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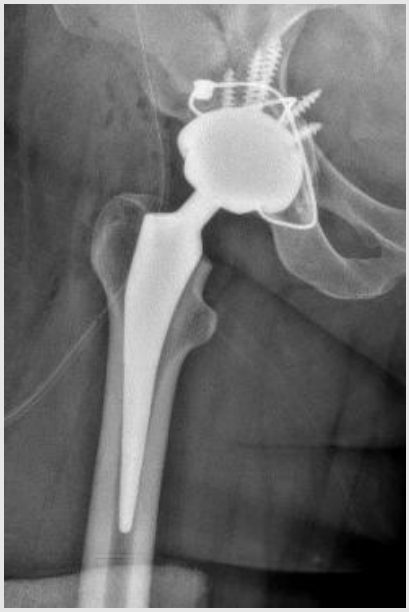

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EDITORIAL

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Ismail Demirkale

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Human intelligence is the complex of higher-order cognitive functions, including learning, thinking, problem-solving, and creativity, which enable people to perceive the world, apply knowledge, and act upon the environment. The ability lets humans solve complex problems, come up with new ideas, and adapt to the environment. While AI, on the other hand, is a simulation technology designed to transfer human intelligence into the computer environment, with developments in both NLP and machine learning, it has come out to a point of interaction with humans in a very intimate and natural way. More precisely, it has improved in the fronts of understanding and generating human languages, especially with technologies such as NLP and language large models. NLP is the technology enabling machines to understand and speak the human language, basically the backbone of voice assistants such as Siri and Alexa. LLMs are deep AI models that have been trained on big text data, can generate texts-often indistinguishable from those created by humans. Models like OpenAI's GPT-3 are among the most popular examples of their breed. Thanks to these technologies, AI no longer performs simple tasks but also successfully completes creative and complex tasks. Fundamentally, there is a big difference between AI and human decision-making. Decisions made by AI are based on algorithms and data only; emotions or morals are never taken into consideration.

With growing application in key sectors like autonomous vehicles and forensic systems, this approach has indeed raised many questions. After all, human beings base their decisions not only on logical data, but on ethical values, emotional reactions, and experiences. The same depth in this layered evaluation process is yet to be emulated by AI. One study has shown that while AI can accelerate judicial processes, it cannot replace the ethical and moral judgment capabilities of judges.[1]

It is undeniable that artificial intelligence (AI) is fundamentally transforming the editorial processes of medical journals. As an orthopaedic surgeon and journal editor myself, I've seen the process firsthand. Currently, AI assists in triaging initial manuscript evaluations, publication appropriateness reviews, plagiarism surveillance, and identifying authors' qualifications.[2]

With AI tools, it helps in the selection of reviewers, sends automated reminders, and analyzes reviewer comments. However, while AI provides valuable data-driven insight, human judgment remains irreplaceable. The future of medical publishing is through a balanced synergy between AI-powered automation and the critical thinking of experienced editors. And finally, differences and similarities that will be drawn between artificial and human intelligence make for one very thoughtful comparison. While AI-amazing as it is, a creation of human ingenuity-does indeed impress by manipulating large volumes of data and carrying out certain tasks with a very high degree of precision, human intelligence-which has been whittled over in a tussle with millions of years of evolution-offers that special combination of skills that include contextual understanding, knowledge generalization, ethical evaluations, and emotional experiences.

The interaction and boundaries of these two kinds of intelligence do seem to raise some very significant questions about our future.

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The Effect of Nocturia Etiology on Quality of Life in Individuals Over the Age of 65

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ABSTRACT

Objective: This study aims to evaluate the effect of nocturia etiology on quality of life (QoL) in individuals over 65 years of age.

Materials and Methods: Quantitative descriptive and correlational design was used. The study was carried out with 102 patients aged 65 and over, who were followed up in the Urology Outpatient Clinic of a city hospital in Istanbul between November 2021 and April 2022. Structured Information Form, tracking and assessing nocturia to guide outcomes (TANGO) Nocturia Screening Tool, and the Short Form-36 Health Survey were used.

Results: The mean daily fluid intake of the patients was 1906.86±801.39 L, and the average number of urinations at night was 3.77±1.33. When the relationship between the number of nocturia episodes and the QoL of the patients was examined, a negative and statistically significant difference was found between the number of nocturia episodes and the mean physical functioning (p=0.001), bodily pain (p=0.000), and role-physical (p=0.000) scores.

Conclusion: This study revealed that the urinary tract etiological factor in the TANGO screening tool is the most dominant factor influencing the elderly with nocturia. The study further showed that the participants had a moderate level of QoL, and the most affected QoL sub-dimension is role-physical.

Keywords: Elderly, Nocturia, Quality of life, Urology

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INTRODUCTION

Nocturia is one of the most prevalent symptoms of lower urinary tract issues that can negatively impact one's quality of life (QoL). The likelihood of experiencing nocturia rises as individuals get older. Approximately 40% of both men and women in their 60s experience this condition, while the incidence increases to about 50% in those aged 80 and above.[1,2]

The primary risk factor for developing nocturia is advancing age. With aging, the urinary system undergoes several changes, such as a reduction in bladder capacity, a decrease in urinary flow rate, diminished ability to postpone urination and impaired kidney function.[3] The causes of nocturia can be indicative of serious underlying systemic issues, including cardiovascular, respiratory, endocrine, and metabolic diseases. It may also stem from age-related alterations in the lower uri-

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nary system, various hypervolemic conditions, modifications in medication due to aging, and shifts in lifestyle and sleep quality.[3-5]

Nocturia leads to significant negative consequences in terms of general well-being and sleep quality of the individual.[1,5,6] Poor sleep quality negatively affects the individual's QoL.[7] Since nocturia is the leading cause of sleep disruption, it can cause daytime fatigue, increased susceptibility to diseases, impaired cognitive performance, depression, insomnia-related accidents, and death. With advanced age, nocturia causes an increase in the risk of both falling and hip fracture, and this increase can be more prominent especially in motor and cognitive dysfunctions.[1,2,8] Nocturia can exacerbate symptoms of coexisting chronic conditions. As a result, addressing nocturia, particularly in older adults, has the potential to enhance quality of sleep and overall QoL while also alleviating certain symptoms linked to chronic diseases.[8]

It is the responsibility of healthcare professionals to define the early signs and symptoms and etiology of nocturia, which significantly increases mortality and morbidity in elderly individuals, and to follow approaches to eliminate it and increase the QoL. No studies have yet investigated the effect of nocturia etiology on QoL.[6,8,9] This study sought to investigate how the underlying causes of nocturia impact the QoL in individuals aged 65 and older.

MATERIALS AND METHODS

This study aimed to examine the impact of nocturia's underlying causes on the QoL in individuals aged 65 and older.

Setting and Participants

The study included 102 participants aged 65 and above who were followed up at the Urology Outpatient Clinic of a city hospital in Istanbul between November 2021 and April 2022. Eligible participants were those diagnosed with nocturia, without cognitive or perceptual impairments, and who consented to participate.

Instruments

The data were collected using the structured information form, tracking and assessing nocturia to guide outcomes (TANGO) Nocturia Screening Tool, and the Short Form-36 Health Survey (SF-36).

Structured Information Form

The form, which was prepared in line with the literature, consists of ten questions to collect information about the following characteristics of the participants: age, gender, marital status, presence of a chronic disease, continuous drug use status, the amount of fluid taken daily, and the number of urinations at night.[4,5]

TANGO Nocturia Screening Tool

The TANGO tool, developed by Bower et al.[10] and adapted into Turkish by Culha et al.,[5] was used to identify the potential and existing causes of nocturia. TANGO is a checklist-based tool consisting of 22 items across four domains: Cardiovascular-metabolic status, sleep, urinary tract, and well-being. Each item is scored as "true" (1 point) or "false" (0 points). Domain scores are calculated by summing "true" responses and dividing by the total number of items in the domain, with the highest scoring domain identified as the likely cause of nocturia. The Turkish version of the tool demonstrated a Cronbach's alpha of 0.73, while in this study, it was found to be 0.81.[5, 10]

SF-36, created by Ware and Sherbourne[11] and adapted into Turkish by Koçyiğit et al.,[12] is used to evaluate QoL. The scale consists of 36 items under eight sub-dimensions (physical functioning, role-physical, social functioning, role-emotional, mental health, vitality, bodily pain, and general health). The total scale score ranges between 0 and 100 points and higher scores indicate a better level of health. In the Turkish validation, the Cronbach's alpha for the sub-dimensions was reported between 0.73 and 0.76, reflecting reliable internal consistency.

Ethical Considerations

Data collection began after receiving ethics committee approval from the institution where the research was conducted (Approval Number: 2021/378). Written consent was obtained from all participants. The study was conducted in accordance with the Declaration of Helsinki.

Data Analysis

Data were analyzed using SPSS 25.0 statistical software for Windows (IBM, USA).[13] The Kolmogorov–Smirnov test was applied to determine whether continuous variables followed a normal distribution. The Kruskal–Wallis test was employed to compare demographic data across different etiological factors. A significance level of $p<0.05$ was applied.

RESULTS

The analysis of the individual characteristics revealed that 57.8% of the participants were male; their mean age was 68.95±4.02; 67.6% were married, and 53.9% had a chronic disease. It was revealed that the average daily fluid intake of the patients was 1906.86±801.39 L, and the average number of urinations at night was 3.77±1.33 (Table 1).

The findings obtained from the TANGO Nocturia Screening Tool are displayed in Table 2. The analysis of the etiological factors of nocturia according to the TANGO screening tool revealed that the cardiovascular-metabolic factors were prevalent in 22 (21.56%) participants. The prevalence of other fac-

Table 1. Characteristics of the patients (n=102)

Characteristics	Mean	SD	Minimum	Maximum	n	%
Age	68.95	4.02	65	79		
Height (cm)	165.14	8.88	150	185		
Weight (kg)	80.87	12.29	48	100		
The amount of fluid taken per day	1906.86	801.39	1000	4000		
Nocturia (times/d)	3.77	1.33	2	6		
Gender						
Female					43	42.2
Male					59	57.8
Marital status						
Married					69	67.6
Single					33	32.4
Educational level						
Not literate					10	9.8
Primary school					29	28.4
High school					40	39.2
University					23	22.5
Chronic disease						
Yes					55	53.9
No					47	46.1

tors can be listed as follows: Sleep in 26 (25.49%) participants, urinary tract in 34 (33.33%) participants, and well-being in 20 (19.61%) participants (Supplementary Fig. 1).

The mean scores of the participants on the SF-36 Health Survey sub-dimensions are as follows: Physical functioning 53.63±33.49, bodily pain 50.78±28.69, role-physical 37.50±38.34, role-emotional 58.50±34.29, mental health 56.61±18.49, social functioning 57.72±62.50, vitality 52.99±18.86, and general health 44.12±17.92 (Table 3).

Evaluation between the frequency of nocturia episodes and patients' QoL revealed a negative and statistically significant association. Higher numbers of nocturia episodes correlated with lower mean scores in physical functioning (p=0.001), bodily pain (p=0.000), and role-physical (p=0.000) dimensions of QoL (Table 4).

There was a negative relationship between TANGO cardiovascular-metabolic status domain and the mean scores for the bodily pain (p=0.000), role-physical (p=0.004), role-emotional (p=0.008), social functioning (p=0.000), and vitality (p=0.003) sub-dimensions of the SF-36 Health Survey (Table 4).

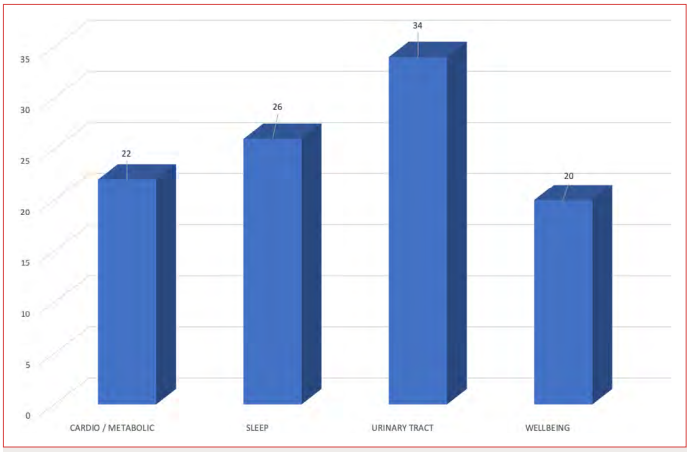

Figure 1. Distribution of etiological factors of nocturia by tracking and assessing nocturia to guide outcomes nocturia screening tool (n=102).

