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Evaluation of Knowledge, Attitudes and Behaviors Regarding Foot Care in Patients Diagnosed with Type 2 Diabetes Who Applied to A Family Health Center

Aile Sağlığı Merkezine Başvuran Tip 2 Diyabet Tanısı Almış Hastaların Ayak Bakımı Hakkında Bilgi, Tutum ve Davranışlarının Değerlendirilmesi

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ABSTRACT

Objective: Diabetic foot ulcers are one of the most common causes of non-traumatic lower extremity amputations. This complication can be prevented by providing diabetes patients with the right information and attitude about foot health and by providing appropriate diagnosis, treatment and follow-up. The aim of the study is to evaluate the foot health, knowledge, attitudes and behaviors of patients with type 2 diabetes mellitus (DM) who applied to a family health center regarding diabetic foot.

Material and Methods: The study was cross-sectional in nature and conducted with 382 type 2 DM patients. Participants are type 2 DM patients who applied to the Adana Yüreğir Afetevleri Family Health Center for any reason. In the research, the participants were interviewed face-to-face and the questions in the diabetes foot self-care behavior scale and the questions evaluating the participants' socio-demographic and clinical situations were answered.

Results: The average age of the participants was 60±11, 52.1% of the participants were women, and 69.1% of the participants had at most primary school education. According to the diabetes foot self-care behavior scale in the study, the participants were 73.11% successful in diabetic foot self-care. While young patients and women were more successful in diabetic foot self-care, patients who had diabetic foot ulcers at some point in their lives were found to be less successful (p=0.004). Apart from this, no relationship was found between the type of medication used, family characteristics, income status, presence of non-DM diseases, frequency of DM control and diabetic foot self-care.

Conclusion: Participants did not have the desired level of knowledge regarding diabetic foot self-care. This condition was negatively affecting the diabetic foot self-care behavior. For this purpose, we think that blood sugar regulation can be achieved with appropriate treatments for the individual, regular health checks and frequent patient education can be provided, and diabetic foot self-care can be increased.

Keywords: Type 2 diabetes, diabetic foot, self-care, family health center

ÖZ

Giriş: Non-travmatik alt ekstremite ampütasyonlarının sık karşılaşılan sebeplerinin başında diyabetik ayak ülserleri gelmektedir. Diyabetli hastaların ayak sağlığı konusundaki doğru bilgi ve tutumu; buna bağlı olarak uygun tanı, tedavi ve takibin sağlanması ile bu komplikasyonun önüne geçilebilir. Araştırmanın amacı bir aile sağlığı merkezine başvuran tip 2 diabetes mellituslu (DM) hastaların ayak sağlığını, diyabetik ayak konusundaki bilgi, tutum ve davranışlarını değerlendirmektir.

Gereç ve Yöntemler: Araştırma kesitsel nitelikte olup 382 tip 2 DM'li hasta ile yürütülmüştür. Katılımcılar Adana Yüreğir Afetevleri Aile Sağlığı Merkezi 01.01.2025-30.04.2025 tarihleri arasında herhangi bir sebeple başvurmuş olan tip 2 DM hastalarıdır. Araştırmada katılımcılarla yüz yüze görüşülmüş, diyabetik ayakta öz bakım davranışı ölçeğindeki sorular ile katılımcıların sosyo-demografik ve klinik durumlarını değerlendiren sorular cevaplanmıştır.

Bulgular: Katılımcıların ortalama yaşı 60±11 idi, %52,1 katılımcı kadındı, %69,1 katılımcı en fazla ilkokula gitmişti. Araştırmada diyabetik ayakta öz bakım davranışı ölçeğine göre katılımcılar diyabetik ayak öz bakımında %73,11 oranında başarılıydılar. Genç hastalar ve kadınlar

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ÖZ

diyabetik ayak öz bakımında daha başarılıyken kendisinde yaşamının bir döneminde diyabetik ayak yarası olan hastalar daha başarısız bulundular (p=0,004). Bunun dışında kullanılan ilaç türü, aile özellikleri, gelir durumu, DM dışı hastalık varlığı, DM kontrol sıklığı ile diyabetik ayak öz bakımı arasında ilişki bulunamadı.

Sonuç: Diyabetik ayak öz bakımı konusunda katılımcılar istenilen seviyede bilgili değillerdi. Bu durum diabetik ayak öz bakım davranışını olumsuz etkilemekteydi. Bu amaçla kişiye uygun tedavilerle kan şekeri regülasyonunu sağlanması, düzenli sağlık kontrolleri ve sık tekrarlayan hasta eğitimleri yapılabilir, diyabetik ayak öz bakımının artırılması sağlanabilir düşüncesindeyiz.

Anahtar Kelimeler: Tip 2 diyabet, diyabetik ayak, öz-bakım, aile sağlığı merkezi

INTRODUCTION

According to World Health Organization data, at least 43 million people worldwide died from non-communicable diseases in 2021. At least two million of these deaths were attributed to diabetes-related causes (1).

Diabetes mellitus (DM) constitutes a significant public health challenge due to its prevalence, associated complications, and the burden of comorbid diseases. The prevalence of DM is rising rapidly; according to the International Diabetes Federation there were 463 million people living with diabetes in 2019, a figure projected to reach 700 million by 2045 (2).

This increase is particularly pronounced in low-to-middle-income countries. A similar upward trend observed in Türkiye reinforces the necessity for preventive education and monitoring in primary care settings (2-4).

Peripheral vascular disease and DM-related wounds are the leading causes of non-traumatic lower-extremity amputations. However, achieving glycemic control in the early stages and providing patients with appropriate diabetes education may help reduce the incidence of diabetic foot cases (5).

Family health centers are the healthcare facilities most accessible to patients, where they can receive medical care for all health concerns (6). Therefore, it is of vital importance to perform standardized foot examinations for diabetic patients in family medicine practices and to inform patients about foot care (7). Screening appropriate patients with DM wounds at family health centers can help many patients receive an early diagnosis.

This study aims to evaluate foot health and the knowledge, attitudes, and behaviors regarding diabetic foot care among patients with type 2 DM presenting to a family health center.

MATERIALS and METHODS

This cross-sectional study was conducted with 382 patients diagnosed with type 2 DM. The sample size was calculated to be 384, assuming a 50% prevalence of adequate foot care, a 5% margin of error, and a 95% confidence level; 99.45% of the targeted sample size was reached.

Participants were patients with type 2 DM who presented to Adana Yüreğir Afetevleri Family Health Center for any reason between January 1, 2025, and April 30, 2025. Inclusion criteria were: A known diagnosis of type 2 DM; presentation to the specified family health center within the designated dates; age 18 years or older; and provision of written and verbal informed consent to participate in the study. Individuals who did not meet one or more of these criteria were excluded.

Data were collected through face-to-face interviews, during which participants completed the diabetes foot self-care behavior scale (DFSBS) along with a questionnaire regarding their socio-demographic and clinical characteristics. The DFSBS was developed by Chin and Huang (8); it is a 5-point Likert-type scale consisting of seven items across two subdimensions. Total scores range from 7 to 35; higher scores indicate better self-care behaviors. The Turkish adaptation and psychometric evaluation of the scale were performed by Bakır and Samancıoğlu Bağlama (9). Permission to use the scale was obtained by email from the authors of the Turkish validity and reliability study. The items of the DFSBS are as follows:

1. I examine the soles of my feet.
2. I examine the interdigital spaces of my toes.
3. I wash between my toes.
4. I dry between my toes after washing.
5. If my skin is dry, I apply a moisturizing lotion to my feet.
6. Before putting on my shoes, I check the inside of each shoe.
7. I gradually break in new shoes.

Ethical approval for the research was obtained from the University of Health Sciences Türkiye, Adana City Training and Research Hospital Scientific Research Ethics Committee, dated December 5, 2024, with protocol/approval number 254. Verbal and written informed consent was obtained from all patients.

Statistical Analysis

IBM SPSS Statistics version 30.0 was used for data analysis. Statistical significance was set at $p<0.05$. Descriptive statistics were expressed as frequency, percentage, mean, median, standard deviation, minimum, maximum, and range. Normality of the data distribution was assessed using the Kolmogorov-Smirnov test. Categorical variables were evaluated using chi-square and Fisher's exact tests, while numerical variables were analyzed using the Mann-Whitney U test.

RESULTS

In our study, participants ranged in age from 22 to 92 years, with a mean age of 60±11 years; 52.1% (n=199) were female and 47.9% (n=183) were male. Educational attainment was generally low, with primary school graduates and those with no formal schooling accounting for 69.1% (n=264) of

the population. For 94.5% of the participants, income was less than or equal to their expenditures. Regarding living arrangements, 88.5% lived with their families, while 11.5% lived alone.

Participants reported attending physician examinations for diabetes-related reasons once every 5±3 months on average, with a range of 1 to 12 months.

The duration of type 2 DM ranged from 1 to 40 years. Obesity was prevalent among the evaluated individuals, with a mean body mass index of 30.40±4.84.

Selected diabetes-related data of the participants are presented in Table 1.

The status of regular antidiabetic medication use among participants was compared across gender, age, and presence of DM wounds. The results are shown in Table 2.

Participants' total scores from the scale ranged from a minimum of 7 to a maximum of 35, with a mean score of 25.59±6.2 and an overall success rate of 73.11%. The distribution, mean, and standard deviation of responses to individual items are presented in Table 3.

The Cronbach's alpha for the "DFSBS" was 0.758. As shown in Table 3, participants most frequently performed "washing between the toes", while the least frequently performed behavior in the case of dry skin was "applying moisturizing lotion to the feet".

Table 1. Selected DM data of the participants

		Frequency	Percent
Presence of chronic diseases other than DM	No	135	35.3%
	Yes	247	64.7%
DM drug use	OAD only	303	79.3%
	Insulin only	42	11.0%
	No medication used	6	1.6%
	OAD and insulin	31	8.1%
Regular use of DM medication	Doesn't use it regularly	44	11.5%
	Uses it regularly	338	88.5%
Dietary adjustments due to DM	No	92	24.1%
	Yes	290	75.9%
Has anyone in your family/close circle had DM wounds?	No	297	77.7%
	Yes	85	22.3%
History of diabetic foot amputation in family/close social circle	No	344	90.1%
	Yes	38	9.9%
Presence of DM wounds	No	359	94.0%
	Yes	23	6.0%
Current active DM wound?	No	364	95.3%
	Yes	18	4.7%

DM: Diabetes mellitus, OAD: Oral antidiabetic drugs

Regarding smoking habits, 100 participants (26.17%) were smokers, while 282 participants (73.82%) were non-smokers. No statistically significant relationship was found between smoking status and foot care scores (p=0.323).

Furthermore, no statistically significant correlation was observed between time since diabetes diagnosis and foot care scores in diabetic patients (p=0.092).

Among diabetic patients, female participants scored higher than male participants on foot inspection scores, and younger participants scored higher than older participants. However, the result is not statistically significant. The distribution is presented in Table 4.

Having an individual with a DM wound in the person's family or social circle, or having a history of diabetes-related amputation in the family or social circle, was not associated with foot care scores (p=0.995 and p=0.811, respectively).

In contrast, the results varied with respect to the presence of a personal history of DM wounds. Participants who had never experienced a DM wound in their lifetime scored a total of 25.79±6.08, while those with a history of DM wounds (n=23, 6.02%) scored a total of 22.3±7.18. The relationship between these groups, shown in Table 5, was statistically significant (p=0.020). Additionally, the distribution of the participants' scores is provided in Table 5.

At the time of the study, 18 participants (4.71%) had active DM wounds. These individuals scored a total of 20.77±7.20, whereas those without an active DM wound scored a total of 25.82±6.05 (p=0.004). The score distribution of the participants is shown in Table 6.

The high prevalence of active diabetic wounds (4.71%) and lifetime history of diabetic wounds (6.02%) are noteworthy. These rates indicate that DM wounds constitute a serious public health problem.

When participants were categorized into three groups based on income (income less than expenses, equal to expenses, and greater than expenses), no statistically significant relationship was found between income status and diabetic foot care scores (p=0.727).

Similarly, when family type was categorized as nuclear family, extended family, or living alone, there was no statistically significant relationship between family type and diabetic foot care scores (p=0.187).

Participants were also divided into three groups based on the medications used for type 2 DM: Those using oral antidiabetics only, those using insulin only, and those using a combination of oral antidiabetics and insulin. No statistically significant relationship was observed between the type of medication used and diabetic foot care scores (p=0.246).

