mean CSF HOXB3 concentrations for pwMS and IIH were 3.42 ± 0.81 and 3.63 ± 0.81, respectively. No statistically significant difference was observed in CSF HOXB3 level between the groups (p=0.267) (Figure 1A). Acording to the gender; CSF HOXB3 level was lower in men than women (p=0.037) (Figure 1B).

Relationship between CSF HOXB3 and disability

The median EDSS score was 2.00 (1.0–2.5) for pwMS, and no significant correlation was found between CSF HOXB3 and EDSS score (r= 0.1594, p= 0.368).

ROC curve for CSF HOXB3

The 95% confidence interval of the ROC curve of pwMS and IIH was from 0.4420 to 0.7029. The area under the curve, AUC, was 0.5725 (p=0.282). The best cut-off value was 2.475. As per this cut-off point, the sensitivity and specificity of HOXB3 were 0.9706 and 0.1463, respectively (Figure 2).

Table 1. Demographic and clinical characteristics of the study cohorts

Characteristics		RRMS (n=41)	IIH (n=34)	P value
Age, years [a]		32.4±9.1	41.4±11.9	**<0.001**
Gender [b]	Male	5 (12.2)	6 (17.6)	0.506
	Female	36 (87.8)	28 (82.4)	
IgG Index [c]		0.87 (0.13-4.32)	0.51 (0.08-6.81)	**<0.001**
OCB [b]	Negative	8 (20.0)	32 (97.0)	**<0.001**
	Positive	33 (80.0)	1 (3.0)	

RRMS: Relapsing-Remitting Multiple Sclerosis, IIH: Idiopathic Intracranial Hypertension, EDSS: Expanded Disability Status Scale, IgG: Immunoglobulin G, OCB: Oligoclonal band.
[a]: Mean ± standard deviations. P value was determined via the Independent Samples T-test for age.
[b]: Values are frequency (%). P values were determined via the Chi-Square test.
[c]: Values are medians (min. – max.). P value was determined via the Mann-Whitney U test.
Bold p values indicate statistical significance.
The assessment for OCB was not conducted in 1 patient with IIH. IgG index data was made up of 40 patients with MS and 24 patients with IIH.