There was a significant relationship which was found between TANGO sleep domain and the mean scores for the sub-dimensions of bodily pain (p=0.002), role-emotional (p=0.011), social functioning (p=0.005), and vitality (p=0.000) in the SF-36 Health Survey (Table 4).

Table 2. Distribution of patients' responses to TANGO (n=102)

	STATEMENT	Yes, n (%)	No, n (%)
CARDIO/METABOLIC	1- My ankles, feet or legs swell during the day.	35 (34.3)	67 (65.7)
	2- I take fluid tablets (e.g. Lasix).	18 (17.6)	84 (82.4)
	3- I have kidney disease.	21 (20.6)	81 (79.4)
	4-I take tablets to control my blood pressure.	13 (12.7)	89 (87.3)
	5- I often get dizzy when standing up.	26 (25.5)	76 (74.5)
	6- I have high blood sugar OR diabetes.	16 (15.7)	86 (84.3)
	7- My blood sugar levels are difficult to keep stable.	5 (4.9)	97 (95.1)
SLEEP	1- I have 5 hours or less sleep per night.	46 (45.1)	56 (54.9)
	2- I would describe my sleep quality as bad.	41 (40.2)	61 (59.8)
	3- It takes me longer than 30 minutes to fall asleep at night.	33 (32.4)	69 (67.6)
	4- I have difficulty staying asleep at night because of my bladder.	39 (38.2)	63 (61.8)
	5- I often experience pain at night.	20 (19.6)	82 (61.8)
	6- I have been told I snore loudly OR stop breathing at night.	46 (45.1)	56 (54.9)
URINARY TRACT	1- I need to get up to pass urine within 3 hours of going to sleep.	84 (82.4)	18 (17.6)
	2- I experience a sudden urge to urinate on most days.	78 (76.5)	24 (23.5)
	3- I have a bladder urgency accident once a week or more.	60 (58.8)	42 (41.2)
	4- I often need to strain or push to start urinating.	31 (30.4)	71 (69.6)
	5- I have an enlarged prostate gland.(MALES ONLY)	26 (25.5)	76 (74.5)
WELLBEING	1- In general, I would say that my health is not good.	55 (53.9)	47 (46.1)
	2- I have trouble staying awake while driving, eating or during social activities.	10 (9.8)	92 (90.2)
	3- I have had a fall in the last 3 months.	31 (30.4)	71 (69.6)
	4- I don't look forward to things with as much enjoyment as I used to.	54 (52.9)	48 (47.1)

TANGO: Tracking and Assessing Nocturia to Guide Outcomes.

Table 3. Subscales Scores of The 36-Item Short Form Health Survey questionnaire of the Patients (n=102)

Subscales	Mean	SD	Min	Max
Physical functioning	53.63	33.49	0	100
Pain	50.78	28.69	2.5	100
Role limitations due to physical health	37.50	38.34	0	100
Role limitations due to emotional problems	58.50	34.29	0	100
Emotional well-being	56.51	18.49	16	88
Social functioning	57.72	62.50	12.5	87.5
Energy/fatigue	52.99	18.86	15	80
General health	44.12	17.92	5	70

A positive relationship between TANGO urinary tract domain and the mean scores for the SF-36 Health Survey sub-dimensions of physical functioning (p=0.001) and role-physical (p=0.012). In addition, a negative and statistically significant relationship was found between the urinary tract domain and the SF-36 sub-dimension of vitality (p=0.001) (Table 4).

Another finding is that a negative and statistically significant relationship was found between TANGO well-being domain and the SF-36 Health survey sub-dimensions of bodily pain (0.004), role-emotional (p=0.000), social functioning (p=0.001), and vitality (p=0.000) (Table 4).

DISCUSSION

It was found that among the etiologies of nocturia, urinary tract (33.33%) was the prior etiological condition, followed by sleep (25.49%), cardiovascular-metabolic status (21.56%), and well-being (19.61%). The items under the urinary tract domain

Table 4. The relationship between nocturia etiology and quality of life in patients (n=102)

Nocturia times and TANGO etiology factors	Physical Functioning	Pain	Role Limitations Due To Physical Health	Role Limitations Due To Emotional Problems	Social Functioning	Energy/ Fatigue	General Health	Emotional Well-Being
Nocturia (Times/d)								
r	-,327**	-,468**	-,494**	-0,106	-0,129	-0,099	-0,179	-0,112
p	0,001	0,000	0,000	0,288	0,198	0,320	0,072	0,264
TANGO Cardıo/Metabolic								
r	-0,150	-,351**	-,280**	-,260**	-,558**	-,295**	-0,173	-0,056
p	0,133	0,000	0,004	0,008	0,000	0,003	0,083	0,576
TANGO Sleep								
r	-0,023	-,307**	-0,163	-,251*	-,274**	-,422**	-0,063	0,019
p	0,815	0,002	0,101	0,011	0,005	0,000	0,530	0,849
TANGO Urinary Tract								
r	,317**	0,034	,247*	-0,149	0,018	-,311**	0,085	0,093
p	0,001	0,738	0,012	0,136	0,858	0,001	0,395	0,355
TANGO Wellbeing								
r	0,039	-,281**	-0,179	-,340**	-,318**	-,392**	-0,093	0,058
p	0,698	0,004	0,071	0,000	0,001	0,000	0,350	0,566

*Pearson Correlation test was used; TANGO: Tracking and Assessing Nocturia to Guide Outcomes.

in the TANGO Nocturia Screening Tool express the presence of voiding disorders and the frequency of nocturia due to the enlargement of the prostate, which is frequently seen in elderly men with overactive bladder.[5,10] It is highlighted in the literature that bladder storage problems; decrease in maximum urine flow rate, ability to delay urination, and kidney functions; increase in post-void residual volume; and age-related changes in detrusor muscle activity cause nocturia.[3,5,14]

The analysis of QoL among participants with nocturia revealed that the highest mean score was observed in the role-emotional sub-dimension, which reflects limitations due to emotional problems (58.50±34.29), while the lowest mean score was in the role-physical sub-dimension, which refers to limitations caused by physical problems (37.50±38.34). The total scores on the SF-36 Health Survey range from 0 to 100. The findings indicated that all sub-dimensions, except for role-physical and general health, had mean scores above average. This suggests that the overall QoL for participants was moderate, with role-physical being the most negatively impacted dimension, highlighting limitations in performing physical activities, including self-care tasks.

The literature underscores that nocturia significantly reduces individuals' QoL, with the physical functioning dimension being particularly affected due to the adverse impact of poor sleep quality associated with nocturia.[1,8,15,16]

A study examining the link between the frequency of nocturia episodes and participants' QoL found a negative and statistically significant association with the mean scores in the SF-36 Health Survey sub-dimensions of physical functioning, bodily pain, and role-physical. This result suggests that an increase in nocturia episodes among elderly individuals leads to a decline in QoL in these specific areas. In addition, the connection between nocturia and insomnia is widely recognized in existing research.[3] Sleep is essential for overall well-being, but its restorative function diminishes, particularly with aging, often leading to more frequent awakenings. In older adults, nocturia, along with the aging process itself, is a primary contributor to sleep disturbances. The resulting sleep deprivation from frequent nighttime awakenings can adversely impact overall health and well-being.[8] It is reported in the literature that poor sleep quality may have a negative impact on physical and mental functions as well as activities of daily living, which may lead to deterioration in QoL.[7,17,18] Studies which investigated the effect of nocturia and sleep disturbance on QoL found that nocturia is an independent risk factor for the physical component of QoL.[1,15]

A negative and statistically significant relationship was found between the TANGO cardiovascular-metabolic status domain and the mean scores of the participants for the sub-dimensions of bodily pain, role-physical, role-emotional, social functioning, and vitality. The items under the TANGO cardiovascular-metabolic status domain refer to disorders that contribute to nocturnal polyuria (peripheral edema, hypertension, kidney diseases, diabetes, etc.).[5,10] In this context, this finding indicates that as the cardiovascular-metabolic factors increase, the QoL associated with these areas is negatively affected. The low mean scores for the sub-dimensions of bodily pain, role-physical, and vitality may be attributed to biological changes in the physical dimensions of elderly individuals.[19] In cardiovascular diseases, peripheral edema may occur due to changes in salt and water retention, and the increase in the load on the heart causes an increase in urine production in the kidneys. This situation brings about nocturia and nocturnal polyuria, resulting in poor sleep quality.[20] After the onset of a cardiovascular disease, a decrease in physical activity and problems with the ability to physically perform daily routines such as self-care are to be expected.[21]

The study revealed a positive and statistically significant relationship between the TANGO urinary tract etiological factor and the mean scores for the SF-36 Health Survey sub-dimensions of physical functioning and role-physical. In addition, the study found a negative and statistically significant relationship between the TANGO urinary tract etiological factor and the mean score for the sub-dimension of vitality. Overactive bladder, incontinence, or the increase in voiding disorders due to the enlargement of the prostate in male patients can negatively affect the physical functioning dimension of QoL. Decreased bladder capacity, increased postvoid residual volume, overactivity of the detrusor muscle, and weak pelvic floor muscles are responsible for the development of both nocturia and urge incontinence, especially in older women. Decreased physical performance and weakness in older individuals have been strongly associated with the possibility of incontinence in the literature. The decrease in physical performance is associated with an increased risk of falling and hinders the elderly individual's ability to perform toilet activities.[22-24]

A negative and statistically significant relationship was found between the TANGO well-being etiological factor and the mean scores for the SF-36 Health Survey sub-dimensions of bodily pain, role-emotional, social functioning, and vitality. Health status, daytime sleepiness, and history of falls define the well-being domain of the TANGO. Nocturia is known to cause sleep disruption, fatigue, and impairment in performing activities of daily living. Especially fatigue due to poor sleep quality and daytime sleepiness are very important risk factors for accidents such as falls in elderly individuals.[3,10]

Previous studies reported that nocturia affects the physical and social functions of patients and causes a deterioration in general well-being. It has also been emphasized in the literature that the relationship between low walking speed and decrease in activities of daily living in elderly individuals can be evaluated as the consequence of the negative effect of nocturia on physical functioning and well-being.[3,7,25]

CONCLUSION

The study identified the urinary tract as the most prominent etiological factor contributing to nocturia in elderly individuals, as determined by the TANGO screening tool. It also highlighted that participants generally experienced a moderate QoL, with role-physical being the most affected dimension. To enhance care, improve QoL, and mitigate nocturia-related chronic conditions, healthcare professionals should thoroughly assess nocturia and its underlying causes as part of a comprehensive geriatric evaluation. Strategies to address and manage nocturia and its root causes should be carefully planned and implemented.

DECLARATIONS

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Ethics Committee Approval: The study was approved by Istanbul Prof. Dr. Cemil Taşçıoğlu City Hospital Ethics Committee (No: 2021/378, Date: 08/11/2021).

Author Contributions: Concept – Y.Ç.; Design – E.E., S.E.M.; Supervision – M.G.Ç.; Materials – Y.Ç., M.G.Ç.; Data collection &/or processing – E.E.; Analysis and/or interpretation – M.G.Ç., S.E.M.; Literature search – Y.Ç., E.E.; Writing – Y.Ç., E.E.; Critical review – M.G.Ç.

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Assessing Tetanus Vaccine Knowledge and Attitudes Among Emergency Department Physicians: A Comprehensive Investigation

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ABSTRACT

Objective: The primary goal of this study was to assess the knowledge and attitudes of general practitioners and emergency medicine specialists working in emergency departments regarding tetanus vaccines and prophylaxis.

Materials and Methods: This cross-sectional prospective study involved administering an online questionnaire to emergency physicians to gauge their knowledge and attitudes toward tetanus vaccination and prophylaxis. Data collection spanned from June 15, 2022, to September 15, 2022. The study compared the knowledge and attitudes of general practitioners and emergency medicine specialists regarding tetanus vaccination and prophylaxis.

Results: The study included 167 physicians, comprising 94 males (56.3%), 69 females (41.3%), and 4 unspecified (2.4%). Among them, 97 (58.1%) were emergency medicine specialists and 70 (41.9%) were general practitioners, with an average age of 32.42±8.47 years (range 21–55). Comparisons of knowledge levels about tetanus-suspect injuries (dirty wounds, wounds in contact with feces and saliva, burns, bites, and frostbite) revealed that environmental management systems had significantly higher knowledge levels than general practitioners ($p=0.005$, $p<0.0001$, $p=0.001$, and $p<0.0001$). Similarly, emergency medicine specialists exhibited superior knowledge regarding tetanus prophylaxis, particularly in relation to wound cleanliness, vaccination frequency, and years since the last vaccination.