Various socio-demographic characteristics of the participants were compared with their foot care scores. Foot care scores were higher among participants with higher education levels, those who used their medications regularly, those who adhered to a diabetic diet, and those who underwent

Table 2. Evaluation of regular antidiabetic medication adherence among participants				
		Does the patient take their diabetes medication regularly?		
Variable	Category	No	Yes	p*
Gender	Male	21 (11.5%)	162 (88.5%)	1.000
	Female	23 (11.6%)	176 (88.4%)	
Age	<65	22 (11.2%)	174 (88.8%)	0.981
	⩾65	22 (11.8%)	164 (88.2%)	
Presence of DM wound	Yes	10 (43.5%)	13 (56.5%)	**0.004**
	No	34 (9.5%)	325 (90.5%)	
*: Fisher's exact test, DM: Diabetes mellitus				

Table 3. Distribution of scores and items of the diabetes foot self-care behavior scale		
Scale questions	Mean	Standard deviation
1. I inspect the bottoms of my feet.	3.94	1.30
2. I inspect between my toes.	4.02	1.22
3. I wash between my toes.	4.26	1.09
4. I dry between my toes after washing.	3.86	1.41
5. If my skin is dry, I apply moisturizing lotion to my feet.	2.86	1.61
6. Before putting on my shoes, I check the inside of my shoes.	3.28	1.51
7. I break in new shoes gradually.	3.35	1.45

Table 4. Comparison of total foot scale scores by gender and age					
Variable	Category	Minimum score	Maximum score	Mean ± standard deviation	p*
Gender	Female	7	35	26.23±6.38	0.011
	Male	10	35	24.89±5.92	
Age	<65	9	35	25.67±6.10	0.791
	⩾65	7	35	25.44±6.37	
*: Mann Whitney U test					

regular health check-ups for DM. The median and p-values are presented in Table 7.

DISCUSSION

In our study, participants demonstrated a 73.11% success rate on the DFSBS. Although this rate may appear high, it remains below expectations, considering that all participants were patients with type 2 DM receiving active treatment and attending regular medical follow-ups.

The study included 382 patients with type 2 DM, of whom 18 (4.71%) had active DM wounds. Additionally, five patients had a history of resolved diabetic foot lesions. Globally, 18.6 million people are affected by DM wounds annually, and approximately 20% of these cases result in amputation (10). It is crucial for healthcare professionals to maintain awareness of DM wounds; patients with DM should undergo a foot examination by a physician or podiatrist at least once a year (11). In this study, participants reported attending diabetes-related health check-ups at an average interval of five months (range, 1-12 months). Regular foot examinations at every visit, regardless of follow-up frequency, could help minimize gaps in care.

According to our research results, the rate of regular antidiabetic medication use among participants was 88.5%. This result was based on the participants' self-reports. While this indicates a positive outlook, it should be noted that self-report scales may overestimate adherence due to recall and social desirability biases (12,13).

While no significant differences were found between genders or among age groups regarding regular use of DM medications, adherence was significantly lower in those with active DM wounds (p=0.004). This finding is consistent with studies showing no significant gender-based differences in medication adherence and research reporting a weak or insignificant relationship between age and adherence (14,15). Furthermore, it aligns with literature indicating that treatment non-adherence and irregular medication use in patients with DM wounds or infections can delay healing (16,17).

In our study, when the distribution of total scale scores was examined according to various participant characteristics, no

Table 5. Analysis of diabetes foot self-care behavior scale scores between participants with and without a history of DM wounds				
Those who have never had DM wounds	**N**	**Mean****	**Std. deviation****	**p***
Item 1	359	3.98	1.29	0.020
Item 2	359	4.05	1.21	
Item 3	359	4.29	1.07	
Item 4	359	3.89	1.41	
Item 5	359	2.89	1.62	
Item 6	359	3.30	1.52	
Item 7	359	3.37	1.46	
Total	**359**	**25.79**	**6.08**	
Those who have had DM wounds at some point in their lives	**N**	**Mean****	**Std. deviation****	
Item 1	23	3.26	1.35	
Item 2	23	3.60	1.33	
Item 3	23	3.73	1.28	
Item 4	23	3.39	1.37	
Item 5	23	2.43	1.30	
Item 6	23	2.86	1.32	
Item 7	23	3.00	1.31	
Total	**23**	**22.30**	**7.18**	

*: The mean total scores obtained from the diabetic foot self-care behavior scale were compared between participants who had and did not have diabetes mellitus (DM) wounds at some point in their lives. The Mann-Whitney U test was used, **: Data were divided into two groups using the split-file method: Those who had experienced DM wounds at some point in their lives and those who did not. The scores obtained by the participants from the diabetic foot self-care behavior scale were calculated as mean ± standard deviation

significant differences were found based on smoking status, family or social DM-related wounds or amputation, or duration since diagnosis. In contrast, scale scores were significantly lower among individuals with active or prior DM wounds. This decline in scale scores likely reflects inadequacies in foot-care-related knowledge and self-care behaviors, or psychosocial factors such as concomitant burnout. Current guidelines recommend an integrative prevention approach for individuals at risk of ulceration, comprising structured education, appropriate footwear, and professional foot care; it has been shown that isolated, limited educational interventions do not always reduce hard clinical outcomes (18-21). Conversely, according to the findings of the team in Taiwan that developed the diabetic foot care scale, patients who had experienced a DM wound at some point in their lives scored higher than those who had never had one (8). It is estimated that patients with a history of DM-related wounds in that sample group gained access to the aforementioned integrative prevention approach.

Furthermore, a systematic review of 11 studies on DM wounds reports that short-term foot care education alone positively influences patient knowledge and behaviors in the short term but is ineffective in preventing DM wounds (20). However, it has been reported that structured, integrated, and repetitive education, achieving glycemic control, and regular patient follow-up can prevent diabetic foot pathologies (20). These results are consistent with our findings.

As in our research, the study by Bakır and Samancıoğlu Bağlama (9) found that the item with the most correct responses was "I wash between my toes", while the item with the most incorrect responses was "If my skin is dry, I apply moisturizing lotion to my feet". The high rate of washing between the toes observed in both studies is estimated to be attributable to socially accepted hygiene standards and the participants' religious beliefs. Additionally, providing education on all foot self-care behaviors, especially for those in high-risk groups, may help increase these rates.

In our study, the rate of inspection of the soles of the feet was slightly higher among women and younger participants. This is consistent with findings in the literature reporting that plantar inspection is somewhat more frequent in women and that the relationship with age is weak/unstable, while the relationship with DM duration remains inconsistent (21,22).

Our DM wound prevalence is close to the global prevalence (23), and due to the high lifetime risk (19-34%) emphasized by the International Working Group on the Diabetic Foot, primary prevention and early risk screening must remain clinical priorities (18).

Table 6. Analysis of diabetes foot self-care behavior scale scores between participants with and without active DM wounds					
Those without existing DM wounds		**N**	**Mean****	**Std. deviation****	**p***
	Item 1	364	3.98	1.29	
	Item 2	364	4.06	1.21	
	Item 3	364	4.30	1.07	
	Item 4	364	3.90	1.41	
	Item 5	364	2.87	1.63	
	Item 6	364	3.31	1.52	
	Item 7	364	3.37	1.46	
	Total	**364**	**25.82**	**6.05**	
Those with existing DM wounds		**N**	**Mean****	**Std. deviation****	0.004
	Item 1	18	3.11	1.36	
	Item 2	18	3.22	1.30	
	Item 3	18	3.44	1.29	
	Item 4	18	3.00	1.28	
	Item 5	18	2.55	1.24	
	Item 6	18	2.55	1.14	
	Item 7	18	2.88	1.32	
	Total	**18**	**20.77**	**7.20**	

*: The mean total scores obtained from the diabetic foot self-care behavior scale were compared between participants who currently had diabetes mellitus (DM) wounds and those who did not. The Mann-Whitney U test was used, **: Data were divided into two groups using the split-file method: Those with and without existing DM wounds. The average scores obtained by the participants from the diabetic foot self-care behavior scale were calculated separately and as a total

Table 7. Comparison of median total diabetes foot self-care behavior scale scores according to selected socio-demographic and clinical characteristics			
Variable		**Median**	**p***
Education	Primary school and below	26	0.054
	Middle school and above	28	
Employment status	Employed	27	0.239
	Unemployed	27	
Presence of chronic diseases other than DM	Yes	27	0.491
	No	27	
Using DM medication regularly	Use regularly	27	0.053
	Doesn't use regularly	26	
Making dietary adjustments	Regular nutrition	27	0.006
	Not regular nutrition	25.5	
DM control frequency	The patient goes for regular diabetes checkups.	27	0.015
	The patient does not go for regular diabetes check-ups.	25	

*: Mann-Whitney U test, DM: Diabetes mellitus

Study Limitations

The limitations of this study include its single-center design, its sample size of 382, and its cross-sectional nature. A single-center design limits generalizability; self-reported data may be subject to social desirability bias; a cross-sectional design precludes causal inference. The results cannot be generalized to the entire population; therefore, further studies are needed to draw broader conclusions on this subject.

CONCLUSION

Several factors influencing diabetic foot self-care were identified in this study. Rates of diabetic foot self-care behaviors were higher among younger patients, patients with higher education levels, female patients, and patients with better medication adherence and dietary compliance.

Furthermore, patients with a history of DM wounds had significantly lower rates of self-care behaviors.

To reduce diabetic foot complications, we believe increasing the frequency of health check-ups would be beneficial, particularly for high-risk diabetic patients—specifically those who are of advanced age, have lower education levels, poor dietary compliance, and/or medication adherence issues.

Additionally, it may be beneficial for physicians to perform a foot examination at least once a year for every diabetic patient who presents to family health centers, and to provide education on diabetic foot self-care behaviors at every visit. In addition, patients with a history of DM wounds and poor medication adherence may be evaluated more frequently.

Ethics

Ethics Committee Approval: Ethical approval for the research was obtained from the University of Health Sciences Türkiye, Adana City Training and Research Hospital Scientific Research Ethics Committee, dated December 5, 2024, with protocol/approval number 254.

Informed Consent: Verbal and written informed consent was obtained from all patients.

Footnotes

The article was written as a thesis on the salvation of Hasan Gürsel Ulusoy (2025, University of Health Sciences Türkiye, Adana City Training and Research Hospital).

Authorship Contributions

Concept: H.G.U., H.H.K., Z.A., Design: H.G.U., H.H.K., Z.A., Data Collection or Processing: H.G.U., H.H.K., Z.A., Analysis or Interpretation: H.G.U., H.H.K., Z.A., Literature Search: H.G.U., H.H.K., Z.A., Writing: H.G.U., H.H.K., Z.A.

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9

Evaluation of Nutritional Status and Associated Factors in Patients Receiving Nutritional Support in Home Health Care Units

Evde Sağlık Biriminde Nütrisyon Desteği Alan Hastaların Nütrisyonel Durum ve İlişkili Faktörlerinin Değerlendirilmesi

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ABSTRACT

Objective: To identify the socio-demographic characteristics, clinical parameters, and factors influencing the nutritional status of patients receiving nutritional support under the supervision of a home health care unit.

Material and Methods: A retrospective cross-sectional study was conducted among patients followed by the Home Health Care Unit of University of Health Sciences Türkiye, Adana City Training and Research Hospital, in 2022. Demographic data, mini nutritional assessment (MNA) scores, Braden scale results, and clinical and laboratory findings were recorded. Normality was evaluated using skewness and kurtosis coefficients. Statistical analyses included parametric and non-parametric tests, correlation analyses, and multiple linear regression. Statistical significance was defined as $p<0.05$.

Results: A total of 189 patients were included; 60.9% were female, with a mean age of 71.32±22.37 years. Hypertension was the most prevalent comorbidity (56.1%), followed by dementia/depression (54.5%). The mean MNA score was 13.9±4.12, and 91.5% of patients were orally fed. A statistically significant positive correlation was observed between triglyceride levels and MNA score ($r=0.20$, $p=0.012$). Female patients exhibited significantly higher MNA scores than male patients ($p=0.019$). No significant correlation was identified between MNA score and caloric intake or between MNA score and other biochemical parameters.

Conclusion: Among patients receiving nutritional support under the supervision of a home health care unit, psychological disturbances, nasogastric tube feeding, and fall risk were associated with malnutrition. The observed positive correlation between triglyceride levels and MNA score indicates that lipid metabolism may serve as a marker of nutritional status in this population. Regular monitoring of nutritional status by family physicians and home health care units is recommended.