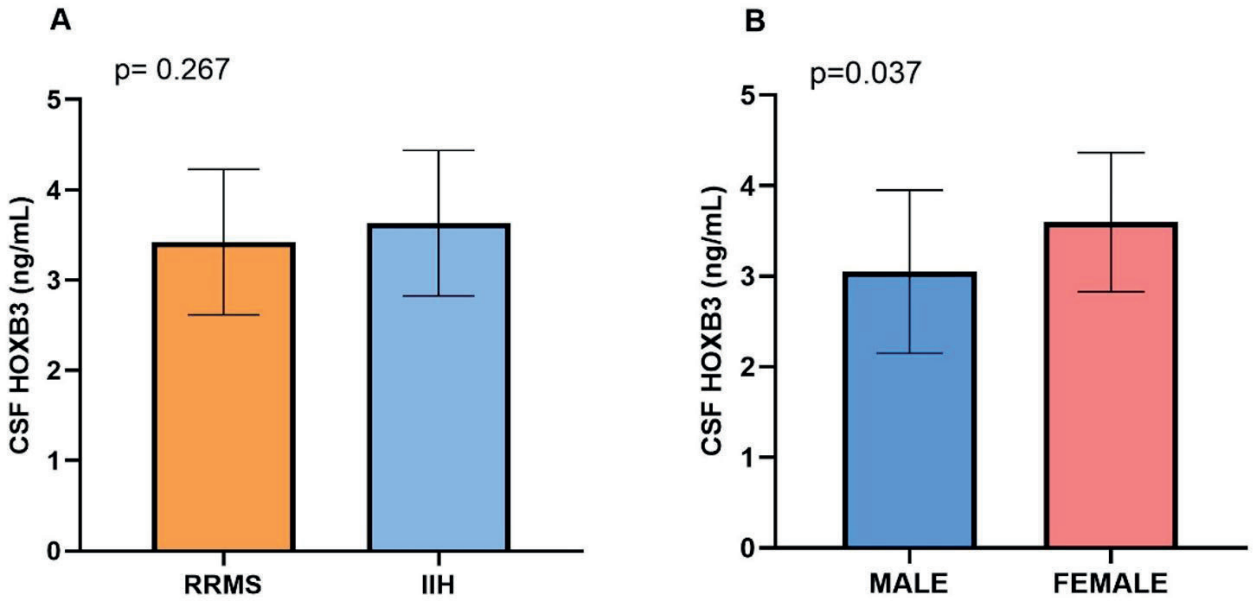

Figure 1. Comparison of CSF HOXB3 levels (A, B). (A) No difference was found in CSF HOXB3 levels between pwMS and IIH. (B) CSF HOXB3 levels were higher in female compared with male. The error bar indicates mean ± standard deviation. Comparisons between two independent groups were assessed through the Student T-test.

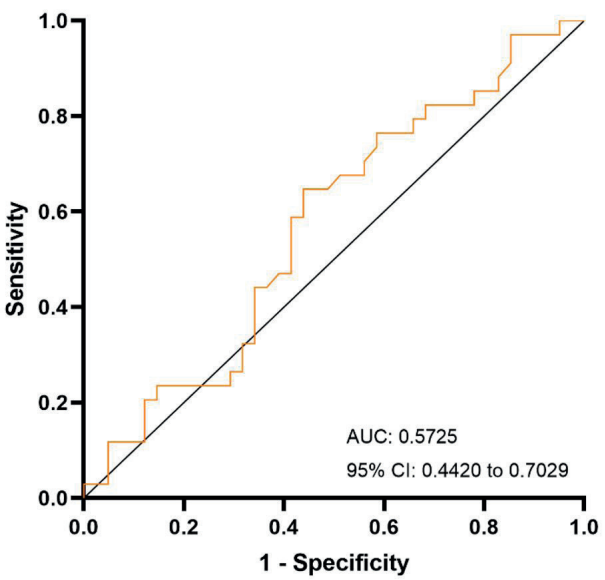

Figure 2. ROC curve of CSF HOXB3 concentration. The 95% confidence interval is from 0.4420 to 0.7029. The area under the ROC curve is 0.5725.

DISCUSSION

In this pilot study, we measured HOXB3 level in CSF obtained during the first clinical attack within the first 30 days of the relapse. We found no significant difference in CSF HOXB3 level in pwMS than IIH which is another infilamatory disease. Although HOXB3 is recognised as a transcription factor involved in the embryonal stages of neurogenesis and brain development (14), its role in autoimmunity is largely unknown. Our results indicated that CSF HOXB3 levels in pwMS were not statistically different from those of the control group under the present study conditions. Previous reports have demonstrated that biomarker measurements may vary depending on whether sampling is performed during relapse or remission (8,9,15). Therefore, our findings suggest that CSF HOXB3 does not differentiate pwMS from controls during the relapse phase in this cohort. At the same time, this observation illustrates a broader challenge in MS biomarker research, namely that reliance on a

single candidate molecule may not provide adequate diagnostic or prognostic performance. Increasing evidence supports the use of multimodal biomarker panels capable of reflecting the complex and dynamic nature of MS. In this context, integrative strategies combining proteomic, metabolomic, transcriptomic, and epigenetic data may facilitate the identification of more robust molecular signatures for disease characterization, relapse prediction, and treatment monitoring.