Conclusion: The findings indicated that while emergency physicians possess general knowledge about tetanus, their understanding of the tetanus vaccination program and proper application of prophylaxis post-acute injury is insufficient. The study advocates for regular and comprehensive training on tetanus immunization for all emergency department physicians to enhance awareness and application accuracy in clinical settings.

Keywords: Injury, Prophylaxis, Rappel dose, Tetanus

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INTRODUCTION

Tetanus is a central nervous system disease characterized by resistant tonic spasms caused by *Clostridium tetani neurotoxins*.[1] Tetanus, a vaccine-preventable disease, results in 100% mortality in the absence of vaccine protection. The United States Center for Disease Control (CDC) and Prevention reported a total of 264 tetanus cases between 2009 and 2017.[2] According to the World Health Organization data, only one neonatal tetanus case

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was reported from our country after 2011, and 18 adult tetanus cases were reported in 2019.[3] The Tetanus vaccination program that started in 1937 in our country has gained momentum with the National Vaccination Campaign since 1985.[4] It is implemented throughout our country within the framework of the Expanded Immunization Program of the Ministry of Health.[5] Within the scope of the neonatal tetanus elimination program, tetanus vaccine has been administered to pregnant women since 1990. In addition, a monovalent tetanus vaccine is administered to men during military service.[6] It is also recommended that tetanus vaccination be repeated every 10 years for adults. As in the whole world, there are inadequacies in the implementation of these reminder doses recommended within the scope of adult immunization in our country. Another important point that contributes to the prevention of tetanus, which has a high mortality rate, is the appropriate treatment of patients presenting to emergency departments with injuries. Therefore, in case of any injury, the person should be carefully evaluated for tetanus vaccination and/or tetanus immunoglobulin administration according to previous immunization status, the condition, and shape of the wound.[7] The tetanus prophylaxis recommended by the CDC and prevention in the USA in cases of injury is based on the characteristics of the wound (Table 1) and the immune history of the patient (Table 2).[8,9] Wounds with non-viable tissues or dirt/rust contamination, open fractures, penetrating injuries, and abscesses are considered wounds at risk of tetanus because they provide an anaerobic environment for *C. tetani*.

Table 1. Wound characteristics

Not at risk of tetanus	At risk of tetanus
<6 h	(Time since injury) >6 h
<1 centimeter depth	>1 centimeter depth
Clean	Contaminated
Linear	Star-shaped
Nerves and vessels intact	Denervated, ischemic, frostbite
Not Infected	Infected

Despite tetanus vaccination programs, tetanus continues to be seen in our country. The reasons for this include the lack of regular administration of additional doses of vaccines, insufficient social awareness, the increase in the number of people whose vaccination schedule is unknown due to regular and irregular migration as a result of the turmoil in neighboring countries in recent years, and deficiencies in prophylaxis in tetanus-related injuries. To overcome these deficiencies, it is of great importance that our physicians working in emergency departments perform tetanus prophylaxis appropriately. Our study was planned to comparatively examine the level of knowledge and attitudes of general practitioners and emergency medicine specialists working in emergency departments about tetanus vaccination and tetanus prophylaxis.

MATERIALS AND METHODS

The study was a cross-sectional prospective study. Physicians working in the emergency department were administered an online questionnaire containing questions about their knowledge and attitudes about tetanus vaccination and tetanus prophylaxis. Data were collected between June 15, 2022, and September 15, 2022, through responses to online survey questions. Information on recommendations and practices regarding tetanus prophylaxis in trauma patients was evaluated with a 20-question questionnaire. The first 5 questions assessed demographic characteristics and 15 questions assessed knowledge about tetanus vaccination and tetanus prophylaxis practices in trauma patients. According to the responses obtained, the knowledge levels and attitudes of general practitioners and emergency medicine specialists about tetanus vaccination and tetanus prophylaxis were compared. This study was conducted in accordance with the 1964 Declaration of Helsinki and its subsequent amendments. Ethical approval was obtained from the İstanbul İstinye University Human Research Ethics Committee (June 08 2022, 22/95) before the study. Written informed consent was obtained from all participants before their inclusion in the study.

Table 2. Tetanus prophylaxis recommendations for injury

History of immunization	Clean and minor wounds	All other wounds
Unknown or <3	Td vaccine	TIG
≥3	No (Yes, if >10 years have passed since the last dose)	No (Yes, if >5 years have passed since the last dose)
Age <7 years	DBT vaccine	DBT vaccine
Age ≥7 years	Td vaccine	Td vaccine

Advisory Committee on Immunization Practices (ACIP) recommendations. Td: Tetanus and diphtheria, DBT: Diphtheria, tetanus, and pertussis, TIG: Tetanus immunoglobulin.

Statistical Analysis

Descriptive statistics are presented as frequency, percentage, mean, standard deviation, median, minimum, maximum, 25th percentile, and 75th percentile. In the analysis of categorical data, Fisher's Exact test was used if the percentage of cells with an expected value <5 was >20%, and the Pearson Chi-square test was used if the expected value was <5. The normality assumption was checked with the Shapiro-Wilk test. In the analysis of the difference between the numerical data of the two groups, the Mann–Whitney U-test was used because the data did not fit the normal distribution. Analyses were performed with the SPSS 23.0 program. P<0.05 was considered statistically significant.

RESULTS

A total of 167 physicians, 82 (65.6%) male, and 32 (32%) female, participated in the study. Age was reported by 166 of the participants. The mean age was 32.42±8.47 (21–55). It was determined that 58.1% (97) of the participants were emergency medicine specialists. Descriptive information about the physicians who participated in the survey is shown in Table 3. It was found that 94 (56.6%) physicians had no difficulty remembering the tetanus vaccination schedule and 97.6% (163) recommended tetanus vaccination for rabies prophylaxis. When asked about the conditions to be taken into consideration when administering tetanus prophylaxis to a patient presenting with an injury, eight physicians gave the incorrect answer intradermal and 59 (35.3%) physicians gave the incorrect answer patient age. The comparison of the knowledge levels and attitudes of general practitioners and emergency medicine specialists working in the emergency department about tetanus vaccination is shown in Table 4.

Table 3. Descriptive findings on participants' gender, field of specialization, titles, ınstitution of employment, and duration of employment

	N	%
Gender		
Female	69	41.3
Male	94	56.3
Unspecified	4	2.4
Specialization branch		
General practitioner	70	41.9
Emergency medicine	97	58.1
Title		
General practitioner	70	41.9
Residencies staff	33	19.8
Expert	46	27.5
Assistant professor	5	3
Associate professor	7	4.2
Professor	6	3.6
Current institution		
University hospital	55	32.9
Training and research hospital	51	30.5
State hospital	61	36.6
Duration of employment		
1–5 years	133	79.6
6–10 years	24	14.4
11–15 years	6	3.6
16–20 years	3	1.8
Over 20 years	1	0.6

DISCUSSION

The most common conditions requiring tetanus prophylaxis are traffic accidents, gunshot wounds, penetrating sharps injuries, and traumas. Lack of appropriate wound care and tetanus prophylaxis after these injuries contributes to the increased incidence of the disease. Therefore, physicians working in emergency departments should perform tetanus prophylaxis appropriately. In our country, emergency medicine specialists and general practitioners work together in emergency departments in hospitals without a Department of Emergency Medicine. Our study aimed to measure the level of tetanus vaccine prophylaxis knowledge and attitudes of physicians working in emergency departments and to compare the level of tetanus vaccine prophylaxis knowledge and attitudes of emergency medicine specialists and general practitioners. Of the participants, 97 (58.1%) were emergency medicine specialists and 70 (41.9%) were general practitioners.

Those who present with trauma should be evaluated for tetanus suspicious injuries. In our study, when the knowledge levels of general practitioners and emergency medicine specialists were compared for tetanus suspicious injuries (dirty, feces, and saliva contact wounds, burns, bites, and frostbite), the knowledge level of emergency physicians was found to be statistically significantly higher (p=0.005, p<0.0001, p=0.001, and p<0.0001, respectively). In a study by Dabas et al.[10] involving nurses and family physicians, it was shown that the sample group had low knowledge about adult tetanus immunization and only 48.3% of physicians knew the correct indication for tetanus vaccination. However, since our study included more emergency physicians compared to Dabas et al.,[10] we think that our rate of identifying the correct indication for tetanus vaccination is higher. Correct identification of tetanus suspi-

Table 4. Comparative analysis of knowledge and attitudes on tetanus vaccination among general practitioners and emergency medicine specialists

	General practitioner (%)	Emergency medicine specialists (%)	p
Tetanus suspected injuries			
Contact with dirt, feces, and saliva	50 (71.4)	86 (88.7)	0.005[1]
Burns	44 (62.9)	90 (92.8)	<0.0001[1]
Bites	55 (78.6)	93 (95.9)	0.001[1]
Freezing	18 (25.7)	62 (63.9)	<0.0001[1]
Recommendation for tetanus prophylaxis in a patient presenting to the emergency department with an injury and unknown vaccination status			
Adult-type tetanus toxoid, reduced diphtheria toxoid (Td)	40 (57.1)	40 (57.1)	<0.0001[2]
Recommendation for tetanus prophylaxis in a patient presenting to the emergency department with a clean injury and unknown vaccination status			
Tetanus vaccine only	52 (74.3)	92 (94.8)	<0.0001[2]
Recommendation for tetanus prophylaxis in a patient presenting with a clean minor injury, >3 doses of tetanus vaccine, and less than 10 years since the last dose of tetanus vaccine			
I do not recommend vaccination and immunoglobulin	38 (54.3)	67 (69.1)	0.024[2]
Recommendation for tetanus prophylaxis in a patient presenting to the emergency department with a dirty wound and unknown vaccination dose			
Tetanus vaccine and tetanus immunoglobulin	52 (74.3)	89 (91.8)	0.004[2]
Recommendation for tetanus prophylaxis in a patient presenting to the emergency department with a dirty wound, who has received ≥3 doses of tetanus vaccine and 5 years have not passed since the last dose of vaccine.			
I do not recommend vaccination and immunoglobulin	30 (42.9)	38 (39.2)	0.859[1]
Recommendation for tetanus prophylaxis in a patient with ≥3 doses of tetanus vaccine presenting to the emergency department with a dirty wound and 5 years since the last dose of tetanus vaccine			
Tetanus vaccine only	25 (35.7)	25 (25.8)	0.188[2]
In these cases, human tetanus immunoglobulin should be recommended for dirty wounds, regardless of previous vaccination status.			
Human immunodeficiency virus infection	61 (87.1)	87 (89.7)	0.609[1]
Severe immunosuppression	67 (%95.7)	95 (%97.9)	0.651[2]
Do you recommend tetanus vaccine for patients aged 65 years and over?			
I recommend it for patients with additional diseases	1 (1.4)	0	0.608[2]
I recommend to all patients	26 (37.1)	35 (36.1)	0,718[2]
Tetanus vaccine contraindications			
Previous vaccination after Td's history of pain in the region	7 (10)	0	0.002[2]
Previous vaccination after Td's history of rash in the region	6 (8.6)	2 (2.1)	0.07[2]
After a previous Td history of neurologic reaction	57 (81.4)	68 (70%)	0.096[1]
History of severe hypersensitivity after previous Td	61 (87.1)	61 (87.1)	0.038[1]

P[1]: Pearson Chi-square test; P[2]: Fisher Exact test. Different letters in the same row indicate that the column rates are statistically different from each other. P<0.05 is statistically significant. Td: Adult-type tetanus toxoid, reduced diphtheria toxoid.

cious injury in patients presenting with trauma will make a significant contribution to tetanus immunization in the adult age group. It is of great importance to whom the booster doses administered to patients admitted to emergency departments with injuries should be administered. In classical guidelines, the indication for prophylaxis is evaluated according to the patient's vaccination history and wound characteristics. In our study, tetanus prophylaxis knowledge levels were found to be statistically significantly higher in emergency medicine specialists in patients who presented with injury, whose last dose of tetanus vaccine was unknown, who had a clean injury, and whose last dose of tetanus vaccine was unknown, who had a clean minor injury, who had >3 doses of tetanus vaccine and whose last dose of tetanus vaccine had not been given for 10 years ($p<0.0001$, $p<0.0001$, and $p=0.024$).