Keywords: Malnutrition, nutritional support, home care services

ÖZ

Giriş: Bu çalışmada, evde sağlık birimi tarafından takip edilen ve nütrisyon desteği alan hastaların sosyo-demografik özellikleri, klinik parametreleri ve nütrisyonla durumlarını etkileyen faktörlerin belirlenmesi amaçlanmıştır.

Gereç ve Yöntemler: Çalışma, Sağlık Bilimleri Üniversitesi, Adana Şehir Eğitim ve Araştırma Hastanesi Evde Sağlık Birimi tarafından 2022 yılında takip edilen hastalar üzerinde retrospektif ve kesitsel tasarımda gerçekleştirilmiştir. Hastaların demografik verileri, mini nütrisyon değerlendirmesi (MNA) skoru, Braden skalası, klinik ve laboratuvar bulguları kayıt altına alınmıştır. Verilerin istatistiksel analizinde normallik değerlendirmesi çarpıklık-basıklık katsayılarıyla yapılmış; parametrik ve parametrik olmayan testler, korelasyon analizleri ve çoklu doğrusal regresyon analizi kullanılmıştır. İstatistiksel anlamlılık sınırı $p<0,05$ olarak belirlenmiştir.

Bulgular: Çalışmaya 189 hasta dahil edilmiş olup hastaların %60,9'u kadın, yaş ortalaması 71,32±22,37 yıldır. En sık gözlenen komorbidite hipertansiyon (%56,1) olurken, bunu demans/depresyon (%54,5) izlemiştir. Hastaların ortalama MNA skoru 13,9±4,12 olarak saptanmış olup hastaların %91,5'i oral yolla beslenmekteydi. Trigliserid düzeyi ile MNA skoru arasında anlamlı pozitif korelasyon saptanmıştır ($r=0,20$, $p=0,012$). Kadın hastaların MNA skoru erkeklere göre anlamlı düzeyde yüksek bulunmuştur ($p=0,019$). Kalori alımı ve diğer biyokimyasal parametreler ile MNA skoru arasında anlamlı bir ilişki saptanmamıştır.

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ÖZ

Sonuç: Evde sağlık birimi tarafından takip edilen nütrisyon desteği alan hastalarda psikolojik bozukluk, nazogastrik tüp ile beslenme ve düşme riski varlığının malnütrisyon ile ilişkili olduğu saptanmıştır. Trigliserid düzeyinin MNA skoru ile pozitif korelasyon göstermesi, bu hasta grubunda lipid metabolizmasının nütrisyonla durumun bir yansıması olabileceğine işaret etmektedir. Evde bakım hastalarının nütrisyonla durumlarının aile hekimi ve evde sağlık birimi tarafından düzenli olarak izlenmesi ve gerektiğinde müdahale edilmesi önerilmektedir.
Anahtar Kelimeler: Malnütrisyon, nütrisyon desteği, evde sağlık hizmetleri

INTRODUCTION

Malnutrition is a clinical syndrome characterized by impaired body composition, decline in physical and mental functions, and increased morbidity and mortality due to inadequate or unbalanced nutrition as well as increased catabolic processes (1). Elderly individuals, those with chronic diseases, those with immobility problems, and patients requiring high levels of care are at high risk for malnutrition (2,3).

According to data from many studies, malnutrition is detected in approximately 30-50% of hospitalized adults worldwide, and this rate is even higher in patients receiving home care services (4,5). Malnutrition prolongs hospital stays, increases the risk of infection, delays wound healing, and significantly reduces overall quality of life (2-5).

In Türkiye, nutritional products constitute a significant portion of total drug expenditures (6). Nutritional supplements are among the most frequently prescribed medications by number of boxes, and these products are quite expensive (6). To use health resources effectively and in a balanced manner, family physicians and home health care units should exercise caution and selectivity when prescribing nutritional support. To prevent unnecessary or inadequate use of nutritional support, it is crucial to evaluate patients' nutritional status using accurate, objective methods. In primary care settings, lifestyle interventions led by family physicians have been shown to improve nutritional status and health outcomes in individuals (7).

Home health care units are an important health service model that provide care for patients who need follow-up care in their homes due to chronic diseases, advanced age, immobility, or cognitive impairment. In this patient population, the risk of malnutrition is elevated by several factors, including dysphagia, decreased appetite, polypharmacy, depression, dementia, immobility, and social isolation (8). However, retrospective or prospective studies that systematically evaluate nutritional status and that identify the demographic and clinical characteristics of patients receiving home health care and nutritional support in our country are limited. In the literature, the prevalence of malnutrition or risk of malnutrition in home care patients ranges from 20-70%, and low levels of hemoglobin, iron, vitamin B12, and folate are frequently observed (9,10).

In this study, we aimed to evaluate, using the mini nutritional assessment (MNA) score, the nutritional status of patients receiving nutritional support from a home health care unit and to identify the demographic, clinical, and laboratory factors associated with malnutrition in this population.

MATERIALS and METHODS

This study was designed as a retrospective cross-sectional study. The study was initiated after receiving ethical approval from the Ethics Committee of University of Health Sciences Türkiye, Adana City Training and Research Hospital (decision number: 2365, dated: 12.01.2023). The study population consisted of 343 patients who were followed up by the Home Health Care Unit of University of Health Sciences Türkiye, Adana City Training and Research Hospital and who received nutritional support in 2022. Informed consent was not required because the study used only aggregated institutional data and did not involve direct patient contact or identifiable information. The sample size was calculated to be 181 using the Epi-Info statistical program, with a 95% confidence interval, a 5% margin of error, and 80% power. However, after considering data integrity and accessibility, 189 patients were included in the study. There were no age or gender restrictions.

Inclusion Criteria

• Patients followed up by the Home Health Care Unit of University of Health Sciences Türkiye, Adana City Training and Research Hospital in 2022,

• Patients who had been receiving nutritional support (oral, enteral, or parenteral) for at least one month.

Exclusion Criteria

• Patients followed up outside of 2022,

• Patients with missing or inaccessible records in the data form.

Demographic characteristics (age, gender, marital status, education level), comorbidities (hypertension, diabetes, dementia, etc.), feeding method [oral, nasogastric (NG) tube, a percutaneous endoscopic gastrostomy (PEG), parenteral], MNA score, Braden score (bedsore risk assessment), anthropometric measurements (height, weight, body mass index), and laboratory parameters (hemogram, biochemistry, lipid profile, etc.) were recorded by the researcher from the patients' files using a standard data collection form.

The MNA scale (11), used to evaluate the nutritional status of patients, is a valid and reliable screening tool consisting of 18 questions and evaluated out of a total of 30 points, and a short form is also available (⩽17 points → Malnutrition, 17-23.5 points → Risk of malnutrition, ⩾24 points → Normal nutritional status).

The risk of developing bedsores (pressure ulcers) was assessed using the Braden score. The Braden score is a risk assessment tool with high validity and reliability, developed

by Bergstrom et al. (12). The Turkish validity and reliability of the Braden scale was established by Pınar and Oğuz (13), and it has been widely used in Turkish clinical settings since then. The score consists of 6 sub-parameters. Each parameter is evaluated on a scale of 1 to 4 points. The total score ranges from 6 to 23 (≤18 points → Risk of bedsores, ≤16 points → Moderate-high risk, ≤12 points → Very high risk).

Statistical Analysis

Statistical analysis of the data was performed using SPSS 23.0 (Statistical Package for the Social Sciences). Continuous variables are presented as mean ± standard deviation or median (minimum-maximum), and categorical variables are presented as numbers (percentages). The Student's t-test, Mann-Whitney U test, chi-square test, and Fisher's exact test were used for intergroup comparisons. Pearson or Spearman correlation tests were used to assess correlations, and multiple linear regression was applied to determine the effects of independent variables on the MNA score. Statistical significance was set at $p<0.05$. Because some laboratory parameters and assessment scores were unavailable for some patients due to the retrospective nature of the study, analyses were performed using the available data for each variable. The number of patients included in each analysis is specified in the relevant tables.

RESULTS

In this study, 189 patients who were followed by the home health care unit and who received nutritional support were evaluated. 60.8% (n=115) of the patients were female, and 39.2% (n=74) were male, with an average age of 71.32±22.37 years (Table 1). The majority of patients (91.5%) were fed orally, while the remainder were fed via a NG tube or via a PEG tube.

When the distribution of comorbidities among patients was examined, hypertension was the most frequent comorbidity (56.1%). This was followed by dementia or depression (54.5%), musculoskeletal diseases (42.3%), coronary artery disease (39.2%), diabetes mellitus (37%), and cerebrovascular events (36%). When the patients' biochemical and hematological parameters were examined, the mean hemoglobin level was 11.8±2.1 g/dL, and the mean albumin level was 3.6±0.6 g/dL. Prealbumin level was 18.4±7.2 mg/dL, and C-reactive protein, an indicator of inflammation, was found to be 12.6±18.4 mg/L on average.

Table 1. Clinical characteristics of the participants

Characteristics				n	%
Psychological status					
Normal				18	9.5
Apathetic				97	51.3
Sad				52	27.5
Anxious/tense				22	11.6
Feeding route					
Self-feeding				173	91.5
Fully dependent (nasogastric tube)				12	6.3
Fully dependent (PEG)				4	2.2
Edema					
Absent				159	84.1
Present				30	15.9
Fall risk				164	86.8
Pressure ulcer				29	15.3
Level of nutritional support					
Balanced				127	67.2
High energy				62	32.8
Special nutritional formula					
Diabetes-specific				38	20.1
Severe metabolic stress				11	5.8
Parameter	**n**	**Minimum**	**Maximum**	**Mean**	**SD**
MNA score	169	3	25	13.9	4.12
Braden scale	153	6	22	15.78	3.2

MNA: Mini nutritional assessment, SD: Standard deviation, PEG: Percutaneous endoscopic gastrostomy

When metabolic parameters were evaluated, the mean glucose level was 118.5±42.3 mg/dL, blood urea nitrogen (BUN) was 28.4±14.7 mg/dL, and creatinine was 1.12±0.68 mg/dL. When the lipid profile was examined, triglyceride (TG) levels were 148.7±72.5 mg/dL, total cholesterol 168.4±45.2 mg/dL, and LDL cholesterol 98.6±32.1 mg/dL. The mean white blood cell count was found to be 7.8±3.1×10³/μL. Overall, mild anemia and moderate inflammation were observed in the patient group, and the nutritional indicators albumin and prealbumin were borderline (Table 2).

The nutritional status of the patients was assessed using the mini nutrition assessment (MNA) score, with an average MNA score of 13.9±4.12. Female patients had significantly higher MNA scores than male patients. Significantly lower MNA scores were found in patients with restlessness or anxiety, patients fed via NG tube, and patients at risk of falls.

When the relationship between laboratory parameters and nutritional status was evaluated, a significant positive correlation was found between TG levels and the MNA score. In contrast, no significant relationship was found between calorie intake and other biochemical parameters, including albumin, hemoglobin, BUN, and creatinine. The risk of pressure ulcers was assessed using the Braden score, with an average score of 15.78±3.2. Among patients, 15.3% had pressure ulcers. Furthermore, psychological disorders, insomnia, and nutritional dependency were observed more frequently in patients with a high risk of malnutrition.

Multiple linear regression analysis revealed no statistically significant independent predictors of MNA score among the variables examined (Table 3).