An intriguing finding was that the CSF HOXB3 level in IIH was similar with pwMS. IIH is a rare disease in which intracranial pressure is increased in the absence of intracranial pathology and normal cerebrospinal fluid composition (16). The two most prominent symptoms of IIH are papillary oedema and progressive visual impairment resulting from chronic headache. Additional symptoms such as cranial nerve palsies, cognitive disorders, tinnitus and olfactory dysfunction are frequently part of the clinical picture (17). Since CSF sample from healthy individuals can not obtained due to ethical procedures, samples of patients with IIH are generally used a control group in studies (18). However, the accuracy of using IIH as a control group has begun to be discussed in recent studies due to the similar characterization of the some conditions present in IIH such as pericyte degeneration, blood-brain barrier dysfunction, and perivascular aquaporine-4 expression as in chronic degenerative diseases (19-22). This challenges the validity of IIH as a true control group in biomarker studies and underscores the need for alternative disease controls or statistical approaches that adjust for overlapping biological pathways.

In the levels of some biomarkers, variation according to gender is likely to be a situation, however, no study showing the relation of HOXB3 level with gender difference was found in literature. In our study, we observed higher CSF HOXB3 level in female than male. Although they are preliminary, our finding of sex-related differences in HOXB3 levels corroborate the neccessity of specific analyses based on sex and hormone in biomarker research. Sex hormones are increasingly recognized as modulators of immune and neural processes in multiple sclerosis (23,24), and sex-based analyzes may uncover slight yet clinically significant biomarker patterns.

Several limitations are present in this study. We included samples obtained during the relapse period, because of this, our results should be interpreted within the context of acute disease activity. Since samples obtained during the remission period were not analyzed, potential differences in biomarker levels between relapse and remission could not be determined. Longitudinal studies across various disease periods are necessary to clarify potential temporal variations.

The approximately 10-year age difference between the MS and IIH groups causes an important limitation of this study. Age-related biological variability may have impacted the measured biomarker levels independent of disease status. Therefore, age should be considered a potential confounding effect when interpreting the results, and the observed differences should not be attributed only to disease mechanisms.

The relatively small sample size is an another limitation of the study. This situation is related to the limited number of patients presenting to the neurology clinic and the difficulties associated with enrolling newly diagnosed, drug-naïve individuals. As a result, statistical power of the study may be reduced and the generalizability of the findings may be limited. Clinical studies in MS patients are typically conducted in individuals who have already received treatment, and this may causes certain biomarkers undetectable and reduce the reliability of the results (25). Although the relatively small sample size is a limitation, the recruitment of newly diagnosed, drug-naïve MS patients increases the value of the study. CSF samples obtained from drug-naïve individuals provides a more accurate assessment of HOXB3 levels, free from potential confounding effects of prior treatment, and gives a different insight into the molecular profile at the earliest stage of the disease. Longitudinal sampling across both relapse and remission phases with larger cohorts, combined with imaging and clinical assessments in future studies will be critical for fully understanding the temporal dynamics of candidate molecules such as HOXB3.

CONCLUSION

This pilot study provides the methodological baseline for exploring biomarker in MS. Beyond HOXB3 as a biomarker, the data increase the importance of multi-marker strategies, standardized sampling across disease phases, rigorous control group definition, and the consideration of sex-specific effects.

However, because idiopathic intracranial hypertension (IIH) implied the control group, the interpretability of HOXB3 as a differential biomarker is naturally limited. Within the concept of the present study, HOXB3 did not find a differential parameter for RRMS. Accordingly, these findings cannot be generalized for differential diagnosis of MS.

Future investigations incorporating diverse and disease-relevant control populations will be necessary to determine the true diagnostic utility of HOXB3.

Ethical approval

This study has been approved by the Bolu Abant İzzet Baysal University Local Ethical Committee (approval date 03/03/2024, number 2024/29). Written informed consent was obtained from the participants.

Author contribution

Concept: FU; Design: FU; Data Collection or Processing: FU; Analysis or Interpretation: FU; Literature Search: FU; Writing: FU, FB, NH, SAT. All authors reviewed the results and approved the final version of the article.

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Conflict of interest

The authors declare that there is no conflict of interest.

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RESEARCH ARTICLES

Assessment of the effects of chalazion surgery on intraocular pressure measured by Goldmann applanation tonometry

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ABSTRACT

Aim: We aimed to investigate changes in intraocular pressure (IOP) in patients who underwent chalazion surgery, specifically examining the impact of chalazion location, size, and site on the eyelid.