When the knowledge levels and attitudes toward tetanus prophylaxis of patients who presented to the emergency department with a dirty wound, who had received ≥3 doses of tetanus vaccine, and who had been vaccinated for 5 years since the last dose were compared, no statistically significant difference was found for both participant groups ($p=0.188$ and $p=0.859$). The level of knowledge was found to be quite low in both groups. Talan et al.[11] showed in a study that 35% of 2000 patients admitted to the emergency department with injury did not receive the necessary prophylaxis according to wound type and indications and 8% received unnecessary prophylaxis.

Many studies have shown that tetanus antibody levels decrease with age and age is an important risk factor for tetanus immunity.[9] Regardless of whether the tetanus-diphtheria (Td) vaccine has been given in the last 10 years and if so, when, individuals aged 65 years and older should receive 1 dose of Td vaccine. The CDC recommendation is to give a booster every 10 years to individuals aged 65 years and older.[9] The knowledge and attitudes of both groups of physicians who responded to our questionnaire regarding the recommendation of tetanus vaccination for patients aged 65 years and older were not different. The rate of those who recommended vaccination was low in both groups (36.1% and 37.1%, respectively). Tetanus prophylaxis by emergency physicians, who constitute an important pillar of immunization, in patients aged 65 years and older, regardless of the wound status, will make a significant contribution to reducing the incidence of the disease.

The studies conducted in our country on tetanus immunization are studies in which the level of knowledge of patients or healthcare professionals about tetanus immunization or tetanus immunization is questioned.[12] This is the first study comparing the level of knowledge and attitudes of general practitioners and emergency medicine specialists working in emergency departments in our country on tetanus immunization.

Our study showed that all physicians working in the emergency department who will administer tetanus immunization have sufficient general knowledge about tetanus, but they do not have sufficient knowledge about tetanus vaccination programs and correct tetanus prophylaxis after acute injury. Emergency medicine specialists and physicians in training had higher general knowledge about tetanus and tetanus prophylaxis than general practitioners.[13] We think that this is a result of the tetanus immunization training received by emergency medicine specialists during their training.

CONCLUSION

Tetanus is still an important public health problem in Turkey. Interruption of the immunization program is the main factor in the re-emergence of tetanus. To increase awareness of this issue, we believe that it would be beneficial to give training to all physicians working in emergency departments at regular intervals and to repeat them.

Limitations

Our study had an observational and cross-sectional design and included only specialists and general practitioners working in the emergency department. Therefore, there may be bias because only physicians working in the emergency department were included, rather than comparing their attitudes and general knowledge about tetanus vaccine and/or booster recommendations with the general population of physicians who have knowledge about tetanus vaccine recommendations. On the other hand, as this survey focused on physician attitudes and general knowledge, it could not investigate specific patient preferences for obtaining records to refuse or accept booster vaccination. Further work to support this process is needed to improve the study.

DECLARATIONS

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Ethics Committee Approval: The study was approved by İstanbul İstinye University Human Research Ethics Committee (No: 22-95, Date: 08/06/2022).

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General Characteristics and Mortality Risk Factors in Critically Ill Pediatric Patients in a Pediatric Intensive Care Unit

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ABSTRACT

Objective: This study aims to evaluate the general characteristics of critically ill pediatric patients treated and monitored in our pediatric intensive care unit (PICU) and to examine the factors influencing mortality.

Materials and Methods: We included all critically ill pediatric patients treated and monitored in our PICU from January 2020 to November 2023. Patients were categorized into two groups: Survivors and non-survivors, with various comparisons made between these groups.

Results: The study included 1,035 patients, with a male predominance (56%). The median age was 37 months. The average PICU stay was 10.6±28.1 days. Mortality was 6.8%, with non-survivors having significantly higher Pediatric Risk of Mortality III (PRISM-III) scores (19 vs. 1, $p<0.001$) and longer PICU stays (13 vs. 4 days, $p<0.001$). Mortality increased with the number of affected systems ($p<0.001$). Tracheostomy and central vein catheter placement rates were higher among non-survivors ($p=0.006$ and $p<0.001$, respectively). Inotropic support and blood transfusions were significantly higher in non-survivors ($p<0.001$ and $p<0.001$). The PRISM-III score had a sensitivity of 82.6% and a specificity of 88.9% for predicting mortality at a cutoff of 10. Regression analysis showed that an increased number of affected systems ($p<0.001$), need for tracheostomy ($p=0.023$), inotropic support ($p=0.043$), and higher PRISM-III scores ($p=0.025$) were significant mortality predictors.

Conclusion: The need for tracheostomy, initiation of inotropic therapy, and the number of failing organ systems were identified as factors influencing mortality in critically ill pediatric patients. In addition, the PRISM-III score proved effective in predicting mortality in this cohort.

Keywords: Healthcare, Mortality, Pediatric intensive care units, Quality indicators

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INTRODUCTION

Pediatric intensive care units (PICUs) are specialized units where critically ill pediatric patients with one or more organ failures receive care and treatment from a multidisciplinary team of doctors, nurses, and intensive care health professionals.[1] Accurate prediction of the course of acute illnesses in these patients is crucial for guiding treatment decisions.[2] Mortality prediction models play a vital role in managing critically ill patients, enabling clinicians to anticipate potential adverse outcomes.[3]

Critically ill pediatric patients in PICUs often require monitoring due to severe acute illnesses or acute exacerbations of existing chronic conditions.[4] These patients present unique challenges due to factors such as age and underlying medical conditions, which can significantly affect their clinical management.[5] Furthermore, the use of complex invasive and non-invasive treatments, high-risk medications, and life-saving technology also influences mortality rates.[6]

To improve care quality and reduce mortality in PICUs, the application of validated scoring systems during the early stages of care and throughout the follow-up period has become increasingly important.[7] At present, the pediatric index of mortality and the Pediatric Risk of Mortality III (PRISM-III) are commonly used mortality prediction models in PICUs.[2] The Pediatric Risk of Mortality was first developed by Pollack et al.[8] in 1988 and was updated to the PRISM-III score in 1996.

This study aims to contribute to the literature by examining the clinical and demographic characteristics of critically ill pediatric patients admitted to our unit, assessing the impact of invasive treatment needs on mortality, and evaluating the effectiveness of PRISM-III scores, calculated within the first 24 h, in predicting mortality.

MATERIALS AND METHODS

This retrospective, observational single-center study was conducted at the PICU of the University of Health Sciences Türkiye, Bağcılar Training and Research Hospital, between January 2020 and November 2023. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and approved by the non-interventional clinical studies ethics board of Bağcılar Training and Research Hospital (Date: April 28, 2024, Decision Number: 2024/04/05/042). Informed consent was obtained from the guardians of all patients.

Our unit is an 8-bed tertiary care center. During working hours, the unit is staffed by one general pediatrician, three pediatric residents, and six PICU nurses. For 2 years of the study period, a pediatric intensive care specialist was also present, and for 1 year, an intensive care professor was involved. During night and weekend shifts, the unit was staffed by a pediatric resident, a senior resident overseeing all pediatric units and intensive care units, and a general pediatrician without specific PICU experience. All ancillary services, including radiology, pediatric surgery, orthopedics, and neurosurgery, operate 24/7; with the exception of pediatric surgery, all other clinics function as training facilities similar to ours.

Patients who were admitted to the PICU for <24 h or whose records could not be fully accessed from our hospital's automation system were excluded from the study. The following data were recorded: Demographic information (age, gender), number of organ systems with acute organ dysfunction, acute and chronic diagnoses, length of PICU stay, need for invasive mechanical ventilation (IMV), non-invasive ventilation (NIV), high-flow nasal oxygen (HFNO), central venous catheter (CVC) placement, extracorporeal treatments, requirement for blood and blood products (including erythrocyte suspension, platelets, fresh frozen plasma, albumin, and intravenous immunoglobulin), presence of nosocomial sepsis, need for total parenteral nutrition (TPN), time to initiate enteral feeding, PRISM-III score, and the outcome of the patient's follow-up. The PRISM-III score was calculated using the worst values obtained within the first 24 h of the patient's admission. Sepsis occurring more than 48 h after admission (including bloodstream infections, ventilator-associated pneumonia, and urinary tract infections) was classified as nosocomial sepsis.

The number of dysfunctional organ systems within the first 24 h following the initial PICU admission was determined using the pediatric organ dysfunction information update mandate criteria. Accordingly, a total of six systems were evaluated, including cardiovascular, respiratory, neurological, renal, hepatic, and hematologic systems.[9]

Patients were categorized into two groups based on the outcome of their PICU stay: Survivors and non-survivors.

Statistical Analysis

Data were analyzed using Statistical Package for the Social Sciences software version 29.0. Descriptive statistics summarized demographic and clinical characteristics. The Mann-Whitney U test and Pearson's Chi-square test were used to assess differences between survivors and non-survivors. The Mann-Whitney U test compared non-normally distributed continuous variables, while Pearson's chi-square test evaluated relationships between categorical variables. Receiver operating characteristic (ROC) curve analysis was performed to determine the predictive power of the PRISM-III score for mortality. Logistic regression analysis identified independent factors predicting mortality, and linear regression analysis assessed the impact of continuous variables on mortality. All tests were two-tailed, with a $p<0.05$ considered statistically significant.

RESULTS

A total of 1,035 patients were included in the study, with 56% (580/1,035) being male. The median age was 37 months (3 years and 1 month), with no significant difference between groups (p=0.945). Admissions peaked during winter, but this difference was not statistically significant (p=0.951).

The mortality rate was 6.8% (70/1,035). The average PRISM-III score was 4.6±7.2, significantly higher in non-survivors compared to survivors (19 vs. 1, p<0.001). Non-survivors also had a longer intensive care unit (ICU) stay (13 vs. 4 days, p<0.001).

Most patients were transferred from external centers (35.1%) or the pediatric emergency department (32.2%). Among non-survivors, at least two organ systems were affected within the first 24 h, with 78.6% having four dysfunctional systems. Mortality rates significantly increased with the number of affected organ systems (p<0.001).

The tracheostomy rate was 1.7% overall but significantly higher in non-survivors (5.7% vs. 1.3%, p=0.006). CVC placement was performed in 45.2% of patients, with a higher rate in non-survivors (88.6% vs. 42.1%, p<0.001). CRRT and TPE were more common among non-survivors (34.4% vs. 1.6%, p<0.001, and 17.1% vs. 2.2%, p<0.001, respectively). IMV was required by all non-survivors (100% vs. 25%, p<0.001), while NIV was significantly more frequent in non-survivors (17.1% vs. 7.4%, p=0.004). HFNO use did not differ significantly between groups (p=0.107). Inotropic support and blood product transfusions were also higher in non-survivors (97.1% vs. 6.1%, p<0.001, and 77.1% vs. 21.6%, p<0.001). TPN was needed by 10% of non-survivors compared to 2.7% of survivors (p<0.001). Enteral feeding was initiated in 84.5% of patients, with a higher rate in survivors (86.8% vs. 52.9%, p<0.001).

Nosocomial sepsis occurred in 11.3% of patients, significantly more in non-survivors (38.6% vs. 9.3%, p<0.001). Prolonged hospitalization due to social reasons was rare and did not differ significantly (p=0.884) (Table 1).

Pneumonia was more common in non-survivors (41.4% vs. 21.9%, p<0.001). Post-operative ICU admission and post-cardiopulmonary resuscitation cases were also more frequent in non-survivors (15.0% vs. 2.9%, p=0.005, and 17.1% vs. 1.2%, p<0.001). Central nervous system infections and other medical issues were observed more in non-survivors (7.1% vs. 1.8%, p=0.003, and 11.4% vs. 4.5%, p=0.009). Chronic conditions included neurological diseases (31%), genetic disorders (8.7%), and other categories with no significant differences between groups. Acute and chronic diagnoses are detailed in Table 2.

The PRISM-III score had an area under the curve (AUC) of 0.936, with a sensitivity of 82.6% and specificity of 88.9% at a cut-off of 10 (Fig. 1).

Regression analysis identified significant predictors of mortality: Each additional affected organ system within the first 24 h increased the odds of mortality by 17.8 times (p<0.001), tracheostomy by 15.5 times (p=0.023), and inotropic support by 12.7 times (p=0.043). Higher PRISM-III scores were also associated with increased mortality risk (p=0.025) (Table 3).