Table 2. Distribution of biochemical and hematological parameters of the participants

Parameter	n	Mean ± SD	Median (min-max)
Hemoglobin (g/dL)	189	11.8±2.1	11.9 (7.2-16.4)
Albumin (g/dL)	178	3.6±0.6	3.7 (2.1-4.8)
Prealbumin (mg/dL)	112	18.4±7.2	17.5 (6.0-38.0)
CRP (mg/L)	165	12.6±18.4	6.5 (0.5-112.0)
Glucose (mg/dL)	189	118.5±42.3	106 (62-312)
BUN (mg/dL)	185	28.4±14.7	24.0 (8-92)
Creatinine (mg/dL)	185	1.12±0.68	0.95 (0.4-4.8)
Triglyceride (mg/dL)	172	148.7±72.5	132 (45-456)
Total cholesterol (mg/dL)	172	168.4±45.2	165 (78-298)
LDL cholesterol (mg/dL)	165	98.6±32.1	95 (32-198)
WBC (×10³/μL)	189	7.8±3.1	7.2 (3.1-19.4)

SD: Standard deviation, CRP: C-reactive protein, BUN: Blood urea nitrogen, LDL: Low-density lipoprotein, WBC: White blood cell

Table 3. Multiple linear regression analysis of factors associated with MNA score

Variable	β	SD	95% CI	p-value
Gender	-0.753	0.713	-2.162 to 0.655	0.293
Hypertension	1.469	0.853	-0.215 to 3.155	0.087
Diabetes mellitus	-0.501	0.849	-2.178 to 1.177	0.556
Chronic kidney disease	-1.388	1.209	-3.776 to 0.999	0.253
Coronary artery disease	-0.188	0.700	-1.571 to 1.194	0.788
Malignancy	-0.754	1.398	-3.516 to 2.009	0.591
Cerebrovascular disease	0.484	0.661	-0.821 to 1.790	0.465
Chronic pulmonary disease	-1.876	1.219	-4.284 to 0.533	0.126
Musculoskeletal disease	-1.115	0.638	-2.376 to 0.146	0.083
Dementia/depression	-1.256	0.655	-2.550 to 0.037	0.057
Major surgery history	-1.355	0.806	-2.948 to 0.238	0.095
Smoking	1.391	0.949	-0.483 to 3.265	0.145
Alcohol	1.145	1.763	-2.338 to 4.628	0.517

β: Unstandardized regression coefficient, SD: Standard deviation, CI: Confidence interval, MNA: Mini nutritional assessment

DISCUSSION

In this study, the majority of patients receiving nutritional support from a home health care unit were female (60.9%), with a mean age of 71.32±22.37 years. This demographic profile is consistent with the literature, as several studies have reported that women constitute the majority of home care service users, which may be attributed to women's longer life expectancy and the higher prevalence of functional dependency in older female populations (14).

The most common comorbidity was hypertension (56.1%), followed by dementia/depression (54.5%). This comorbidity profile is in line with previous studies conducted in home care settings, which have consistently identified hypertension and neurocognitive disorders as the leading chronic conditions in this population (15,16).

The high prevalence of dementia/depression in our cohort is particularly noteworthy, as neurocognitive disorders are known to impair eating behavior, reduce appetite, and increase nutritional dependency, thereby elevating the risk of malnutrition (17,18).

The mean MNA score of the patients was 13.9±4.12, indicating that the majority of the study population was either malnourished or at risk of malnutrition. This finding is consistent with previous studies conducted in home care settings, which have reported mean MNA scores ranging from 8.1 to 13.5 in similar patient populations (19-22).

Psychological status, feeding route, and fall risk were significantly associated with MNA scores in our study. Patients with anxious or restless psychological states had significantly lower MNA scores than those with normal psychological states ($p<0.001$). This is consistent with the well-established relationship between depression, anxiety, and malnutrition in elderly patients, as psychological disorders reduce appetite, impair food intake, and lead to functional decline (17,18).

Patients fed via NG tube had significantly lower MNA scores compared to orally fed patients (10.64±4.14 vs. 13.64±4.05; $p=0.009$), reflecting the more severe clinical condition and nutritional dependency of tube-fed patients (1). Similarly, patients at risk of falls had significantly lower MNA scores (13.05±3.95 vs. 15.81±4.63; $p=0.004$), which is in line with the known association between malnutrition, muscle weakness, and fall risk in elderly populations (23,24).

A significant positive correlation was found between TG levels and MNA score ($r=0.20$, $p=0.012$), which is one of the most notable findings of this study. This suggests that patients with better nutritional status tend to have higher TG levels, reflecting adequate energy intake and lipid metabolism. In malnourished individuals, reduced caloric intake leads to decreased hepatic TG synthesis and impaired lipid transport, resulting in lower circulating TG levels. Conversely, adequate nutritional intake supports lipid metabolism and is reflected in relatively higher TG levels (25,26).

In contrast, no significant correlations were found between the MNA score and albumin, hemoglobin, or other biochemical parameters. In current approaches, albumin levels are accepted to reflect inflammation and disease severity rather than nutritional status perse (27,28). Similarly, studies conducted in geriatric populations have demonstrated that clinical parameters, such as anemia, are associated with patient outcomes (29).

The absence of a significant relationship between caloric intake and MNA score is also noteworthy. This may be partly attributable to the study's retrospective design, in which caloric intake data were derived from prescribed nutritional support records rather than from actual consumption, potentially leading to an overestimation of intake. Furthermore, the MNA score encompasses multiple dimensions of nutritional status beyond caloric intake, including mobility, psychological status, and anthropometric measurements, which may explain why caloric intake alone did not emerge as a significant predictor in our analysis.

The Braden score-assessed risk of pressure ulcers and current pressure ulcer rates indicate that a significant proportion of patients are at high risk for immobility and dependence on care. Malnutrition is known to be a significant risk factor for pressure ulcer development, and the coexistence of nutritional deficiencies and functional dependency further increases this risk (30,31).

In our study, female patients had significantly higher MNA scores than male patients. Although older women are traditionally considered vulnerable to malnutrition due to social and physiological factors, previous studies in frail elderly individuals and home-care populations have reported poorer nutritional status among men. This difference may be explained by the higher burden of comorbid diseases, greater functional dependency, and more advanced clinical frailty frequently observed in male home care patients (21,32).

Study Limitations

This study has several limitations that should be considered when interpreting the findings. First, the retrospective, single-center design of the study limits the generalizability of the results to other home care settings and populations. Second, missing data for some variables, including MNA score (n=169), Braden scale (n=153), and certain laboratory parameters, may have introduced selection bias and reduced the statistical power of some analyses. Third, caloric intake data were obtained from prescribed nutritional support records rather than actual dietary intake assessments, and these records may not accurately reflect patients' true nutritional intake. Fourth, the cross-sectional nature of the study precludes any causal inferences regarding the observed associations.

CONCLUSION

This study's findings have important implications for caring for home care patients who need nutritional support. Malnutrition in these patients is complex and cannot be fully understood by looking only at lab results. A thorough nutritional assessment should also consider psychological health, physical abilities, feeding method, their risk of falling, and laboratory data. The MNA is a reliable and comprehensive screening tool and should be used routinely in home health care to detect malnutrition early and enable prompt intervention. Family doctors and home health care workers play a key role in managing nutrition for these patients, as they are often the primary point of contact for people who cannot readily access specialized care. Particular attention should be given to patients with mental health issues, those receiving NG tube feeding, and those at risk of falling, because these factors were associated with lower MNA scores in this study. The positive link between TG levels and MNA scores also suggests that assessing lipid levels can add useful information for monitoring nutritional status. Home health care should adopt a team-based, comprehensive approach to nutrition, and regular screening should be a standard component of home health care.

Ethics

Ethics Committee Approval: The study was initiated after receiving ethical approval from the Ethics Committee of University of Health Sciences Türkiye, Adana City Training and Research Hospital (decision number: 2365, dated: 12.01.2023).

Informed Consent: Informed consent was not required because the study used only aggregated institutional data and did not involve direct patient contact or identifiable information.

Footnotes

This article was prepared based on the thesis study titled "Evaluation of nutritional status and characteristics of patients receiving nutritional support in home health unit" with thesis number 805863.

Authorship Contributions

Surgical and Medical Practices: T.E.K., C.G.Ç., Concept: T.E.K., M.T., Design: T.E.K., M.T., C.G.Ç., Data Collection or Processing: T.E.K., Analysis or Interpretation: T.E.K., M.T., C.G.Ç., Literature Search: T.E.K., M.T., C.G.Ç., Writing: T.E.K., M.T.

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Advantages and Disadvantages of Computed Tomography in Cranial Gunshot Injuries: Experimental Animal Study

Kraniyal Ateşli Silah Yaralanmalarında Bilgisayarlı Tomografinin Avantaj ve Dezavantajları: Deneysel Hayvan Çalışması

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ABSTRACT

Objective: Tomography is the gold standart method for gunshot injury cases but there are limited information in the literature on the use of tomography in shooting analysis. This study aimed to examine the findings required for shooting reconstruction, clinical, forensic evaluation and to show the advantages-disadvantages in gunshot injuries.

Material and Methods: The head of 12 Adana sheep and Canik Mete TP9 9x19 mm were used. Shots were made to the frontal, temporal, and occipital regions from distances of 50 cm, 1, 5 and 10 meters. Vimago GT30 (Epica animal health, USA) computed tomography was used for scanning.

Results: The time required to obtain images for all heads were less than 1 minute. Entry and exit wounds findings were obtained from axial and sagittal images for frontal and occipital shots, and from axial and coronal images for temporal shots. Bullet core trajectory and brain damage were examined from axial and sagittal images for frontal and occipital shots, from axial and coronal images for temporal shots, and Hounsfield unit (HU) values were measured from axial images for all shots. HU values -808±164 (from -530 to -1024) in cavitation area, +2512±200 (from +2332 to +3071) in pathological tissues, +831±85 (from +707 to +966) in brain tissue, and +2683±359 (from +2128 to +3071) in bone were found.

Conclusion: Tomography provides critical information about the location and size of entry-exit wounds, HU values in different tissues, trajectory, cavitation and intracranial foregin bodies. It is possible to determine the azimuth and vertical angles necessary for shooting reconstruction using tomography.

Keywords: Bullet core trajectory, cranial gunshot injuries, computed tomography, shooting reconstruction

ÖZ

Giriş: Kraniyal ateşli silah yaralanması olgularında bilgisayarlı tomografi altın standart yöntemdir fakat adli atış analizi hakkında literatürde yeterli veri yoktur. Bu çalışma adli atış analizi, klinik ve adli değerlendirme için gerekli bulguları araştırmak, kraniyal ateşli silah yaralanmalarında tomografinin avantaj ve dezavantajlarını göstermek amacıyla yapılmıştır.

Gereç ve Yöntemler: On iki adet Adana cinsi koyunun baş bölgesi ve Canik Mete TP9 9x19 mm (M822) tabanca kullanıldı. Deney atışları 50 cm, 1, 5 ve 10 metre mesafeden frontal, temporal, ve oksipital bölgeye gerçekleştirildi. Vimago GT30 (Epica animal health, USA) bilgisayarlı tomografi kullanılarak aksiyal, sagital ve koronal görüntüler elde edildi..

Bulgular: Tüm taramalarda görüntüleme için geçen sürenin 1 dakikadan az olduğu gözlendi. Giriş ve çıkış yarasına ait bulgular frontal ve oksipital atışlarda aksiyal ve sagital, temporal atışlarda aksiyal ve koronal görüntülerden elde edildi. Mermi çekirdeğinin seyri ve beyin dokusunda oluşturduğu hasara ait bulgular frontal ve oksipital atışlarda aksiyal ve sagital görüntülerden, temporal atışlarda aksiyal ve koronal görüntülerden, HU değerleri tüm atışlarda aksiyal görüntülerden elde edildi. Hounsfield birimi (HU) kavitasyon alanında -808±164

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ÖZ

(minimum -530 maksimum -1024), yaralanma alanında +2512 ± 200 (minimum +2332 maksimum +3071), beyin dokusunda +831±85 (minimum +707 maksimum +966), ve kemikte +2683±359 (minimum +2128 maksimum +3071) bulundu.

Sonuç: Tomografi, giriş-çıkış yaralarının yeri ve boyutu, farklı dokulardaki Hounsfield değerleri, traje, kavitasyon ve kafa içi yabancı cisimler hakkında bilgi sağlar. Atışın rekonstrüksiyonu için gerekli olan azimuth ve vertikal açıları tomografi ile tespit etmek mümkündür.

Anahtar Kelimeler: Mermi çekirdeği trajesi, kraniyal ateşli silah yaralanması, bilgisayarlı tomografi, adli atış analizi

INTRODUCTION

Cranial gunshot injuries (GSIs) are severe traumas associated with high mortality and morbidity. Computed tomography (CT) is the gold standard imaging modality for these cases (1-3). Cranial imaging is recommended as soon as possible after arrival at the hospital. Brain damage depends on the type of firearm, the distance of the shot, and the entry angle, mass, and velocity of the bullet. While the majority GSI cases die at the scene, mortality can be reduced in those who reach the hospital with rapid, appropriate and aggressive treatment (3,4). Tomography provides critical information about the location and size of entry and exit wounds, determination of brain damage, bullet trajectory, cranial bone fractures, detection of foreign bodies, and bullet residues (bullet core or jacket fragments). It plays a pivotal role in surgical decision-making and in determining the surgical strategy. Given the high mortality rate associated with GSIs, physicians must make rapid decisions. At this stage, CT provides rapid information among all radiological imaging methods (1,3,5,6).