Materials and Methods: Forty eyes with chalazia were included in this prospective study. Chalazia were categorized based on size (Group 1: 3-5 mm; Group 2: >5 mm), location on the eyelid (central, temporal, nasal), and eyelid site (upper, lower). Before surgery, all patients underwent a comprehensive biomicroscopic examination, IOP measurement using both a pneumotonometer and a Goldmann applanation tonometer (GAT), and central corneal thickness (CCT) assessment. All measurements were repeated at the 1-month postoperative follow-up.

Results: Following chalazion surgery, a significant decrease in IOP was observed using both GAT (p=0.001) and pneumotonometry (p=0.035). No statistically significant difference was found between preoperative and postoperative CCT values (p=0.642). In Group 1 (3-5 mm), a significant postoperative decrease in IOP was observed (p=0.021). Furthermore, significant reductions in IOP measurements were noted in the upper eyelid group (p=0.003) and for centrally located chalazia (p=0.016). No significant correlation was found between changes in IOP measurements and changes in CCT.

Conclusion: Chalazia may influence IOP measurements, particularly those obtained via GAT. Therefore, IOP values measured in the presence of a chalazion should be interpreted with caution; repeating measurements after chalazion treatment may provide a more reliable clinical assessment.

Keywords: chalazion, Goldmann applanation tonometer, intraocular pressure, pneumotonometer

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INTRODUCTION

A chalazion is a common, benign lipogranulomatous eyelid lesion that can affect both children and adults (1). As a specific eyelid disease, chalazia are closely associated with meibomian gland dysfunction. The meibomian glands secrete meibum, which reduces tear film evaporation, facilitates ocular surface lubrication, and ensures a smooth optical surface (2). Meibography studies have demonstrated the obstruction of approximately 5-10 meibomian glands at the site of a chalazion (3). Treatment options include medical therapies—such as warm compresses, topical antibiotics, or ointments—as well as surgical incision and curettage, with or without intralesional triamcinolone injection (4). Incision and curettage are considered definitive treatments, although recurrences may occur (5). Chalazion excision surgery has been shown not to exacerbate dry eye disease and can improve both subjective symptoms and objective ocular surface parameters (6).

Chalazia can influence intraocular pressure (IOP) measurements. Several clinical studies have demonstrated that IOP fluctuates following chalazion surgery, exhibiting both downward and upward trends (7,8). Goldmann applanation tonometry (GAT) and pneumotonometry are standard methods for IOP measurement (9). GAT is currently recognized as the gold standard for measuring IOP (10). Pneumotonometry measures IOP using a probe with a small membrane tip that is applied to the cornea via air pressure (11). However, pneumotonometry has been reported as unreliable for measuring central corneal IOP in various ocular diseases (12). Furthermore, IOP measurements obtained via pneumotonometry have shown higher values in the periphery compared to central IOP (13).

This study aimed to investigate changes in IOP following chalazion surgery using both pneumotonometry and GAT, specifically analyzing the effects of chalazion location, size, and position on the eyelid.

MATERIALS AND METHODS

This study prospectively investigated the ocular findings of patients with chalazia who underwent surgical treatment. The study was approved by the Ethics Committee of İstanbul Fatih Sultan Mehmet Education and Research Hospital (No. FSM EAH-KAEK 2022/67) and adhered to the principles of the Declaration of Helsinki. Written informed consent and voluntary assent were obtained from all participants.

Forty patients undergoing chalazion surgery with no ocular diseases other than refractive errors were included. Surgical intervention was indicated for patients whose condition failed to improve after at least one month of standard treatment (bacitracin ophthalmic ointment and loteprednol/tobramycin eye drops). Topical loteprednol therapy was discontinued at least one week prior to baseline IOP measurements to minimize potential steroid-induced effects. Although preoperative short-term topical steroids were part of the standard protocol, no postoperative steroid therapy was administered.