DISCUSSION

This study analyzed factors influencing mortality in critically ill pediatric patients in the PICU and evaluated the predictive power of the PRISM-III score. The ROC analysis demonstrated strong performance for the PRISM-III score (AUC: 0.936). An increase in the number of affected organ systems, the need for tracheostomy placement, and the requirement for inotropic support were associated with a higher risk of mortality.

Our study's mortality rate was 6.8% (70/1,035). This rate is comparable to other studies but varies across different regions. For instance, a multicenter study in Türkiye reported an 8.2% mortality rate, while studies in Argentina and China found rates of 8% and 8.9%, respectively.[2,10,11] Mortality rates reported by Karakaya et al.,[12] Gündoğan et al.,[13] and Durak et al.[14] were 8.96%, 8.6%, and 6.1%, respectively. While our mortality rate is lower than those reported in PICUs in developing countries and Türkiye, it is higher than the rates observed in European and American PICUs (1.85–5.8%).[15] These variations can be attributed to differences in patient profiles, treatment protocols, and care quality. Notably, the absence of pediatric hematology and oncology, as well as pediatric cardiovascular surgery in our clinic during the study period, likely influenced the lower mortality rate observed in our unit, as patients requiring these specialized treatments were not admitted to our PICU.

The use of mortality prediction models, such as PRISM-III, is crucial for enhancing the quality of care in PICUs.[7,16] The PRISM-III score assesses the risks and potential outcomes for pediatric patients in intensive care, with higher scores reflecting increased mortality risk.[8] Our study demonstrated that the PRISM-III score is a reliable tool for predicting mortality, achieving a sensitivity of 82.6%, specificity of 88.9%, and an AUC of 0.936. We identified a PRISM-III score cut-off value of >10 as the most effective threshold for predicting mortality. Our regression analysis further confirmed the PRISM-III score as an independent predictor of mortality (p<0.001). Consistent with the literature, which shows PRISM-III's predictive ability with AUC values ≥0.70,[2,8,11,17] our findings affirm its

Table 1. General characteristics and comparison of treatments in patients

Parameter	Total (n=1035)	Survivor	Non-survivor	p
Age, months, median (25–75p)	37 (10–124)	37 (11–103)	39 (10–124)	0.945
PICU length of stay, days, median (25–75p)	5 (3–23)	4 (3–9)	13 (3–23)	**<0.001***
PRISM-III score, median (25–75p)	2 (0–31)	1 (0–5)	19 (10–31)	**<0.001***
Sex, n (%)				
Male	580 (56.0)	539 (55.9)	41 (58.6)	0.658
Female	455 (44.0)	426 (44.1)	29 (41.4)	
Admission Season, n (%)				
Summer	266 (25.7)	250 (25.9)	16 (22.9)	0.951
Autumn	250 (24.2)	233 (24.1)	17 (24.3)	
Winter	280 (27.1)	260 (26.9)	20 (28.6)	
Spring	239 (23.1)	222 (23.0)	17 (24.3)	
Referring Department, n (%)				
Pediatric Emergency Department	333 (32.2)	305 (31.6)	28 (40.0)	**0.023**
Pediatric Surgery Department	48 (4.6)	48 (5.0)	0 (0.0)	
Pediatrics Department	61 (5.9)	52 (5.4)	9 (12.9)	
External Center	363 (35.1)	342 (35.4)	21 (30.0)	
In-Hospital other departments	208 (20.1)	198 (20.5)	10 (14.3)	
In-Hospital other ICUs	22 (2.1)	20 (2.1)	2 (2.9)	
Number of organ systems with acute organ dysfunctio (within the first 24 h), n (%)				
1	556 (53.7)	556 (57.6)	0 (0.0)	**<0.001**
2	278 (26.9)	276 (28.6)	2 (2.9)	
3	121 (11.7)	109 (11.3)	12 (17.1)	
4	78 (7.5)	23 (2.4)	55 (78.6)	
5	2 (0.2)	1 (0.1)	1 (1.4)	
Tracheostomy performed, n (%)	17 (1.6)	13 (1.3)	4 (5.7)	**0.006**
Central venous catheter required, n (%)	468 (45.2)	406 (42.1)	62 (88.6)	**<0.001**
CRRT, n (%)	39 (3.8)	15 (1.6)	24 (34.3)	**<0.001**
Therapeutic plasma exchange, n (%)	33 (3.2)	21 (2.2)	12 (17.1)	**<0.001**
IMV, n (%)	311 (30.1)	241 (25.0)	70 (100.0)	**<0.001**
NIV, n (%)	83 (8.0)	71 (7.4)	12 (17.1)	**0.004**
HFNO, n (%)	158 (15.3)	152 (15.8)	6 (8.6)	0.107
Inotropic support, n (%)	127 (12.3)	59 (6.1)	68 (97.1)	**<0.001**
Blood product, n (%)	262 (25.3)	208 (21.6)	54 (77.1)	**<0.001**
TPN requirement, n (%)	33 (3.2)	26 (2.7)	7 (10.0)	**<0.001**
Enteral feeding within the first 24 h, n (%)	875 (84.5)	838 (86.8)	37 (52.9)	**<0.001**
Nosocomial sepsis, n (%)	117 (11.3)	90 (9.3)	27 (38.6)	**<0.001**
Prolonged stay due to social reasons, n (%)	17 (1.6)	16 (1.7)	1 (1.4)	0.884

CRRT: Continuous renal replacement therapy; HFNO: High-flow nasal cannula oxygen therapy; ICU: Intensive care unit; IMV: Invasive mechanical ventilation; NIV: Non-invasive ventilation; PICU: Pediatric intensive care unit; PRISM-III: Pediatric risk of mortality III; TPN: Total parenteral nutrition. Statistical Tests Used: Pearson Chi-square test and *Mann-Whitney U test. Statistically significant p-values are indicated in bold.

Table 2. Comparison of acute and chronic diagnoses between survivors and non-survivors

Diagnosis	Total (n=1035) n (%)	Survivors (n=965) n (%)	Non-survivors (n=70) n (%)	p
Acute diseases				
Pneumonia	240 (23.2)	211 (21.9)	29 (41.4)	**<0.001**
Trauma	168 (16.2)	159 (16.5)	9 (12.9)	0.428
Bronchiolitis	137 (13.2)	131 (13.6)	6 (8.6)	0.233
Post-surgery (non-cardiac)	147 (14.2)	145 (15.0)	2 (2.9)	**0.005**
Status Epilepticus	94 (9.1)	90 (9.3)	4 (5.7)	0.589
Sepsis and septic shock	70 (6.8)	62 (6.4)	8 (11.4)	0.107
Poisoning	59 (5.7)	57 (5.9)	2 (2.9)	0.288
Diabetic ketoacidosis	58 (5.6)	57 (5.9)	1 (1.4)	0.116
Post-CPR	24 (2.3)	12 (1.2)	12 (17.1)	**<0.001**
CNS infection	22 (2.1)	17 (1.8)	5 (7.1)	**0.003**
Others (autoimmune, hematologic, oncologic, and renal diseases)	49 (4.7)	48 (5.0)	1 (1.4)	0.177
Chronic diseases				
Neurological diseases	321 (31.0)	292 (30.3)	29 (41.4)	0.051
Genetic diseases	90 (8.7)	80 (8.3)	10 (14.3)	0.086
Cardiological diseases	83 (8.0)	77 (8.0)	6 (8.6)	0.86
Endocrinological diseases	55 (5.3)	51 (5.3)	4 (5.7)	0.953
Metabolic diseases	45 (4.3)	39 (4.0)	6 (8.6)	0.073
Respiratory diseases	35 (3.4)	34 (3.5)	1 (1.4)	0.349
Gastrointestinal diseases	26 (2.5)	24 (2.5)	2 (2.9)	0.848
Others (autoimmune, hematologic, oncologic, and renal diseases)	51 (4.9)	43 (4.5)	8 (11.4)	**0.009**

Pearson Chi-square test was used. Statistically significant p-values are indicated in bold. CNS: Central Nervous system infections, CPR: Cardiopulmonary resuscitation.

utility in providing accurate prognostic information for PICU patients.

In our study, the number of affected organ systems emerged as a significant independent risk factor for mortality, with each additional affected system increasing the risk by 17.85 times. Notably, all non-surviving patients have involvement of at least two organ systems. As is well known, dysfunction in at least two organ systems is defined as multiple organ dysfunction (MOD). In our study, all patients who did not survive developed MOD within the first 24 h. Overall, the mortality rate among patients with MOD during our study period was 14.6%, a figure consistent with the literature, where rates range from 5% to 80%.[18] While many studies rely on organ failure scoring systems, there is a limited direct examination of the relationship between the number of affected systems and mortality. Ekinci et al.[2] reported that 34% of deceased patients had multi-organ dysfunction syndrome. Similarly, Umegaki et al.[19] found that in adults with sepsis, the risk of mortality increased by 2.2 times for each additional affected organ system.

Respiratory support therapies are critical in the management of critically ill pediatric patients in PICUs.[20] These therapies are essential for various conditions, including respiratory problems, comatose states, post-operative recovery, and chronic neurological issues. In our study, all patients in the non-survivor group received IMV, and 17.1% received NIV, both of which were significantly higher compared to survivors (p<0.001 and p=0.004, respectively). However, neither IMV nor NIV was identified as an independent predictor of mortality. Botan et al.[21] reported similar findings, with 76.8% of non-survivors initially

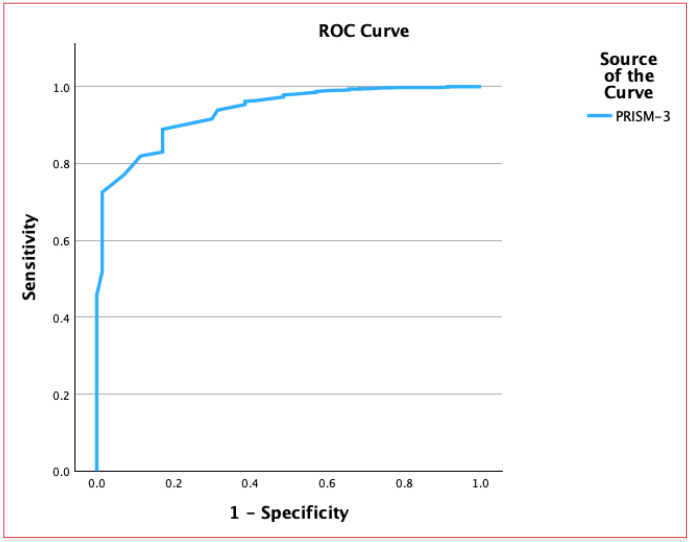

Figure 1. Receiver operating characteristic curve for the predictive power of the pediatric risk of mortality III score on mortality.

receiving IMV and 23.2% receiving NIV. HFNO is another respiratory support method, used in acute respiratory failure. In our study, HFNO was administered to 15.3% of patients, with no significant difference between survivors and non-survivors (p=0.107), consistent with other studies comparing its effectiveness to NIV.[14,20]

In our study, tracheostomy was performed in 5.7% of the non-survivor group, a rate that was statistically significantly higher compared to survivors (p=0.006). Moreover, in the regression model for mortality risk, the need for tracheostomy emerged as an independent risk factor (p=0.023). At present, tracheostomy in PICUs is primarily indicated for prolonged mechanical ventilation, upper airway anomalies, neurological disorders, and chronic lung diseases.[22] Considering these indications, we believe that the association between mortality and tracheostomy is more likely related to the underlying chronic conditions rather than the tracheostomy procedure itself.