The first postmortem CT scan was reported in the late 1970s in a fatal cranial GSI. The VIRTOPSY project, presented in 2003, described minimally invasive imaging methods to complement traditional autopsies. Medical imaging methods, particularly CT, are increasingly used for forensic purposes (7-9). Images obtained using this non-invasive method can be re-examined, stored, shared, presented in courts, and used to create 2D and 3D images (10-12). CT has proven particularly effective in detecting fractures, foreign bodies, and gases (13-16). Forensic physicians detect entry-exit wounds and trajectory, determine the type of weapon, and ascertain the cause of death (17-21). Rapid and accurate identification of victims is essential after disasters. Interpol has deemed CT-based data suitable and useful. The interpretation of reconstructed images, independent documentation from observers, the ability to reconstruct various images long after the event, the sharing of workload through digital transmission of CT data, and the reduction in time and expertise required in the disaster area have demonstrated that it is a valuable tool for disaster victim identification. Age determination and identification through comparison of antemortem and postmortem CT images have become possible with CT (22,23).

Limited literature exists on the use of CT for crime-scene and shooting reconstruction. CT scans detect bullet fragments in decomposed, skeletal, mummified, or charred corpses. Limited data regarding ammunition and caliber support the usefulness of CT. CT findings are valuable in cases with minimal skin findings or intraoral GSIs. While limited number of publications report that shooting distance with CT, these studies are generally based on animal experiments and the detection of gunshot residue (24-26). Shooting reconstruction is the study conducted to identify the person who pulled the trigger and the shooting location (27). Azimuth (horizontal) and vertical angles are the necessary for shooting reconstruction (28). Existing literature provides insufficient information on the contribution of CT to shooting reconstruction by determining azimuth and vertical angles. This study aimed to fill this gap. We aimed to examine the findings required for shooting reconstruction and discuss the advantages and disadvantages of CT in GSIs.

MATERIALS and METHODS

Study Population

Although no ideal subject species has been defined in the literature for use in GSIs, organ models, pigs, and sheep have been used most frequently in ballistic studies (29-32). Sheep were preferred for the study because pigs were unavailable after the regional earthquake. Moreover, sheep were more accessible and required fewer anaesthetic agents for control purposes. The study utilized the heads of 12 Adana breed sheep. The heads were obtained at no cost from a slaughterhouse that processes sheep daily, and the animals were automatically slaughtered at the distal part of the C1 vertebra (Atlas). External examination revealed no differences among the heads used. The heads were stored at +4 °C in sterile conditions and transported to the experimental area.

Ammunition used were 9×19 mm calibre M822 type (Full Metal Jacket) rounds (340 m/s), fired from a Canik Mete TP9 semi-auto handgun; this calibre is the most common in civilian injuries. Experienced tests were performed by the staff of the xxxSpecial Operations Directorate, Special Operations Department, General Directorate of Security, Ministry of Internal Affairs, at the same department shooting range.

Test Shots Plan

Test shots were performed from distances of 0.5, 1, 5, and 10 meters, targeting the frontal, temporal and occipital regions (Table 1).

Table 1. Fire region and distance of heads

Head		Region			Distance		
	FR	T	OC	0.5 meter	1 meter	5 meter	10 meter
1	X			X			
2		X		X			
3			X	X			
4	X				X		
5		X			X		
6			X		X		
7	X					X	
8		X				X	
9			X			X	
10	X						X
11		X					X
12			X				X

FR: Frontal, T: Temporal, OC: Occipital

Cranial Imaging

Heads were positioned with the nape and chin aligned, keeping the heads in the midline. Axial images were obtained using a Vimago GT30 (Epica Animal Health, USA) high-resolution CT scanner. Tomography parameters were as follows: 120 kVp, 80 mAs, gantry rotation time =0.6 s, slice thickness =0.35 mm. The time required for imaging was recorded, and a veterinarian appropriately disposed of the imaged heads.

CT images were evaluated by two authors. The axial images and the sagittal and coronal reformats, recorded in DICOM format, were transferred to digital storage and analysed by researchers on personal computers. During the evaluation, factors such as the location, diameter, and angle of the entry wound, the presence of bullet core residue, the bullet trajectory, brain tissue damage, bone fractures, the distribution of bone fragments, Hounsfield unit (HU) values, and the location and diameter of the exit wounds were examined.

Ethical approval for the study was received from the Çukurova University Experimental Animals Local Ethics Committee on 30.04.2024 (meeting number: 4, decision number: 6).

Statistical Analyses

For this descriptive study, HU values were performed using SPSS 20.0 (Chicago, IL), findings are presented as mean ± standard deviation (minimum-maximum).

RESULTS

The time required to obtain images for all 12 heads was less than 1 minute. Findings of entry and exit wounds were obtained from axial and sagittal images for frontal and occipital shots and from axial and coronal images for temporal shots. Bullet trajectory and brain damage were examined on axial and sagittal images for frontal and occipital shots, on axial and coronal images for temporal shots; HU values were measured on axial images for all shots. HU values -808±164 (from -530 to -1024) in cavitation area, +2512±200 (from +2332 to +3071) in pathological tissues, +831±85 (from +707 to +966) in brain tissue, and +2683±359 (from +2128 to +3071) in bone were found (Tables 2 and 3).

DISCUSSION

In recent years, advancements in tomography and computer technology have created new opportunities for radiologists, clinicians, surgeons, and forensic physicians to evaluate GSI cases. Research on the advantages and disadvantages of CT in forensic cases, particularly in cranial GSIs, has demonstrated that CT is a suitable and beneficial method (Table 4) (33,34).

Multi-slice CT scanners equipped with 64 detectors rotate around the patient at three revolutions per second. At this speed, whole-body screening takes less than 10 minutes, offering significant dose-time advantages (14,35). In our study, the time to obtain images with the multi-slice CT device designed for veterinary use was less than 1 minute in all cases, highlighting CT's efficiency.

During the evaluation, the diameters of skin and/or bone defects were measured after their locations were determined. In frontal and occipital shots, the skin entry wounds were smaller than the bullet diameter, while the bone entry wounds were equal to or larger than the bullet diameter. Millimetric entry wounds were observed on the skin in shots to the temporal region. The skin elastic structure resists penetration, causing the tissue to pit and stretch until the elasticity limit is exceeded, after which the bullet pierces the skin (36,37). This explains why the observed skin entry wound was smaller than the bullet diameter in this study.

Table 2. Cranial computed tomography findings of entry and exit wounds

Head	Entry wounds angle	Entry wounds region	Enrty wounds defect region	Enrty wounds diameter	Exit wounds region	Exit wounds defect region	Exit wounds diameter
1	9.75° Azimuth -31.7°Vertical	FR region right of midline	Skin Bone	1.7x3.8 mm 9.4x88.0 mm	OC bone, right arcus of C1	Bone	150x270 mm
2	0° Azimuth -3.5° Vertical	Right T bone	Skin	3.3x3.0 mm	Left T bone	Bone	20.0x14.0 mm
3	1.0° Azimuth -20.0° Vertical	OC region midline	Bone	9.2x12.0 mm	Nose, right of midline	Bone	3.3x5.0 mm
4	6.0° Azimuth -23.0° Vertical	FR region left of midline	Skin Bone	3.0x3.8 mm 7.5x16.0 mm	OC bone, Midline	Bone	3.8x3.5 mm
5	14.0°Azimuth -8.0° Vertical	Right T bone	Skin	4.0x5.2 mm	Left ear	Skin	7.0x6.0 mm
6	10.0° Azimuth -4.0° Vertical	OC region Midline	Bone	28.0x23.0 mm	Maxilla bone	Bone	7.4x12.0 mm
7	6.6° Azimuth -23.0° Vertical	Vertex-FR region right of midline	Bone	5.8x8.0 mm	OC bone right of midline	Bone	7.2x4.7 mm
8	12.1° Azimuth -6.3° Vertical	Right T bone	Skin	Milimetric	Left T bone	Skin	Milimetric
9	0° Azimuth -20.0° Vertical	OC region midline		8.0x13.0 mm	Nasal region right of midline		4.1x5.2 mm
10	10.0° Azimuth -12.7° Vertical	Maxilla region right of midline	Skin Bone	6.1x6.5 mm 10.0x12.0 mm	Right arcus of C1	Bone	4.0x10.0 mm
11	8.0° Azimuth 1.2° Vertical	Right T bone		7.1x5.3 mm	Left T bone	Skin	6.6x5.7 mm
12	28.0° Azimuth 21.0° Vertical	Posterior arcus of C1	Bone	10.0x14.0 mm	Nasal bone Midline	Bone	10.0x10.0 mm

FR: Frontal, OC: Occipital, T: Temporal, C1: First cervical vertebra

The azimuth angle was determined by measuring the angle formed between the entry wound and the midline in axial images. In contrast, the vertical angle was measured as the angle between the entry wound and the midline on sagittal and coronal images. The vertical angle represents the upward (+) or downward (-) component of the bullet's trajectory, while the azimuth angle reflects the lateral direction as seen from above. For forensic shooting analysis and reconstruction, knowing the impact angles and entry wound characteristics is crucial (28). Our most important findings suggest that CT provides essential data for forensic shooting analysis (shooting reconstruction studies).

Our evaluations also revealed that bullets create varying defects in the skin and bone. Two factors contribute to the variable sizes of exit wounds in GSIs. First is the bullet tumbling and exiting the body at different angles, and the second is the fragmentation and deformation of the bullet (36,38). The CT findings in our study aligned with established principles of wound ballistics.

Cranial CT HU values help differentiate tissues: -1000 represents air, negative values near zero (-10, -20) indicate fatty tissues, positive values near zero (+10, +30) indicate fluid structures, +300 to +350 indicate calcified tissues, and +1000 represents bone, the densest structure (15). Advanced reconstruction algorithms enable more detailed measurement of tissue attenuation and provide a wider HU range. The application used in this study had an HU range of -1024 to +3071. Air was represented by -1024 and bone by +3071. Bullet core residue, depending on its copper, lead, aluminium, or zinc content, can appear with extremely high HU values, such as +10,000 (39,40). In this study, HU measurements showed that air largely replaced brain tissue in the cavitation area, while bone fragments were detected as pathological tissue in the brain. No bullet core residue was found in brain tissue. The absence of bleeding from the vessels was attributed to insufficient blood flow in the cranial region following decapitation.

Table 3. Cranial computed tomography findings of bullet core trajectory and brain damage

Head	Bullet core trajectory	Location	HU	Brain damage
1	At the posterolateral line in the right lobe From cranial to caudal	Cavitaion Pathological Brain Bone	-530 2351 889 2503	Fragmentation in FR sinusoids Fragmented bone pieces and cavitattion in the FR and OC lobes OC and C1 vertebral bone damage
2	From right to left At the midline From cranial to caudal	Cavitaion Pathological Brain Bone	-1024 2439 824 2388	Fragmentation in T bone Fragmented bone pieces and cavitation in the T lobe
3	In the midline From cranial to caudal From posterior to anterior	Cavitaion Pathological Brain Bone	-641 2578 837 2230	Large cavitation in OC lobe Fragmentation in maxillary sinusoids Defect In the nasal bone and distal nose skin
4	At the posterolateral line in the right lobe From cranial to caudal	Cavitaion Pathological Brain Bone	-886 2441 854 3071	Fragmentation in FR sinusoids Fragmented bone pieces in the FR and OC lobes OC bone damage
5	From right to left From cranial to caudal	Cavitaion Pathological Brain Bone	-1024 2659 715 3071	Fragmentation in T bone Fragmented bone pieces and cavitation in the T lobe
6	At the anterolateral line From cranial to caudal	Cavitaion Pathological Brain Bone	-665 2572 898 2601	Fragmentation in FR and maxiller sinosioids Fragmanted bone pieces and cavitattion in the FR and OC lobes
7	At the posterolateral line in the right lobe From cranial to caudal	Cavitaion Pathological Brain Bone	-708 3071 966 3071	Wide fracture line starting from entry wounds in the FR bone and extending posteroleteral line Fragmanted bone pieces and cavitattion in the FR and OC lobes
8	From right to left At the midline From cranial to caudal	Cavitaion Pathological Brain Bone	-816 2594 899 3071	Fragmentation in T bone Fragmented bone pieces and cavitation in the T lobe
9	At the midline From cranial to caudal From posterior to anteior	Cavitaion Pathological Brain Bone	-801 2361 825 2766	Cavitation in OC lobe Fragmentation in maxillary sinusoids and midline bones
10	At the posterolateral line in the right lobe From cranial to caudal	Cavitaion Pathological Brain Bone	-993 2452 707 2128	Extensive tissue loss along the maxillary sinosoids, nasopharyngeal region and posterior jaw
11	From right to left From caudal to cranial	Cavitaion Pathological Brain Bone	-770 2583 752 2513	Fragmentation in mandible, orbital wall Cavitation in brain tissue
12	At the anteromedial line From caudal to cranial	Cavitaion Pathological Brain Bone	-978 2332 713 3071	Bullet core passed from the left to the right of the midline in the nasopharyngeal region, creating fragmentation in the bones and extensive cavitation in the tissue