Before surgery, all patients underwent a comprehensive ophthalmologic examination, including best-corrected visual acuity (BCVA) for distance, detailed biomicroscopic evaluation, CCT assessment, and IOP measurement via pneumotonometry and GAT. All tonometric measurements were performed by experienced ophthalmologists using a standardized protocol to minimize interobserver variability. Pneumotonometer measurements and CCT assessments were obtained using the Full Auto Tonometer TX-209 (Canon, Japan). The sequence of tonometric measurements was standardized: pneumotonometry was performed first, followed by GAT after a short interval. All measurements were repeated at the 1-month postoperative follow-up visit. To mitigate the influence of diurnal variation, preoperative and postoperative measurements were performed at approximately the same time of day. To further reduce measurement variability, the mean of at least three consecutive measurements was used for statistical analysis.

Chalazia were measured vertically and horizontally, with the largest diameter recorded (9). The study included chalazia measuring ≥3 mm (14). Lesions measuring 3-5 mm were categorized as Group 1, and those >5 mm as Group 2. Chalazia were further categorized into three groups based on location, central (Group 1), temporal (Group 2), and nasal (Group 3), as described by Park et al. (15). Patients were also assessed by the eyelid site: upper eyelid (Group 1) and lower eyelid (Group 2).

Chalazion excision was performed under local anesthesia using 40 mg/2 mL lidocaine hydrochloride + 0.025 mg/2 mL epinephrine (Lidofast, Vem, Turkey). The procedure involved eversion of the eyelid followed by a vertical incision. The contents and capsule were removed, and pressure was applied to achieve hemostasis. Antibiotic ointment was applied, and the eye was bandaged. Postoperatively, ointment was applied twice daily for five days.

Statistical analysis was conducted using SPSS version 26 (IBM Corp., USA). A significance level of $p < 0.05$ was established. Data normality was assessed using the Shapiro-Wilk test. Non-parametric tests were used to evaluate the effects of groups (size, location, and site) on pre- and postoperative measurement changes. Quantitative data comparisons were performed using the Mann-Whitney U and Wilcoxon tests for non-normally distributed data. IOP changes were calculated as postoperative minus preoperative values (ΔIOP). ΔIOP and ΔCCT were evaluated using Spearman's rank correlation coefficient. Categorical data were compared using the chi-square test.

RESULTS

Forty patients (25 males, 15 females) were included. The mean age was 39.73±15.55 years (range: 18-74 years). Chalazion size was 3-5 mm in 22 patients and >5 mm in 18 patients. In 25 patients, the chalazion was located on the upper eyelid, and in 15 patients, on the lower eyelid. Localization was temporal in 10 patients, central in 22, and nasal in 8. Preoperative and postoperative visual acuity was 20/20 in 18 patients and 20/25 in 2 patients.

The mean IOP measured by pneumotonometry was 14.98±3.19 mmHg preoperatively and 14.45±2.44 mmHg at 1 month postoperatively. The mean IOP measured by GAT was 14.90±2.56 mmHg preoperatively and 13.88±2.58 mmHg postoperatively. Postoperative IOP measured by pneumotonometry was significantly lower than preoperative values (p=0.035), and GAT measurements were also significantly lower (p=0.001).

The mean preoperative CCT was 557.25±33.97 µm, while the mean postoperative value was 555.85±29.84 µm. No statistically significant difference was observed (p=0.642).

Correlation analysis showed no significant association between the change in IOP measured by GAT (ΔIOP-GAT) and the change in CCT (ΔCCT) (Spearman r=−0.19, p=0.235). Similarly, no significant correlation was observed between ΔCCT and ΔIOP measured by pneumotonometry (Spearman r=0.22, p=0.174).