Acute kidney injury remains a significant concern in critically ill patients, despite advances in PICU technology and renal replacement therapies.[23] CRRT has become a preferred choice in PICUs due to its advantages over peritoneal dialysis and intermittent hemodialysis.[24] Our study found a significantly higher proportion of non-survivors undergoing CRRT (34.4%, p<0.001), which aligns with findings from Botan et al.[21] (26.4% of non-survivors) and Durak et al.[14] (40% of non-survivors). A multicenter study also reported CRRT in 17.9% of non-survivors.[25]

TPE is an extracorporeal blood purification technique used in critical pediatric illness, though most data come from adult studies.[26] In our study, TPE was administered to 33 patients, with 17.1% of non-survivors requiring it, significantly higher compared to survivors (p<0.001). This finding is consistent with other studies, which report TPE needs in deceased PICU patients ranging from 5% to 26.2%.[12,14,21]

Nosocomial sepsis is a significant concern in intensive care units, associated with prolonged ICU stays, increased mortality, and morbidity. Many PICU studies have linked nosocomial

Table 3. Logistic regression analysis for predictors of mortality in patients

Variable	B	S.E.	Wald	df	Sig.	Exp (B)
Tracheostomy	2.743	1.21	5.14	1	**0.023***	**15.536**
Continuous renal replacement therapy	0.267	0.856	0.098	1	0.755	1.306
Non-invasive mechanical ventilation	0.197	0.853	0.053	1	0.817	1.218
Invasive mechanical ventilation	-14.025	1243.7	0	1	0.991	0
Inotropic infusion	2.54	1.252	4.113	1	**0.043***	**12.682**
Blood product transfusion	1.745	0.957	3.324	1	0.068	5.725
Healthcare-associated infections	1.396	0.823	2.875	1	0.090	4.038
Total parenteral nutrition	0.513	1.093	0.221	1	0.639	1.671
Number of organ systems with dysfunction (within the first 24 h)	2.882	0.543	28.201	1	**<0.001***	**17.851**
Enteral feeding initiation within 24 h	0.669	0.728	0.844	1	0.358	1.952
PRISM-III score	0.074	0.03	5.018	1	**0.025***	**1.077**
Constant	-15.029	3.066	24.021	1	**<0.001***	0

PRISM-III: Pediatric risk of mortality III.

sepsis to higher mortality rates.[21,27,28] Reported nosocomial sepsis rates in deceased PICU patients range from 21.3% to 55.5%.[21,27] In our study, the nosocomial sepsis rate was 11.3% (117/1035), significantly higher in the non-survivor group (38.6% vs. 9.3%, p<0.001). The increased infection risk in critically ill pediatric patients in intensive care is due to their underlying chronic diseases, compromised immunity from acute illnesses, and disrupted natural defense barriers from invasive procedures.[27]

Enteral nutrition is critical for the monitoring and treatment of critically ill children in PICUs.[29] It is recommended to start enteral feeding as soon as possible after ICU admission and stabilization of vital signs, provided there are no contraindications such as decompensated shock, ischemic bowel, or critical bowel stenosis.[30] A multicenter study in Türkiye found that critically ill pediatric patients who started early enteral feeding had lower mortality risk, shorter ICU stays, and shorter mechanical ventilation duration.[31] In our study, the rate of enteral feeding within the first 24 h was significantly higher in the survivor group (86.8%) compared to non-survivors (52.9%) (p<0.001). However, initiating feeding within the first 24 h was not identified as an independent risk factor for mortality. One limitation of our study is that we did not account for the time to reach enteral nutrition goals or examine the reasons preventing early enteral feeding. Therefore, our results cannot be generalized, and with only the information on initiating feeding within the first 24 h, it is difficult to comment on the overall relationship with mortality.

Respiratory system diseases were the most common acute diagnoses for PICU admission, accounting for 36.4% (pneumonia 23.2% and bronchiolitis 13.2%), followed by pediatric trauma patients at 16.2% and patients requiring post-operative monitoring at 14.2%. Numerous studies have identified respiratory diseases as the most frequent reason for PICU admissions, although subsequent diagnoses vary.[2,10,11,13,14] These differences may be due to variations in hospital capacities, the diversity of pediatric specialties, and regional differences in patient populations. During our study period, the absence of certain pediatric specialties (hematology, neurology, and cardiovascular surgery) at our hospital affected the diversity of patients admitted to our unit, influencing both the range of critical and accompanying chronic conditions.

In our study, 31% of patients with acute illnesses had neurological disorders, 8.7% had genetic disorders, and 8% had cardiological disorders. While existing literature indicates that accompanying chronic conditions impact mortality, our findings showed similar proportions of chronic conditions in both survivor and non-survivor groups.[2,14] Despite variations in reported proportions, neurological, metabolic, and cardiological disorders consistently rank among the top three. These differences may result from variations in specialization across centers and geographical factors.[10,12-14,21]

Our study also revealed that patients, with a median age of 37 months, most commonly presented during the winter season. The seasonal distribution of admissions showed that 27.1% occurred in winter, 25.7% in summer, 24.2% in autumn, and 23.1% in spring. The higher admission rate in winter may be linked to seasonal illnesses such as lower respiratory tract infections. A limitation of our study is the lack of analysis on the relationship between acute diagnoses and seasonal variations, leading to interpretations based on assumptions.

Our study has several limitations. First, being a retrospective study, the accuracy and completeness of the data rely entirely on hospital records, which may introduce risks of missing or erroneous information. Second, the study was conducted at a single center, which limits the generalizability of the results. In addition, the study population is restricted to patients admitted during a specific period, excluding variables outside of this timeframe. For instance, during the COVID-19 pandemic, our hospital functioned as a pandemic facility, leading to a decrease in admissions for non-respiratory conditions. In addition, our study was designed as a general examination of factors influencing mortality in critically ill pediatric patients, focusing on the number of dysfunctional organ systems. However, it did not analyze which specific organ systems were dysfunctional or their individual contributions to mortality, representing another limitation of the study.

CONCLUSION

PICUs are critical centers where children with severe illnesses receive multidisciplinary care through both invasive and non-invasive treatments. Accurate prediction of mortality risk in critically ill patients offers clinicians the opportunity for timely interventions, with the potential to improve patient outcomes. Our study provides valuable insights into factors affecting mortality in critically ill pediatric patients and highlights the strong predictive performance of the PRISM-III score in this context. Furthermore, we identified that mechanical ventilation, extracorporeal therapies, blood product requirements, and inotropic treatments were more frequently utilized in the non-survivor group. Importantly, we demonstrated that an increase in the number of dysfunctional organ systems significantly impacts mortality risk. These findings contribute to optimizing patient management strategies and improving prognosis in PICUs.

DECLARATIONS

Ethics Committee Approval: The study was approved by Bağcılar Training and Research Hospital Ethics Committee (No: 2024/04/05/042, Date: 28/04/2024).

Author Contributions: Concept – S.A., A.O., U.K.B., N.O.K.; Design – S.A., A.O., O.K.B., N.O.K., M.E.; Supervision – A.O., U.K.B., N.O.K., M.E.; Fundings – S.A., A.O.; Mterials – S.A., A.O., S.Y.; Data collection &/or processing – S.A., A.O., U.K.B.; Analysis and/or interpretation – S.A., A.O., S.Y.; Literature search – S.A., A.O.; Writing – S.A., A.O., S.Y.; Critical review – A.O., U.K.B., N.O.K., M.E.

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ORIGINAL ARTICLE

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Assessment of Bronchiolitis Severity Using Modified Tal and BROSJOD Scores

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ABSTRACT

Objective: Although the majority of patients diagnosed with acute bronchiolitis experience a mild and self-limiting clinical progression, others may develop more severe symptoms necessitating oxygen therapy and even hospitalization. This study aimed to evaluate the correlation between the Modified Tal (M-Tal) scores and the Bronchiolitis Score of Sant Joan de Deu (BROSJOD) with the disease's severity, the requirement for oxygen during treatment, and the duration of hospitalization.

Materials and Methods: Infants aged between 1 and 24 months who visited the Pediatrics Clinic and received a first-time diagnosis of bronchiolitis were included in the study. M-Tal and BROSJOD scores were determined according to the patients' findings, and the scores and treatment characteristics were compared.

Results: Average age of 111 patients who fit criteria of the study was 10.4±6.4 (1.5–24.0) months and 70 (63.1%) were male. The mean M-Tal score of the patients was 4.68±2.17 (1–10) and the mean BROSJOD score was 6.91±2.68 (2–15). High-flow nasal oxygen therapy (HFNC) was applied to 22 patients who did not respond to conventional oxygen therapy. The median M-Tal score of patients who underwent HFNC was 7.5, while the median of the BROSJOD score was 10 in those who underwent HFNC and 6 in those who did not (p=0.001). A positive correlation was found between length of hospital stay and M-Tal score and BROSJOD Score (r=0.532, p<0.001: r=0.477, p<0.001, respectively).

Conclusion: Several scoring systems exist to assess the severity of bronchiolitis and determine the need for hospitalization. While these scores are generally useful in studies, none have been consistently proven to be superior in all aspects. Our study's findings align with other bronchiolitis severity scores reported in the literature. However, a different study demonstrated a significant relationship between blood gas parameters and the Modified Wood's Clinical Asthma Score (M-WCAS), a relationship that we did not observe in our study. This discrepancy may be attributed to the early presentation of patients, where elevated scores were detected before changes in blood gas parameters became evident. In conclusion, clinical scoring systems may serve as valuable tools for assessing the severity of bronchiolitis in young children and predicting the potential need for intensive care.

Keywords: Bronchiolitis, High-flow nasal oxygen therapy, Infant, Score

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INTRODUCTION

Bronchiolitis is a respiratory infection resulting from inflammation and blockage in the lower part of the respiratory system. Its etiology is usually seasonal due to factors such as respiratory syntcytial virus, rhinovirus, adenovirus, metapneumovirus, coronaviruses, boca virus, and influenza virus. While most patients with acute bronchiolitis experience a mild, self-limiting clinical course, some may develop more severe respiratory distress and even respiratory failure.[1-3]

Evaluation of severity of disease in patients with bronchiolitis presents some difficulties, and there is no specific laboratory method that is indicative of the severity of the disease. Although pulmonary function tests are useful for assessing the severity of airway obstruction, they are not practical for use in infants. As a result, validated respiratory severity scores, which incorporate factors such as respiratory rate, auscultation findings, use of accessory respiratory muscles during breathing, physical signs like cyanosis, and occasionally oxygen saturation, can provide a more effective means of assessing the severity of bronchiolitis.[4-10] However, since the normal ranges for respiratory rate and heart rate differ across age groups in children, it is important that these scoring systems are arranged accordingly for each age groups. Among these, the Modified Tal (M-Tal) and Sant Joan de Deu (BROSJOD) score classified the number of respiratory rate according to the normal values of different age groups and determined the scores. [6-9] In addition to the M-Tal score, the BROSJOD score added heart rate and lung ventilation to the score parameters and determined the score by separating the number of respiratory rate and heart rate according to age groups.[9]

In this study, our goal is to assess the severity of the disease, treatment course, and hospital stay by applying both scoring systems to the same patient. In addition, we aim to compare the scores with each other.

MATERIALS AND METHODS

This observational prospective study was conducted in the Pediatric Clinic of our hospital with patients aged between 1 and 24 months who were diagnosed with bronchiolitis. The diagnosis of bronchiolitis was made based on clinical findings when cough, wheezing, rales, and tachypnea were accompanied by respiratory distress and use of accessory respiratory muscles following upper respiratory tract infection.[1,2] Information about the age, gender, complaints, clinical findings of these patients (cyanosis, respiratory rate, heart rate, partial oxygen saturation, use of accessory respiratory muscles while breathing and it's degree, and auscultation findings) and laboratory findings at the time of admission to the hospital were recorded and according to the findings, M-Tal and BROSJOD scores were determined (Appendix 1 and 2). Those who have had a bronchiolitis attack before, those who have received nebulization treatment, patients who are younger than 1 month and older than 24 months, those who have chronic heart, chronic lung and neuromuscular diseases, those who have dysmorphia and congenital anomalies (cleft lip and palate, microcephaly, etc.), those who are intubated in neonatal intensive care and infants with bronchopulmonary dysplasia, infants from multiple pregnancies, and infants with birth weight <2500 g (prematurity and infant small for gestational age) were not included in the study. This study was performed in accordance with the principles of the Declaration of Helsinki. Approval was obtained from the ethics committee of the hospital for this study (22/03/2021; number: 45). Patients requiring high-flow nasal oxygenation (HFNC) treatment and length of stay were recorded. The patients' scores, blood gas parameters, HFNC requirement, and length of stay were compared, and a relationship was sought between the scores. Informed consent was obtained from the parents of the participating children. The study procedures were explained in detail, and written consent was obtained.