FR: Frontal, OC: Occipital, T: Temporal, C1: First cervical vertebra, HU: Hounsfield unit

Table 4. Advantages and disadvantages of computed tomography

Advantages	Disadvantages
Entry wounds localization can be detected	May not provide information in sudden deaths
Diameter of entry wounds can be measured	Necessity of device, computer, HIMS, DICOM, PACS
Two angles of entry wounds can be calculated	Cost
Skin and bone defect can be detected	Artifacts
Bullet core residue can be detected	Radiation risk
Fargmented bullet core can be detected	Experience required in technology, computers, radiology
Bullet core trajectory can be detecetd	
Intracerebral, intraventricular, epidural, subdural, subarachnoid hemorrhage can de shown	
Cerebral edema, pneumocephalus, shift, herniation can be detected	
Bone fragmantation can be detected	
Distrubution of fragmented bone pieces can be shown	
Soft tissue damage, cavitation can be shown	
Presence and distribution of foreign objects can be detected	
Hounsfield unit can be calculated	
Entry and exit wounds can be differentiated	
Exit wound localization can be detected	
Diameter of exit wounds can be measured	
Cause of death can be determinated	
It is a non-invasive method	
Body integrity is perserved	
Examination can be repeated with the same or different method	
Data can be stored digitally	
Data can be re-evaluated and commented on by different people and platforms	
Segmentation and seperation of tissues provide visual dissection in different planes	
Provides time and speed advantage	
Risk of infection transmission is low	
Contributes to the crime scene, wound and shooting reconstruction	
Allows 3Dimension reconstruction	

HIMS: Hospital information management system, DICOM: Digital ımaging and communications in medicine, PACS: Picture archiving and communication systems

The entry wound, bullet trajectory, exit wound, and HU values of subject 10 (impacting the frontal region from a distance of 10 meters) are presented as examples in Figures 1 and 2.

While the need for infrastructure such as hospital information management system, digital imaging and communications in medicine and picture archiving and communication system can be seen as a disadvantage, the "Regulation on Health Information Management Systems (HIMS)" dated August 22, 2022, indicates that the current health system in our country has the necessary infrastructure to support the evaluation of cranial GSI cases using CT (41). During the study, the ability to share, export, and use DICOM-formatted data on personal computers enabled physicians to interpret images independently. Similarly, the HIMS regulation enables physicians to access and report data in certain situations, and telemedicine-integrated systems allow remote physicians to report data rapidly and without interruption. Another disadvantage is the presence of artifacts, including linear and ring artifacts, partial-volume effects, noise and motion artifacts, windmill effects, and beam hardening. However,

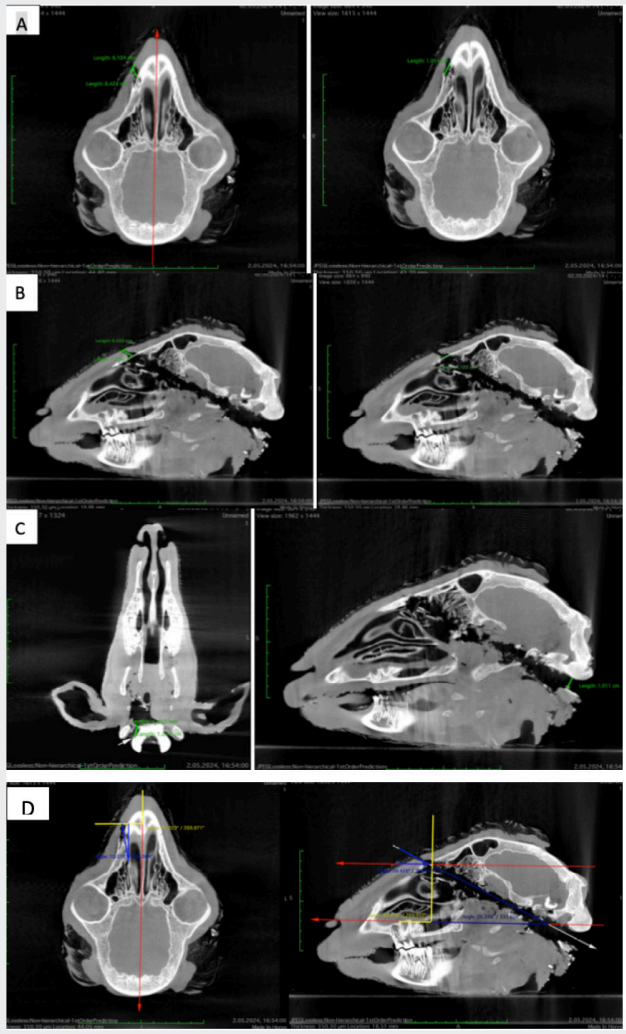


Figure 1. A) Axial view of skin and bone damage and bullet core enter wounds, **B)** Sagittal view of skin and bone damage and bullet core enter wounds, **C)** Axial and sagittal image of bullet core exit wounds, **D)** Bullet core trajectory, measuring azimuth angle in axial image, vertical angle in sagittal image

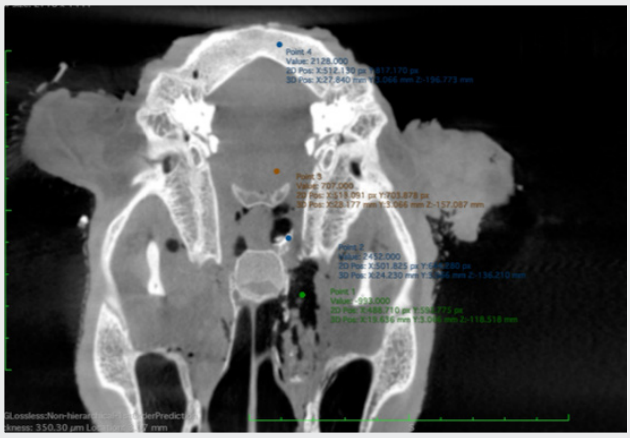


Figure 2. HU values of cavitation (green), brain (brown), pathological tissue (blue) and bone (blue)
HU: Hounsfield unit

these artifacts can be mitigated through various techniques and imaging adjustments (42).

Study Limitations

The limitations of this study include its animal-based design and the small sample size. The anatomy of the sheep head is similar to that of humans, and the small number of subjects does not alter the findings. The study demonstrated that, regardless of shooting distance and location, CT provides the necessary information for shooting reconstruction. The second limitation was that we could not observe intracranial haemorrhage because of insufficient blood volume resulting from post-decapitation bleeding. However, since CT has been shown in previous studies to be a suitable method for demonstrating intracranial haemorrhage, this will not negatively affect the study's value.

CONCLUSION

Cranial CT has numerous advantages, including speed and efficiency. Tomography provides critical information on the location and size of entry and exit wounds, the azimuth and vertical angles of entry, HU values in different tissues, the trajectory of the bullet core, cavitation, and bone fragmentation, and the distribution of bone fragments. The most important result of this study is that we have demonstrated that CT is a fast, non-invasive, and valuable method for forensic ballistic examination and forensic shooting analysis

Ethics

Ethics Committee Approval: Ethical approval for the study was received from the Çukurova University Experimental Animals Local Ethics Committee on 30.04.2024 (meeting number: 4, decision number: 6).

Informed Consent: It is not necessary for animal studies.

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Footnotes

This study was presented as oral presantation at 19th International Forensic Medicine Congress, 23-29 September 2024, Antalya, Türkiye.

Authorship Contributions

Concept: İ.A., G.İ.Ö., Design: İ.A., G.İ.Ö., A.S.K., Data Collection or Processing: İ.A., G.İ.Ö., A.S.K., K.İ., Ç.A., Analysis or Interpretation: İ.A., G.İ.Ö., A.S.K., Literature Search: İ.A., G.İ.Ö., K.İ., Writing: İ.A., G.İ.Ö., A.S.K., K.İ., Ç.A.

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Case Report

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Parapharyngeal Abscess Developing on the Basis of Diabetes Mellitus and Surgical Management

Diabetes Mellitus Zemininde Gelişen Parafaringeal Apse ve Cerrahi Yönetimi

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ABSTRACT

Parapharyngeal abscess (PPA) is a rare but potentially life-threatening deep neck infection. The prognosis may be more severe, especially in the presence of systemic comorbidities. In this case report, the surgical treatment of a PPA that developed in a patient with type 1 diabetes mellitus and hypertension is presented in light of the literature. A 45-year-old man presented with sore throat and neck swelling for 10 days. Imaging revealed an abscess measuring 28×20 mm in the left parapharyngeal space. Due to significant laryngeal edema, an emergency airway was established, and a tracheotomy was performed. A left tonsillectomy was carried out via an intraoral approach, followed by abscess drainage. In deep neck infections, surgical intervention should not be delayed, particularly in patients with systemic comorbidities. Early airway management and effective drainage are of critical importance in preventing life-threatening complications.

Keywords: Parapharyngeal abscess, deep neck infection, surgical drainage,tracheotomy, diabetes

ÖZ

Parafarengeal apse (PFA), nadir görülen ancak potansiyel olarak yaşamı tehdit eden derin boyun enfeksiyonudur. Özellikle sistemik komorbiditelerin varlığında prognoz daha şiddetli seyredebilmektedir. Bu olgu sunumunda, tip 1 diabetes mellitus ve hipertansiyonu olan bir hastada gelişen PFA'nın cerrahi tedavi süreci literatür eşliğinde sunulmuştur. Kırk beş yaşında erkek hasta, 10 gündür devam eden boğaz ağrısı ve boyunda şişlik şikayetleriyle başvurdu. Görüntülemeler sonucunda sol parafarengeal alanda 28×20 mm boyutlarında bir apse saptandı. Belirgin larengeal ödem nedeniyle acil hava yolu güvenliği sağlandı ve trakeotomi uygulandı. İntraoral yaklaşımla sol tonsillektomi gerçekleştirildi ve ardından apse drenajı yapıldı. Derin boyun enfeksiyonlarında, özellikle sistemik komorbiditesi olan hastalarda cerrahi müdahale geciktirilmemelidir. Erken hava yolu yönetimi ve etkili drenaj, yaşamı tehdit eden komplikasyonların önlenmesinde kritik öneme sahiptir.

Anahtar Kelimeler: Parafaringeal apse, derin boyun enfeksiyonu, cerrahi drenaj, trakeotomi, diyabet

INTRODUCTION

Parapharyngeal abscess (PPA) is a deep neck infection of the parapharyngeal space that can progress rapidly and lead to serious complications. Due to the close anatomical relationship between this region and vital structures such as the carotid artery, internal jugular vein, cranial nerves, and the mediastinum, the infection can reach life-threatening proportions. PPA usually develops as a complication of peritonsillar abscess, odontogenic infections, or upper respiratory tract infections. Early diagnosis and appropriate treatment reduce mortality and morbidity. Systemic diseases, such as diabetes mellitus and immunodeficiency, are the primary factors that complicate infection control. In this study, a case of PPA with hyperglycemia detected at admission is presented, along with the treatment approach and a review of the literature.

CASE REPORT

A 45-year-old male patient presented to the emergency department with a 10-day history of sore throat and neck swelling. His medical history included type 1 diabetes mellitus and hypertension for the past 10 years. Laboratory investigations revealed leukocytosis and elevated C-reactive

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protein levels. The patient's HbA1c level within the last 3 months was 6.3%; however, since his blood glucose was detected as 350 mg/dL upon admission, the internal medicine department was consulted. Blood glucose regulation was achieved by initiating treatment with subcutaneous insulin aspart and insulin glargine.

Prior to admission, the patient had been started on oral amoxicillin-clavulanate and intramuscular cefazolin at another center, but no clinical improvement was observed. Physical examination revealed significant erythema and swelling in the left tonsillar fossa, and a culture was obtained via needle aspiration from that area.

Contrast-enhanced computed tomography (CT) of the neck showed a collection compatible with an abscess in the left parapharyngeal space, measuring 28×20 mm with a contrast-enhancing wall. The lesion was located anterior to the vascular compartment and in close proximity to the carotid sheath structures. Specifically, the internal jugular vein was observed at the posterolateral border of the abscess. The carotid artery and internal jugular vein were not involved in the abscess collection, and no mediastinal spread was observed.