Table 1. Comparison of preoperative and postoperative measurements in two groups stratified according to the size of the chalazion

Measurements	Preoperative	Postoperative	P value
	Size 3-5 mm (Group 1)		
IOP (Pneumotonometry) mmHg	15.68±3.257	14.95±2.751	**0.038**
IOP (GAT) mmHg	15.36±2.555	14.41±2.823	**0.010**
	Size >5 mm (Group 2)		
IOP (Pneumotonometry) mmHg	14.11±2.968	13.83±1.886	0.380
IOP (GAT) mmHg	14.33±2.521	13.22±2.157	**0.021**

IOP: intraocular pressure, GAT: Goldmann applanation tonometer.

Table 1 shows the comparison of measurements stratified by chalazion size. In Group 1, pneumotonometer IOP decreased significantly (p=0.038), whereas no significant difference was found in Group 2 (p=0.38). In both groups, GAT-measured IOP showed a significant postoperative decrease (p=0.01 and p=0.021, respectively).

Table 2 displays measurements categorized by eyelid site. In Group 1 (upper eyelid), significant decreases were observed in both pneumotonometer (p=0.044) and GAT (p=0.003) measurements. In Group 2 (lower eyelid), no significant differences were observed (p > 0.05).

Table 3 presents measurements stratified by location. In Group 1 (central), a significant decrease in GAT-measured IOP was observed (p=0.016). In Group 3 (nasal), a significant decrease in GAT-measured IOP was also observed (p=0.04).

DISCUSSION

In this prospective study, we observed a statistically significant decrease in IOP measurements obtained by both GAT and pneumotonometry following chalazion excision. Notably, this reduction was not accompanied by a significant change in CCT and did not correlate with ΔCCT, suggesting that CCT-related measurement artifacts are unlikely to fully explain the findings. These results suggest that chalazia may influence IOP measurements through mechanical or biomechanical factors related to eyelid-globe interaction. However, as corneal biomechanical parameters were not directly evaluated, these mechanisms should be interpreted cautiously within the context of previous literature.

Table 2. Comparison of preoperative and postoperative measurements in two groups, stratified by the site of the chalazion

Measurements	Preoperative	Postoperative	P value
	Upper Eyelid		
IOP (Pneumotonometry) mmHg	14.63±3.173	13.88±2.271	**0.044**
IOP (GAT) mmHg	14.67±2.681	13.42±2.271	**0.003**
	Lower Eyelid		
IOP (Pneumotonometry) mmHg	16.0±3.063	15.86±2.143	0.572
IOP (GAT) mmHg	15.5±2.41	15.0±2.418	0.141

IOP: intraocular pressure, GAT: Goldmann applanation tonometer.

Table 3. Comparison of preoperative and postoperative measurements in three groups stratified by the location of chalazion

Measurements	Preoperative	Postoperative	P value
	Central		
IOP (Pneumotonometry) mmHg	14.45±3.67	13.86±2.436	0.115
IOP (GAT) mmHg	14.36±2.854	13.36±2.647	**0.016**
	Temporal		
IOP (Pneumotonometry) mmHg	16.3±2.214	16.1±1.853	0.493
IOP (GAT) mmHg	16.2±1.549	15.3±2.452	0.119
	Nasal		
IOP (Pneumotonometry) mmHg	14.75±2.55	14.0±2.39	0.161
IOP (GAT) mmHg	14.75±2.375	13.5±2.138	**0.040**

IOP: intraocular pressure, GAT: Goldmann applanation tonometer.

Given the absence of postoperative steroid therapy and stable CCT values, steroid-induced measurement bias is unlikely.

Ilhan et al. reported a postoperative decrease in IOP using an Ocular Response Analyzer and hypothesized that mechanical pressure from a chalazion could affect anterior chamber configuration and episcleral venous resistance (7). Physiologically, a chalazion is both a localized mass and a chronic inflammatory lesion that may alter eyelid tissue stiffness, orbicularis oculi tone, and blink dynamics. Such changes may generate sustained external compressive forces on the globe, particularly in the superior and central eyelid regions.

External eyelid compression may increase episcleral venous pressure (EVP) by mechanically impeding drainage. Because EVP constitutes the distal pressure of the conventional aqueous humor outflow pathway, subtle elevations in EVP can influence measured IOP without changes in aqueous production. This mechanism provides a plausible explanation for the reversible IOP changes observed after chalazion removal.