Statistical Analysis

After the data obtained from the research were coded, it was transferred to the computer and analyzed in the Statistical Package for the Social Sciences (SPSS) (Version 22 for Windows, SPSS Inc., Chicago, IL, USA) package program. Shapiro–Wilk test was used to analyze the suitability of the data for normal distribution. While continuous variables were expressed as mean±standard deviation and median (minimum value–maximum value), frequency data were expressed as numbers and percentage (%). Categorical data were compared using the Pearson Chi-square test and Fisher Exact test. Since continuous variables did not follow a normal distribution, non-parametric tests were used to compare data between groups and in correlational analyses. Mann–Whitney U-test was used to compare paired groups. Kendall's W test for agreement between scores; Spearman correlation test was used for the relationship between scores and other parameters. In all tests, the statistical significance level was accepted as $p<0.05$.

RESULTS

Initially, 132 patients were enrolled in the study, but 21 were excluded due to incomplete records and missing blood gas data, leaving 111 patients for the final analysis. Average age of the patients was 10.4±6.4 (1.5–24.0) months and 63.1% were male (Table 1).

Polymerase chain reaction (PCR) was requested for a total of 72 patients, primarily due to the COVID-19 pandemic, and other etiologies were sought for those who were found negative. COVID-19 PCR was positive in 36 patients. In the respiratory

Table 1. Demographic and laboratory characteristics of the patients

	Mean±SD	Min–Max
Age (month)	10.4±6.4	1.5–24
Weight (kg)	7.2±3.2	3.5–13.5
M-Tal score (median)	4.68±2.17 (4)	1–10
BROSJOD score (median)	6.91±2.68 (6)	2–15
Hemoglobin (g/dL)	11.3±1.86	9,5–13,5
WBC (/mm^3)	12096±4771	4880–13270
Thrombocytes count (/mm^3)	354531±145306	180.000–590000
ph (on admission)	7.36±0.04	7.25–7.45
pCO_2 (on admission)	40.1±5.43	34.3–58.5
	n	**%**
Gender		
Girl	41	36.9
Boy	70	63.1
Age (month)		
1.5–6	38	34.3
7–12	34	30.6
13–24	39	35.1
HFNC/PICU	26	19.8
Total	111	100.0

Percent (%): The percentage of the column. HFNC: High-flow nasal cannula; PICU: Pediatric intensive care unit; BROSJOD: Bronchiolitis Score of Sant Joan de Deu; M-Tal: Modified Tal; WBC: White blood cells; pCO_2: Partial pressure of carbon dioxide; SD: Standard deviation

tract viral panel analysis of the remaining patients, RSV was detected in 10, influenza in 8, rhinovirus in 7 and adenovirus in 2, and no pathogen was found in 11 patients.

M-Tal and BROSJOD scores were determined according to the patients' admission findings.

According to the M-Tal score distribution on admission, 35.1% of the patients were mild, 57.7% have a moderate, and 7.2% have a severe clinical course. The distribution of the scores that patients received from the subcomponents of the M-Tal scoring is shown in Table 2.

According to the BROSJOD score distribution at the time of admission, 39.6% of the patients presented with mild clinical features, 49.6% with moderate features, and 10.8% with severe clinical features. The distribution of the scores that patients received from the subcomponents of the BROSJOD scoring is shown in Table 3.

Table 2. Distribution of M-Tal score parameters in patients

	0 Point n (%)	1 Point n (%)	2 Points n (%)	3 Points n (%)
Respiratory rate	2 (1.8)	66 (59.5)	41 (36.9)	2 (1.8)
Wheezes	13 (11.7)	73 (65.8)	11 (9.9)	13 (11.7)
Oxygen saturation	83 (74.8)	20 (18.0)	7 (6.3)	1 (0.9)
Accessory respiratory muscles	5 (4.5)	33 (29.7)	63 (56.8)	10 (9.0)

%: Percentage of rows. M-Tal: Modified Tal.

Table 3. Distribution of BROSJOD score parameters in patients

	0 Point	1 Point	2 Points	3 Points
Wheezes and rales	13 (11.7)	77 (69.4)	21 (18.9)	
Accessory respiratory muscles	5 (4.5)	82 (73.9)	14 (12.6)	10 (9.0)
Lung ventilation	1 (0.9)	88 (79.3)	18 (16.2)	4 (3.6)
Oxygen saturation	83 (74.8)	26 (23.4)	2 (1.8)	
Respiratory rate	2 (1.8)	64 (57,7)	40 (36.0)	5 (4.5)
Heart rate	3 (2.7)	40 (36.0)	54 (48.6)	14 (12.6)

%: Percentage of rows. BROSJOD: Bronchiolitis Score of Sant Joan de Deu.

When comparing BROSJOD and M-Tal scores, 32 patients were classified as mild, 48 as moderate, and 8 as severe according to the both scoring systems (Table 4).

According to the analysis performed to evaluate the consistency between scores, agreement was found between BROSJOD and M-Tal scores (Kendall's W=0.854, p<0.001). According to another analysis performed for the agreement between the scores, a moderate agreement between the scores was found (Kappa=0.603).

Table 4. Classification of M-Tal and BROSJOD scores in patients

BROSJOD score	M-Tal Score			Total
	Mild	Moderate	Severe	
Mild	32	12	0	44
Moderate	7	48	0	55
Severe	0	4	8	12
Total	39	64	8	111

BROSJOD: Bronchiolitis Score of Sant Joan de Deu, M-Tal: Modified Tal.

Patients showing signs of respiratory failure were initiated on HFNC therapy, and those who didn't respond were transferred to the pediatric intensive care unit (PICU). Throughout the follow-up of the patients involved in the study, it was found that 80.2% did not need HFNC or PICU, while 17.1% needed HFNC and 2.7% also needed pediatric intensive care. These patients were evaluated and compared based on their M-Tal and BROSJOD scores. It was observed that the average M-Tal and BROSJOD scores of those who needed HFNC/PICU were higher than those who did not need HFNC/PICU (p=0.001; p=0.001, respectively) (Figs. 1 and 2). However, no statistically significant difference in pH and partial pressure of carbon dioxide (pCO2) values on admission (p>0.05) (Table 5).

An analysis of the relationship between M-Tal score, BROSJOD scores, and pH and pCO_2 levels on admission revealed no statistically significant correlation between the M-Tal score and pH and pCO_2 levels on admission (r=−0.064, p=0.508; r=−0.018, p=0.855, respectively). No statistically significant correlation between BROSJOD score and pH and pCO_2 on admission (r=−0.039, p=0.685; r=−0.009 p=0.922, respectively).

Average hospital stay of the patients was 4.2±3.3 days. A positive and moderate correlation was found between the duration of hospitalization and M-Tal and BROSJOD scores (r=0.532, p<0.001; r=0.477, p<0.001, respectively) (Table 6).

DISCUSSION

Hospitalization is reported in approximately 13.3–16% of children with bronchiolitis under the age of 2 years.[11,12] About 2–13% of these patients also require treatment in the PICU.[11,13,14] Our patients consisted of hospitalized patients and HFNC treatment was applied to approximately one-fifth.

Several scoring systems, such as the modified Woods Asthma score, M-Tal, BROSJOD scores, are available to assess disease severity and determine the need for hospitalization in patients with bronchiolitis. Although the scores are generally useful in studies, no score has been shown to be superior to others in every aspect.[13,14] The Tal score was first defined in 1983, and in the following years, McCallum et al.[6] adjusted the respiratory rate according to age and modified it by changing oxygen saturation instead of cyanosis which is one of its components, and was validated by Golan-Tripto et al.[7], [5,8] It has been suggested that the M-Tal score is a more accurate predictor of disease severity compared to the Tal score. Different studies have reported that, M-Tal score is a simple and dependable method for hospital admissions. It has been demonstrated that the M-Tal score is a reliable and easily applicable criterion, especially when compared to other scoring systems, for deciding hospitalization in bronchiolitis patients.[15] Our patient group consisted of inpatients and the M-Tal score was generally moderate.

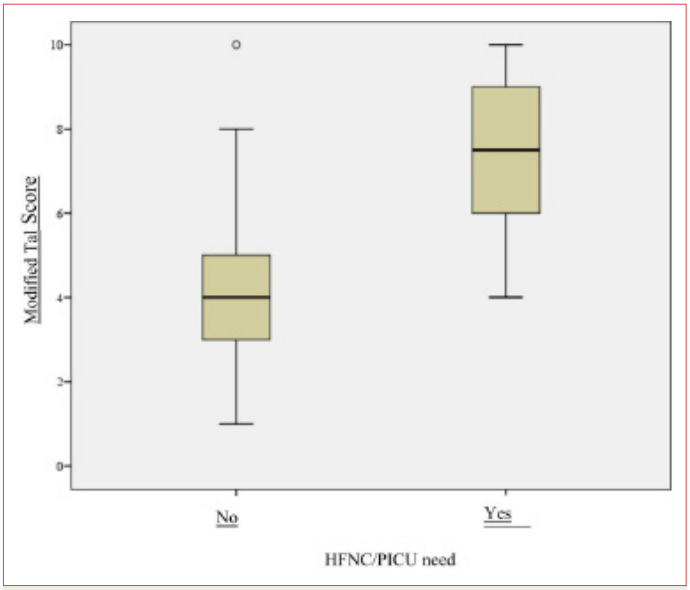

Figure 1. Modified Tal score comparison according to HFNC/PICU need.

HFNC: High-flow nasal cannula; PICU: Pediatric intensive care unit.

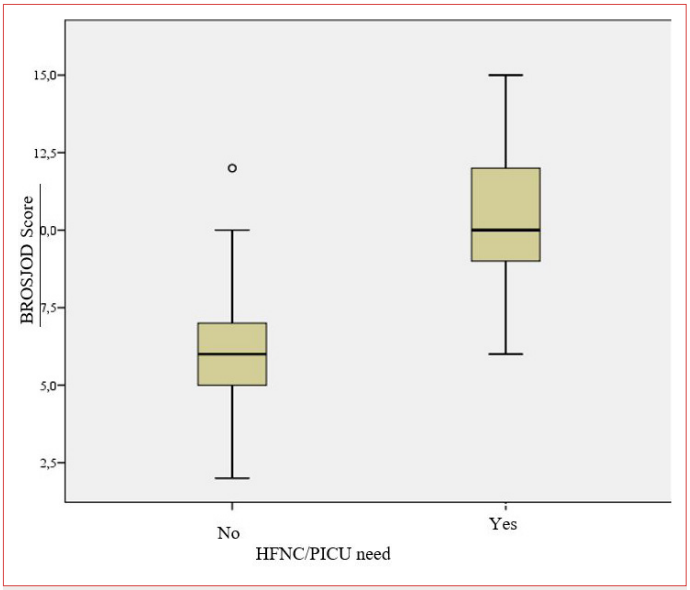

Figure 2. BROSJOD score comparison according to HFNC/PICU need.

BROSJOD: Bronchiolitis score of Sant Joan de Deu; HFNC: High-flow nasal cannula; PICU: Pediatric intensive care unit.

The BROSJOD score evaluates heart rate as well as respiratory findings. Unlike other scores, it also evaluates heart rate and provides the opportunity to score according to age groups. Balaguer et al.[9] evaluated the relationship between

Table 5. Comparison of M-Tal and BROSJOD according to HFNC/PICU need

	No of patient	Median	Min.	Max.	P*
M-Tal score according to HFNC/PICU need					
No need	89	4,0	1	10	**<0.001**
Needed	22	7,5	4	10	
BROSJOD score according to HFNC/PICU need					
No need	89	6	2	12	**<0.001**
Needed	22	10	6	15	
Ph according to HFNC/PICU need					
No need	89	7.37	7.24	7.46	0.781
Needed	22	7.37	7.19	7.43	
CO_2 according to HFNC/PICU need					
No need	89	40.6	24.4	51.4	0.953
Needed	22	41.0	25.0	54.3	

Mann–Whitney U. HFNC: High-flow nasal cannula; PICU: Pediatric intensive care unit; BROSJOD: Bronchiolitis Score of Sant Joan de Deu; M-Tal: Modified Tal; CO_2: Carbon dioxide.

Table 6. Relationship between length of stay and M-Tal and BROSJOD Score

	M-Tal score	BROSJOD score
Length of Hospitalization (day)		
n	111	111
r	0.532	0.477
P*	<0.001	<0.001

Spearman correlation test. BROSJOD: Bronchiolitis Score of Sant Joan de Deu; M-Tal: Modified Tal.

bronchiolitis severity and BROSJOD and reported that as the scale score increased, the patient's oxygen and ventilation requirements increased.[9] In a study, it was suggested that the best-validated score among bronchiolitis scores is BROSJOD, and that the sensitivity of the BROSJOD score is higher than others, especially in RSV infections, and that it is followed by the M-Tal score.[16] In our study, a significant number of the patients were found to have COVID-19 as the underlying cause. It was observed that M-Tal and BROSJOD scores were high in line with the severity of bronchiolitis, patients with high scores needed HFNC treatment, and some of them required treatment in the PICU.