Treatment

The culture obtained via aspiration before treatment was reported as "no growth". Following consultation with the infectious diseases department, broad-spectrum intravenous antibiotic therapy (clindamycin 600 mg three times daily and ampicillin-sulbactam 1500 mg four times daily) was initiated, because the literature indicates that polymicrobial involvement (anaerobes: *Bacteroides* spp., *Peptostreptococcus* spp., *Fusobacterium* spp.; aerobes: *Streptococcus* pyogenes [Group A beta-hemolytic *Streptococcus*], *Staphylococcus aureus*, viridans group *Streptococci*) is most commonly responsible for these infections.

On the second day of hospitalization, following a drop in blood oxygen saturation to 72%, flexible laryngoscopy revealed widespread edema involving the uvula, epiglottis, and arytenoids, along with significant narrowing of the glottic airway. Due to airway obstruction, the airway was secured by emergency tracheotomy after intubation with video laryngoscopy. Subsequently, PPA drainage was performed. During intraoral exploration using a Davis-Boyle mouth gag, a left tonsillectomy was performed and a focus for PPA drainage was identified at the inferior pole of the left tonsillectomy bed. Adequate abscess drainage was achieved by expanding the tonsillectomy bed area. The field was irrigated with rifampicin and saline. The operation was completed without complications.

Rapid clinical improvement was observed in the early postoperative period. A control CT scan taken on the 7th postoperative day showed that the PPA had completely regressed. On the 7th postoperative day, after reconsultation with the Infectious Diseases service, the patient was discharged following decannulation with a prescription for oral therapy consisting of amoxicillin-clavulanate 1000 mg, 2x1 tablet/day, and clindamycin 450 mg, 3x1 tablet/day for 14 days.

DISCUSSION

PPA can cause high-mortality complications, such as carotid artery erosion, internal jugular vein thrombosis (Lemierre's syndrome), and mediastinitis, because of the anatomical proximity of the parapharyngeal space to these structures. In this case, a history of diabetes mellitus and the detection of hyperglycemia at admission stand out as the most fundamental risk factors that accelerate the progression of the infection and create resistance to treatment.

The literature indicates that diabetic patients are more prone to deep neck infections and have significantly higher complication rates than non-diabetic patients. In a study by Huang et al. (1), it was shown that high HbA1c levels and hyperglycemia facilitate the spread of the abscess by impairing leukocyte chemotaxis. In the present case, the blood sugar level of 350 mg/dL explains the aggressive initial course of the infection and the lack of response to oral antibiotic therapy.

The etiology in PPA cases is generally polymicrobial. It has been stated in the literature that the most common agents isolated in patients with deep neck infections are *Streptococcus viridans* and *Klebsiella pneumoniae*; however, the incidence of *Klebsiella pneumoniae* is higher in diabetic patients (2). The absence of growth on culture may be attributed to the broad-spectrum antibiotics (amoxicillin-clavulanate and cefazolin) administered prior to admission. Despite the negative culture, the combination of ampicillin-sulbactam and clindamycin is consistent with the empirical treatment approach recommended in current guidelines, as it covers both the aerobic and anaerobic spectrum (3).

The sudden drop in saturation and the widespread supraglottic edema, detected on laryngoscopy on the second day of hospitalization, are among the most feared complications of PPA. Cho et al. (4) emphasized that inflammation in the parapharyngeal region could trigger laryngeal edema, rapidly leading to obstruction. In these situations requiring difficult airway management, an intubation attempt via video laryngoscopy and, in case of failure, an emergency tracheotomy are life-saving. The proactive airway management in this case supports the "airway security first" principle in the literature.

Contrast-enhanced neck CT is the gold standard for PPA diagnosis. The literature recommends that surgical drainage should not be delayed in abscesses larger than 2 cm and those causing airway compression (5). An intraoral approach may be preferred, especially in cases where vascular structures are not involved and the abscess is prominent medially (in the

tonsillar bed) (6). In this case, drainage performed through the tonsillectomy bed was a surgical choice consistent with the localization of the abscess.

The patient's rapid postoperative clinical improvement and decannulation on the 7th day demonstrate the combined success of aggressive surgical drainage and strict glycemic control. Gidley et al. (5) stated that oral antibiotic treatment for patients discharged after deep neck infections should be completed for at least 10-14 days, noting that recurrences often stem from inadequate treatment duration.

CONCLUSION

PPA is an infection that requires rapid diagnosis and aggressive treatment and can be life-threatening, especially when accompanied by systemic diseases. In cases occurring in patients with underlying diabetes mellitus, early airway protection, timely surgical drainage, and multidisciplinary management are vital to preventing serious complications.

Ethics

Informed Consent: Informed consent was obtained from the patient based on their information.

Footnotes

Authorship Contributions

Surgical and Medical Practices: M.N.Ş., M.I., Ö.İ., D.Y., Concept: M.N.Ş., M.I., Ö.İ., D.Y., Design: M.N.Ş., M.I., Ö.İ., D.Y., Data Collection or Processing: M.N.Ş., M.I., Ö.İ., D.Y., Analysis or Interpretation: M.N.Ş., M.I., Ö.İ., D.Y., Literature Search: M.N.Ş., M.I., Ö.İ., D.Y., Writing: M.N.Ş., M.I., Ö.İ., D.Y.

Conflict of Interest: No conflict of interest was declared by the authors.

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Original Article

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Clinical Outcomes and Safety of Immediate Sequential Bilateral Cataract Surgery Performed Under General Anesthesia: A Retrospective Case Series

Genel Anestezi Altında Uygulanan Hemen Ardışık Bilateral Katarakt Cerrahisinin Klinik Sonuçları ve Güvenliği: Retrospektif Olgu Serisi

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ABSTRACT

Objective: To evaluate the clinical outcomes and surgical safety of immediately sequential bilateral cataract surgery performed under general anesthesia. The effectiveness and safety of operating on both eyes in the same session were specifically investigated in patients requiring general anesthesia.

Material and Methods: This retrospective, single-center, non-comparative case series included 34 patients (68 eyes) who underwent immediately sequential bilateral cataract surgery under general anesthesia between January 2018 and February 2025. All surgeries were performed by the same surgeon using strict aseptic separation protocols, including separate sterile instrument sets, separate irrigation solutions, and separate intraocular lenses for each eye. Demographic characteristics, accompanying systemic diseases, intraoperative and postoperative complications were recorded. Surgical outcomes were evaluated based on best-corrected visual acuity and refractive results at postoperative 1 month. Visual and refractive success, as well as complication rates, were analyzed in detail.

Results: The mean age of the patients was 60.6±17.8 years. The intraoperative complication rate was 5.9%, with posterior capsule rupture and vitreous loss (2.9%) being the most common complication. Postoperatively, wound leakage was observed in 2.9% of cases. No endophthalmitis or serious bilateral vision-threatening complication occurred. At postoperative 1 month, the mean best-corrected visual acuity was 0.05±0.07 logMAR, and the mean spherical equivalent was 0.02±0.80 D.

Conclusion: Immediately sequential bilateral cataract surgery performed under general anesthesia is a safe and effective procedure when appropriate patient selection and meticulous surgical separation protocols are applied. Performing both surgeries in a single session may improve patient comfort, reduce anesthesia-related risks, and provide satisfactory visual and refractive outcomes, particularly in patients requiring general anesthesia.

Keywords: Cataract extraction, intraoperative complications, postoperative complications

ÖZ

Giriş: Genel anestezi altında uygulanan hemen ardışık bilateral katarakt cerrahisinin klinik sonuçlarını ve cerrahi güvenliğini değerlendirmek amaçlandı. Özellikle genel anestezi gereksinimi olan hasta grubunda aynı seansta her iki gözün opere edilmesinin etkinliği ve güvenilirliği araştırıldı.

Gereç ve Yöntemler: Bu retrospektif, tek merkezli ve karşılaştırmasız olgu serisine Ocak 2018-Şubat 2025 tarihleri arasında genel anestezi altında hemen ardışık bilateral katarakt cerrahisi uygulanan 34 hasta (68 göz) dahil edildi. Tüm cerrahiler aynı cerrah tarafından gerçekleştirildi ve her iki göz için ayrı steril setler, ayrı irrigasyon solüsyonları ve ayrı intraoküler lensler kullanılarak sıkı aseptik ayrım protokolü uygulandı. Demografik veriler, eşlik eden sistemik hastalıklar, intraoperatif ve postoperatif komplikasyonlar kaydedildi. Cerrahi sonuçların değerlendirilmesinde postoperatif 1. ay en iyi düzeltilmiş görme keskinliği ve refraktif sonuçlar analiz edildi. Görsel ve refraktif başarı ile komplikasyon oranları ayrıntılı olarak incelendi.

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ÖZ

Bulgular: Hastaların yaş ortalaması 60,6±17,8 yıl idi. İntraoperatif komplikasyon oranı %5,9 olup en sık arka kapsül rüptürü ve vitreus kaybı (%2,9) izlendi. Postoperatif dönemde %2,9 oranında insizyon kaçağı saptandı. Endoftalmi veya ciddi bilateral görmeyi tehdit eden komplikasyon gelişmedi. Postoperatif 1. ayda ortalama en iyi düzeltilmiş görme keskinliği 0,05±0,07 logMAR, ortalama sferik ekivalan 0,02±0,80 D olarak bulundu.

Sonuç: Genel anestezi altında uygulanan hemen ardışık bilateral katarakt cerrahisi, uygun hasta seçimi ve titiz cerrahi ayrım protokolleri ile gerçekleştirildiğinde güvenli ve etkili bir yöntemdir. Özellikle genel anestezi gereksinimi olan hastalarda cerrahi sürecin tek seansta tamamlanması hasta konforunu artırmakta, anesteziye bağlı riskleri azaltmakta ve tatmin edici görsel ile refraktif sonuçlar sağlamaktadır.

Anahtar Kelimeler: Katarakt ekstraksiyonu, intraoperatif komplikasyonlar, postoperatif komplikasyonlar

INTRODUCTION

Cataract surgery is one of the most commonly performed surgical procedures in ophthalmology practice and is currently characterized by high visual success and low complication rates. In patients with bilateral cataracts, the traditional approach is delayed sequential cataract surgery, which involves operating on both eyes at different times. This approach has been accepted as the standard practice for many years, particularly to prevent refractive surprises and to reduce the risk of bilateral endophthalmitis (1).

Immediate sequential bilateral cataract surgery (ISBCS) refers to operating on both eyes in the same surgical session, and this practice has been considered to have limited acceptance due to the risk of infection (2,3). However, with advancements in phacoemulsification technology, standardization of surgical techniques, and the routine use of intracameral antibiotics, the safety of ISBCS has been re-evaluated (4). Recent studies have reported that when appropriate patient selection is made and strict asepsis–antisepsis separation is ensured for surgical procedures in both eyes, there is no significant difference in terms of serious complication rates between ISBCS and delayed sequential cataract surgery (4,5).

Among the main reported advantages of ISBCS are rapid binocular visual rehabilitation, increased patient satisfaction, reduced healthcare costs, and particularly a reduction in anesthesia-related risks (6,7). These advantages become more pronounced in patient groups with accompanying systemic diseases, limited mobility, or where repeated surgical and anesthesia procedures pose a risk. Especially in patients requiring general anesthesia, performing bilateral surgery in a single session instead of two separate surgical sessions is considered an important factor that may reduce anesthesia-related morbidity (7).

The most important concern regarding ISBCS is the risk of bilateral severe complications, particularly the development of endophthalmitis. However, retrospective studies conducted on large series have shown that the risk of bilateral endophthalmitis is extremely low, provided that separate sterile sets, separate surgical instruments, and separate medications are used for each eye (6,8). These findings demonstrate that strict aseptic separation of surgical procedures is a key determinant in the safe implementation of ISBCS (9).

This study evaluated the clinical outcomes and surgical safety of patients undergoing ISBCS under general anesthesia, and examined the effectiveness and complication profile of this approach in the appropriate patient group, in light of the literature.

MATERIALS and METHODS

Study Design

This study was planned as a retrospective, single-center, and non-comparative case series and was conducted at University of Health Sciences Türkiye, Adana City Hospital. Approval for the study was obtained from the University of Health Sciences Türkiye, Adana City Training and Research Hospital Clinical Research Ethics Committee (decision no: 401, date: 06/03/2025). The study was conducted in accordance with the principles of the Declaration of Helsinki. Informed consent was not obtained from the patients due to the retrospective design.