Ilhan et al. further emphasized that GAT measurements should be interpreted alongside corneal viscoelastic properties, as variations may reflect biomechanical factors (7). The cornea functions as a biomechanical transducer; increased eyelid pressure may alter corneal deformation during applanation, requiring greater force to achieve the standard applanation area and artificially elevating measured IOP.

Consistent with these considerations, studies have shown that chalazia can induce changes in corneal shape. Bagheri et al. reported significant alterations in refractive error and topography following excision, indicating that eyelid pressure modifies corneal curvature (16). Similarly, Santa Cruz et al. described chalazion-induced hyperopic shifts, and Cosar et al. demonstrated that chalazia may compromise visual outcomes even after refractive surgery (17,18). Recent investigations have shown improvements in corneal aberrations and densitometric parameters post-excision, alongside alterations in meibomian gland morphology (19,20). Experimental evidence confirms that the cornea exhibits viscoelastic behavior and responds dynamically to external forces, providing a basis for how eyelid pressure influences applanation-based IOP measurements (21).

Beyond mechanical factors, chalazia may influence IOP through the ocular surface microenvironment. Guo et al. demonstrated that chalazia are associated with tear film instability and inflammation, which can affect the cornea-tonometer interface (6). Tear film irregularity may modify applanation dynamics; postoperative normalization of the ocular surface may thus contribute to more stable and lower measured IOP values.

A chalazion is increasingly recognized as a chronic disorder. Evans et al. identified factors associated with recurrence and surgical intervention, supporting the concept of sustained tissue remodeling (1). Chronic inflammatory changes may increase eyelid stiffness and alter blink-induced globe compression, thereby modulating EVP. These mechanisms may account for the higher preoperative IOP measurements observed in specific subgroups.

Li et al. reported that chalazia and their treatments can induce persistent structural alterations in the meibomian glands (22). Lipid layer impairment may increase tear film breakup. In our study, the absence of CCT changes supports the interpretation that postoperative IOP differences reflect eyelid- and surface-mediated influences rather than intrinsic corneal structural changes.

Conversely, Ben Simon et al. observed a non-significant increase in IOP after surgery (8). The lack of detailed lesion characteristics in that study limits direct comparison. Variability in size, location, and inflammatory burden may result in heterogeneous degrees of episcleral venous compression, leading to inconsistent findings across studies.

The inclusion of subgroup analyses based on size and location allowed a detailed assessment of factors influencing IOP. Chalazia on the upper eyelid and those with central or nasal localization showed more pronounced postoperative changes. Given their proximity to the limbal episcleral venous network, these findings are consistent with mechanical and venous influences on tonometry.

Limitations include the modest sample size and one-month follow-up, suggesting the findings should be interpreted in an exploratory context. Diurnal variation was not strictly controlled, and corneal biomechanical parameters (e.g., hysteresis) were not assessed. Therefore, biomechanical explanations remain hypothesis-generating. Nevertheless, the prospective design and use of two tonometric techniques enhance the clinical relevance of the findings.

In conclusion, chalazia may influence IOP measurements, particularly those obtained via GAT. Accordingly, IOP values measured in the presence of a chalazion should be interpreted with caution, and reassessment after treatment may improve clinical reliability.

Ethical approval

This study has been approved by the Ethical Committee of İstanbul Fatih Sultan Mehmet Education and Research Hospital (approval date 11/08/2022, number FSMEAH-KAEK 2022/67).

Author contribution

Surgical and Medical Practices: AK, CK, AOY; Concept: AK, SAK; Design: SAK, EA; Data Collection or Processing: AK, CK, AOY; Analysis or Interpretation: AK, SAK; Literature Search: AK, EA; Writing: AK, SAK. All authors reviewed the results and approved the final version of the article.

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Conflict of interest

The authors declare that there is no conflict of interest.

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