Patient Population

Thirty-four patients (68 eyes) aged 18 years and older who underwent ISBCS under general anesthesia between January 2018 and February 2025 were included in the study. All data were obtained by retrospectively reviewing hospital medical records. General anesthesia was indicated and preferred for patients who could not tolerate the procedure under local anesthesia, particularly those presenting with significant cooperation and communication difficulties due to cognitive conditions such as Alzheimer's disease or Down syndrome. All included patients were classified according to the American Society of Anesthesiologists (ASA) physical status classification system.

Inclusion Criteria

- Patients aged 18 years and older,
- Bilateral cataract diagnosis,
- Having undergone ISBCS under general anesthesia.

Exclusion Criteria

- Lens subluxation or iridodonesis,
- Previous ocular trauma,
- History of endophthalmitis,

- Active ocular surface or adnexal infection,
- Systemic immunosuppression or immunodeficiency.

Patients who did not attend follow-up appointments regularly or who had incomplete clinical data were excluded from the study.

Surgical Technique

All patients underwent blepharitis (eyelash base cleaning) for three days prior to surgery and were started on moxifloxacin as a topical antibiotic and nepafenac as a topical non-steroidal anti-inflammatory drug. All surgeries were performed by the same surgeon while the patient was under general anesthesia.

In all cases, phacoemulsification was performed using the Centurion® Vision System (Alcon Laboratories, Fort Worth, TX, USA), and Sensar® (Johnson & Johnson Vision, Santa Ana, CA, USA) posterior chamber monofocal intraocular lens implantation was performed in uncomplicated cases. In cases that developed posterior capsule rupture (PCR), a three-piece intraocular lens (AcrySof® MA60AC Soft Acrylic Multipiece IOL, Alcon Laboratories Inc., Fort Worth, TX, USA) was placed in the sulcus.

Both eyes were operated on in the same session, but considered as completely independent surgeries. Prior to the operation, the intraocular lenses to be implanted in each eye were checked separately by the surgeon, assistant, and nurse, and only the intraocular lens belonging to the eye to be operated on was brought into the operating room.

The first eye was prepared and operated on using standard sterile ophthalmic methods. Following the uncomplicated completion of the surgery, intracameral cefuroxime axetil was administered to the anterior chamber. Patients with mature cataracts received subconjunctival antibiotic and steroid injections.

Prior to the second eye surgery, the surgeon and auxiliary healthcare personnel changed their gowns and gloves. A separate sterile surgical set, disposable surgical instruments, separate irrigation solutions, and a separate intraocular lens were used for the second eye. At the end of the surgery, intracameral cefuroxime axetil was administered to the anterior chamber, and subconjunctival antibiotic and steroid injections were repeated in cases with mature cataracts.

Postoperative Follow-up and Evaluation

All patients received topical antibiotic and steroid treatment in the postoperative period. Patients were followed up at 1 week, 1 month, and 3 months (or longer) postoperatively.

The following data were recorded by retrospectively reviewing patient files:

- Intraoperative complications (PCR, zonular dialysis, vitreous loss, etc.)
- Postoperative complications (corneal edema, cystoid macular edema, etc.)
- Systemic and additional ocular diseases
- Best corrected visual acuity (BCVA) at 1 month postoperatively
- Intraocular pressure
- Autorefractometer measurements
- Anterior and posterior segment examination findings.

Statistical Analysis

Statistical analyses were performed using SPSS for Windows version 20.0 (IBM Corp., Chicago, IL, USA). Descriptive statistics were used. Categorical variables were expressed as numbers and percentages [n (%)], and continuous variables were expressed as mean ± standard deviation (minimum-maximum where necessary). To prevent statistical dependence between data from two eyes, in patient-based analyses, the eye with lower postoperative visual acuity was evaluated for each patient.

RESULTS

A total of 34 patients (68 eyes) were included in the study. 20 of the patients (58.8%) were female and 14 (41.2%) were male. The mean age was 60.6±17.8 years (18-86). It was determined that 38.2% (n=13) of the patients had previously tried local anesthesia, while 61.8% (n=21) had not tried local anesthesia.

29.4% (n=10) of the cases were classified as ASA II, and 70.6% (n=24) were classified as ASA III. Of the 24 patients in the ASA III group, 8 (33.3%) required mechanical ventilation in the postoperative period and were monitored in the intensive care unit.

Six patients (17.6%) had Down syndrome or congenital intellectual disability, and seven (20.6%) had Alzheimer's disease or advanced dementia. Three patients (8.8%) had additional ocular disorders. These were pseudoexfoliation (n=1), degenerative myopia (n=1), and strabismus (n=1). Thirty-one patients (91.2%) had no additional ocular disorders.

Cataract types were evaluated on an eye-by-eye basis, and the findings are presented in Table 1 as numbers and percentages based on 68 eyes. Accordingly, nuclear senile cataract was detected in 31 (45.6%) of the 68 eyes, cortical cataract in 5 (7.4%), posterior subcapsular cataract in 4 (5.9%), mixed cataract in 15 (22.1%), mature cataract in 9 (13.2%), and intumescent cataract in 4 (5.8%).

In the patient-based analysis conducted at one month postoperatively, the mean BCVA was found to be 0.05±0.07 logMAR (0.00-0.20) in 34 eyes. The mean spherical equivalent was 0.02±0.80 D (-2.00-1.50). The mean corneal astigmatism was measured as -1.09±0.73 D (-3.50 – -0.30). The mean astigmatism axis was 97.8±33.1° (10-180). The mean implanted intraocular lens power was calculated as 22.1±3.6 D (8.0-29.0) (Table 2).

Intraoperative and postoperative complications were evaluated on an eye-by-eye basis and presented as numbers

and percentages based on 68 eyes. Intraoperatively, PCR and vitreous loss occurred in 2 out of 68 eyes (2.9%). Zonular weakness was observed in 1 eye (1.5%), and intraoperative incision leakage in 1 eye (1.5%). These complications occurred in the second eyes of different patients (Table 3).

Incision leakage was detected in 2 eyes (2.9%) in the postoperative period, and no other serious postoperative complications were observed (Table 4).

DISCUSSION

Performing cataract surgery on both eyes in the same session is still a controversial topic in the field of ophthalmology. In a survey conducted in our country, 20.7% of the 169 ophthalmologists participating in the survey reported that they performed ISBCS, 70.9% did not, and 2.4% reported that they had performed it before but no longer preferred it. In addition, it was shown that ophthalmologists with more than 10 years of professional experience significantly preferred ISBCS more often (p=0.027) (10). In this study, the visual and refractive outcomes and intraoperative and postoperative complication profile of ISBCS performed under general anesthesia were evaluated. The findings show that ISBCS is a safe and effective method when performed with appropriate patient selection and meticulous surgical precautions.

The most important point of contention regarding ISBCS is the risk of bilateral endophthalmitis and serious bilateral complications. However, large-scale studies published in recent years have reported that this risk is extremely low when both eyes are treated as completely independent surgeries, using separate surgical sets, separate irrigation fluids, and separate sterilization processes (11). The incidence of bilateral endophthalmitis reported in the literature is less than one in a million (8). In our series, no patient experienced endophthalmitis. This finding supports the reliability of the surgical protocol applied.

A study by Buchan et al. (12), published in the Royal College of Ophthalmologists National Ophthalmology Database, reported an increasing use of ISBCS in the United Kingdom, particularly in cases requiring careful patient selection. This study highlighted the advantages of ISBCS in reducing anesthesia exposure and providing faster binocular visual rehabilitation; key determining factors for safe application were treating both eyes as completely independent surgeries, applying strict surgical separation protocols, and selecting the appropriate patient (12). These findings are consistent with the principles recommended by the ISBCS and support the idea that ISBCS can be a safe surgical option in the appropriate patient group.

In our study, the intraoperative complication rate was found to be 5.9%, with the most frequent complications being PCR and vitreous loss. This rate is comparable to the complication rates reported for unilateral or delayed sequential cataract surgery (11). Previous studies have reported PCR rates ranging from 1-4% (13). Our results suggest that ISBCS does not pose an additional risk in terms of surgical difficulty.

Only 2.9% of cases experienced incision leakage in the postoperative period, and no complications leading to serious vision loss were detected. This finding indicates that the postoperative safety profile of ISBCS is also at an acceptable level. The literature reports that postoperative complication rates after ISBCS are similar to those after unilateral surgery (11,14).

In terms of visual outcomes, the mean BCVA and refractive results obtained at the first postoperative month in our study were found to be satisfactory. Previous studies have

Table 1. Types of cataracts (n=68 eyes)

Type of cataract	n (%)
NSC	31 (45.6)
CC	5 (7.4)
PSC	4 (5.9)
Mixed	15 (22.1)
Mature	9 (13.2)
Intumescent	4 (5.8)
Total	68 (100.0)

Data are presented as n (%).
NSC: Nuclear senile cataract, CC: Cortical cataract, PSC: Posterior subcapsular cataract

Table 2. Postoperative visual acuity and refractive outcomes

Parameter	Mean ± SD (min-max)
BCVA (logMAR)	0.05±0.07 (0.00-0.20)
SE (D)	0.02±0.80 (-2.00-1.50)
Astigmatism (D)	-1.09±0.73 (-3.50 – -0.30)
Axis (°)	97.8±33.1 (10-180)
IOL power (D)	22.1±3.6 (8.0-29.0)

Data are presented as mean ± standard deviation (SD) (minimum-maximum).
SD: Standard deviation, BCVA: Best corrected visual acuity, SE: Spherical equivalent, IOL: Intraocular lens

Table 3. Intraoperative complications

Complication	n (%)
PCR and vitreous loss	2 (2.9)
Zonular weakness	1 (1.5)
Incision leakage	1 (1.5)
Total	4 (5.9)

Data are presented as n (%).
PCR: Posterior capsule rupture

Table 4. Postoperative complications

Complication	n (%)
Incision leakage	2 (2.9)
Total	2 (2.9)

Data are presented as n (%)

shown that significant improvement in visual acuity and high achievement of refractive targets are obtained after ISBCS (6,15). Our findings are also consistent with the literature.

Key advantages of ISBCS include reducing anesthesia-related risks, especially in elderly patients, those with systemic comorbidities, and those requiring general anesthesia, thanks to the operation of both eyes in a single session (7). Other important advantages of ISBCS include shorter hospital stays, reduced healthcare costs, and faster functional rehabilitation for patients (16). In our specific case series, performing ISBCS provided significant clinical and socioeconomic advantages. Because our patient population consisted of individuals with severe cooperation difficulties (such as Down syndrome and Alzheimer's disease), a second surgical session would have required a second exposure to general anesthesia. By completing the procedure in a single session, we minimized cumulative anesthesia-related systemic risks for these vulnerable patients. Furthermore, this approach reduced the overall healthcare costs, shortened hospital stays, and significantly decreased the logistical and emotional burden on caregivers, who would otherwise have to manage multiple hospital visits for uncooperative patients.

Study Limitations

There are several limitations to our study that should be acknowledged. First, the study was conducted with a relatively small sample size consisting of 34 patients (68 eyes), and its retrospective, single-center design without a comparative control group may have introduced selection bias. Second, our follow-up period was limited to one month; while this duration is sufficient to evaluate early postoperative outcomes, a longer follow-up period is essential to assess long-term visual stability and to detect extremely rare complications, such as delayed endophthalmitis. Consequently, the lack of long-term follow-up data limits the comprehensive evaluation of late outcomes and the generalizability of our findings to a broader population. Therefore, future prospective, randomized, multi-center controlled trials with larger cohorts and extended follow-up periods are warranted to confirm our results.

CONCLUSION

ISBCS performed under general anesthesia is a safe and effective method when performed with appropriate patient selection and meticulous surgical separation protocols. This approach provides predictable visual and refractive outcomes with acceptable complication rates, especially in patients requiring general anesthesia.

Ethics

Ethics Committee Approval: Approval for the study was obtained from the University of Health Sciences Türkiye, Adana City Training and Research Hospital Clinical Research Ethics Committee (decision no: 401, date: 06/03/2025).

Informed Consent: Due to the retrospective nature of the study, the requirement for informed consent was not required/applicable by the ethics committee.

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Footnotes

This study was presented as an oral presentation at the 59th National Congress of the Turkish Ophthalmological Association (TOD), held on November 20, 2025.

Authorship Contributions

Concept: D.T.E., E.Ç., E.Ş., Design: D.T.E., E.Ç., E.Ş., Data Collection or Processing: D.T.E., E.Ç., E.Ş., Analysis or Interpretation: D.T.E., E.Ç., E.Ş., Literature Search: D.T.E., E.Ç., E.Ş., Writing: D.T.E., E.Ç., E.Ş.

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