Guitart et al.[17] compared M-Tal and BROSJOD scores and reported that they were not superior to each other. In different studies, it has been reported that the M-Tal score is compatible with the Wang score, and in another study, it is also compatible with the BROSJOD, ESBA, and Wood-Downes-Ferrés scores.[10,17] Similarly, in our study, no superiority was shown between the M-Tal and BROSJOD scores, and there was no superiority between them. A medium strength relationship was detected.

It is recommended that respiratory failure that may occur in patients be monitored with blood gas parameters (p<7.25; PCO_2>45 mmHg).[18] The association between blood gas levels and respiratory scores has been demonstrated in bronchiolitis patients treated in the PICU, using another respiratory scoring system, the Modified Wood's clinical asthma score.[19,20] In our study, patients were evaluated according to their blood gas parameters at admission. However, no relationship was found between the scores and pH and PCO_2 levels. It is thought that this result is due to the fact that the patients applied early and the scores were found to be high without being reflected in the blood gases. In our study, only blood gases at the time of admission were evaluated; it is thought that this result occurred because their levels during follow-up were not evaluated.

Proven treatment options for bronchiolitis are hydration, oxygen, and nasal aspiration.[1,2] In situations where conventional oxygen therapy is ineffective, HFNC treatment is recommended. If HFNC treatment fails to provide adequate support, invasive ventilation is advised.[21-23] Studies have reported that HFNC treatment may be a safe treatment option that helps improve clinical parameters such as oxygen saturation, heart rate, respiratory rate, and blood gas levels in patients with

bronchiolitis. This treatment approach may help decrease the need for invasive ventilation support.[23,24] In their study on infants with bronchiolitis aged 1–24 months Murphy et al.[25] found that HFNC use led to improvements in respiratory parameters, heart rate and M-Tal scores compared to the control group. However, there was no significant difference in hospitalization duration with this treatment. In another study, it was suggested that an M-Tal score of >5 4 h after HFNC treatment and a young age indicate HFNC insufficiency.[26] In cases where the BROSJOD score is >8, HFNC treatment is recommended.[27] The scores of our patients were found to be higher in those requiring HFNC and PICU than the others and showed similar scores. This shows that these scores have a significant place in determining the severity of bronchiolitis.

The hospitalization length in patients with bronchiolitis is generally reported to be 3–7 days.[3,10] Another result of our study was that the hospitalization length of patients with high scores was longer than the others. In different scores made in patients with bronchiolitis, neither the Children's Hospital of Wisconsin Respiratory Score nor Respiratory Distress Assessment Instrument showed a significant relationship with the duration of hospitalization and the scores.[28-30] The pediatric component of the comprehensive severity index scoring, which evaluates clinical, laboratory and radiological findings, was found to be associated with the duration of hospital stay.[31] Our research is the first to investigate the relationship between length of hospital stay and M-Tal and BROSCOD scores. The fact that this result is achieved by only including clinical findings and oxygen saturation in our scoring systems shows that these scores also have an effect on prognosis. However, it has been reported that there is no effect in the duration of hospital stay of patients with high M-Tal and severe respiratory distress who require HFNC treatment compared to those who are not given HFNC treatment.[25] Unlike treatment methods, patients with high scores are thought to require longer hospitalization.

CONCLUSION

As the BROSJOD and M-Tal scores increase, the length of hospitalization also increases. This indicates that clinical scoring systems may be valuable tools for assessing the severity of bronchiolitis in young children and predicting the potential need for intensive care.

Limitations

The first limitation is that our patient group was small-scale, the second is that not all respiratory viruses were isolated, another is that the study was conducted during the pandemic, and the last limitation is that it was a single-center study.

This study was based on the my medical specialization thesis of the corresponding author.

DECLARATIONS

Ethics Committee Approval: The study was approved by University of Health Sciences, Hamidiye Medical Faculty Ethics Committee (No: 45, Date: 22/03/2021).

Author Contributions: Concept – L.A., Y.T.; Design – L.A., Y.T.; Supervision – Y.T.; Fundings – L.A., A.K., M.T.P. Y.T.; Materials – L.A., A.K., M.T.P. Y.T.; Data collection &/or processing – L.A.; Analysis and/or interpretation – L.A., Y.T.; Literature search – L.A., A.K., M.T.P. Y.T.; Writing – L.A., Y.T.; Critical review – L.A., A.K., M.T.P. Y.T.

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Appendix 1. Modified Tal score (6.8)

SCORE	Respiratory rate/min		Wheezes	Oxygen saturation	Accessory respiratory muscles
	<6 months	>6 months			
0	<40	<30	No	≥95	No
1	41–55	31–45	With Stethoscope During Expiration	92–94	+
2	56–70	46–60	During Inspiration and Expiration	90–91	++
3	>70	>60	Without Stethoscope	≤89	++++

The total score obtained from the M-Tal score is considered as mild disease between 1 and 3 points, as moderate disease between 4 and 8 points, and as severe disease between 9 and 12 points.

Appendix 2. BROSJOD Score (9)

Wheezes and Rales	0: No			
	1: Expiratory wheezes, inspiratory rales			
	2: Expiratory and inspiratory wheezes/rales			
Accessory respiratory muscles	0: No			
	1: Subcostal, lower intercostal			
	2: (1) + supraclavicular + nasal flaring			
	3: (2)+ upper intercostal + tracheal retraction			
Lung ventilation	0: Normal			
	1: Regular and symmetrical			
	2: Asymmetrical			
	3: Very little			
Oxygen saturation	Without oxygen	With oxygen		
	0: >95%	1:>94% with FiO_2 ≤40%		
	1: 91–94%	2:<94% with FiO_2 >40%		
	2: <94%			
Respiratory rate (beats/min)	0	1	2	3
<3 months	<40	40–60	60–70	>70
3–12 months	<30	30–50	50–60	>60
12–24 months	<30	30–40	40–50	>50
Heart rate (beats/min)	0	1	2	3
<1 year	<130	130–150	150–170	>170
1–2 years	<110	110–120	120–140	>140

O_2: Oxygen; FiO_2: Fraction of inspired oxygen, BROSJOD: Bronchiolitis Score of Sant Joan de Deu. When the total score from the BROSJOD Bronchiolitis Score is evaluated, 0–5 points are considered minor crisis; 6–10 points, moderate crisis; and 11–16 is considered a severe crisis.

ORIGINAL ARTICLE

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High Heterotopic Ossification Occurs in Acetabulum Fracture Patients Undergoing Combined Hip Surgery with Plate Fixation

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ABSTRACT

Objective: Acetabular fractures, often resulting from high-energy traumas, are serious orthopedic injuries that significantly affect both the stability and function of the hip joint. This study aims to evaluate the functional, clinical, and radiological outcomes of various fixation materials (cables, plates, and screws) used during acute total hip arthroplasty (THA) in patients with acetabular fractures. By comparing different fixation techniques, it seeks to determine their relative efficacy and their contributions to achieving stable fixation and improved clinical outcomes.

Materials and Methods: This retrospective study analyzed data from 57 patients treated with acute THA between 2007 and 2018. Patients were grouped based on the fixation method used: Cables, plates, or screws. Clinical outcomes were assessed using the Harris Hip Score (HHS) and Merle d'Aubigne-Postel scoring systems, while radiological evaluations focused on stability, heterotopic ossification (HO), and component alignment. Statistical analyses were performed to compare functional and radiological outcomes among groups.

Results: The mean HHS was 85.5, and the overall mobility rate was 86%. While no statistically significant differences were found in functional scores, complication rates, or radiological outcomes among the fixation groups, trends were observed. Cable fixation was associated with lower HO rates (39% vs. 61% overall), while plate fixation showed slightly higher mobility rates. The overall complication rate was 26.3%, with HO observed in 61% of patients. Despite these challenges, patient outcomes were generally satisfactory, with stable fixation achieved in all cases.

Conclusion: Acute THA is a viable treatment option for acetabular fractures, particularly when open reduction and internal fixation alone cannot ensure adequate stability. Stable fixation is the primary determinant of successful outcomes, irrespective of the fixation method used. Future studies with larger cohorts are needed to validate these findings and optimize fixation strategies based on patient-specific factors such as bone quality and fracture complexity.

Keywords: Acetabulum, Fracture fixation, Functional outcomes, Hip prosthesis, Orthopedic implants

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INTRODUCTION

Acetabular fractures are serious orthopedic injuries that typically occur due to high-energy trauma (e.g., traffic accidents) in young adults and low-energy trauma (e.g., falls from standing height) in elderly individuals. The treatment of these fractures ranges from conservative methods to surgical approaches.[1] Among the surgical options, open reduction and internal fixation (ORIF) is considered the gold standard for managing acetabular fractures.[2] The primary objectives of ORIF are to achieve anatomical alignment of the joint sur-

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face, restore stability, and prevent long-term complications such as post-traumatic osteoarthritis. However, post-traumatic osteoarthritis (12–57%) remains the most common cause of failure[3,4] and even in the hands of experienced surgeons, the 10-year incidence of total hip arthroplasty (THA) varies between 8% and 35%, depending on factors such as fracture type and patient age.[5]

Patients requiring acute THA following ORIF are often confronted with complications such as heterotopic ossification (HO), scar tissue formation, contractures, avascular necrosis (AVN) of the femoral head and acetabulum, vascular injury, and occult infections.[6] These complications render secondary THA procedures challenging and negatively impact surgical outcomes. Despite the possibility of such complications, ORIF is generally the first-line treatment choice. However, acute THA may be preferable in cases involving osteoporosis, severe comminuted fractures, extensive wear of the femoral head, fractures of the femoral head that cannot be reconstructed, pre-existing hip arthritis, and articular impaction of the medial wall.[2,7-10]

Mears et al.[8] have reported that acute THA could be a treatment option for selected acetabular fractures. Acute THA confers the advantage of immediate post-operative weight-bearing, thereby reducing the risk of thrombotic events, decubitus ulcers, and pulmonary complications.[11-16] Moreover, by stabilizing the fracture in a single operation, it minimizes complications associated with soft tissue.

In acetabular fractures, the acetabular component alone may not provide sufficient stability, and supplementary methods (e.g. cables, plates, and screws) may be required. The present study aims to evaluate the functional, clinical, and radiological outcomes of implants used for additional stabilization in patients undergoing THA.

MATERIALS AND METHODS

This retrospective study was conducted at a university hospital between January 2007 and July 2018. The study protocol received approval from the Local Ethics Committee (No: 2018-13/23) and informed consent was obtained from all participants. The study was conducted in accordance with the Declaration of Helsinki.

The indications for performing acute THA operations on patients are detailed in Table 1[3,10,17,18] which elucidates the necessity of the procedure and summarizes the patient selection criteria. The patients underwent acute THA and open reduction internal fixation (ORIF) using cables, plates, or screws. These procedures were collectively classified as a combined hip procedure (CHP). Patients who were followed up for a minimum of 12 months were included in the study. The exclusion criteria comprised patients who had undergone surgical interventions at other centers during the follow-up period or those who did not adhere to follow-up appointments regularly.

The patients were assessed for various parameters, including age, gender, weight, body mass index (BMI), the affected side, additional injuries, the cause of trauma, and the need for post-operative intensive care. The patients were categorized into three groups based on fixation methods – Group 1: THA fixation with cable (Fig. 1), Group 2: THA fixation with plate (Fig. 2), and Group 3: fixation with screws (Fig. 3).

Table 1. Acute total hip arthroplasty indications[3,10,17,18]

Absolute	n	Relative	n
Femoral head impaction	3	Delayed presentation	3
Acetabular impaction – especially. If >40%	3	High risk fracture types; t type, posterior column/ posterior wall, and transverse posterior wall	10
Inability to adequately reduce fracture	2	Comorbidities	
İntraarticular comminution	3	Obesity	
Full-thickness abrasive loss of the articular cartilage	2	Advanced age	2
Displaced fracture of the femoral neck or fracture of femoral head	3	Somatosensory, neurologic, or psychiatric impairment	
Loss of joint congruity	2		
Osteopenia or osteoporosis	16		
Pre-existing severe osteoarthritis or AVN	7		
Pathological	1		

n: Patient number; AVN: Avascular necrosis.

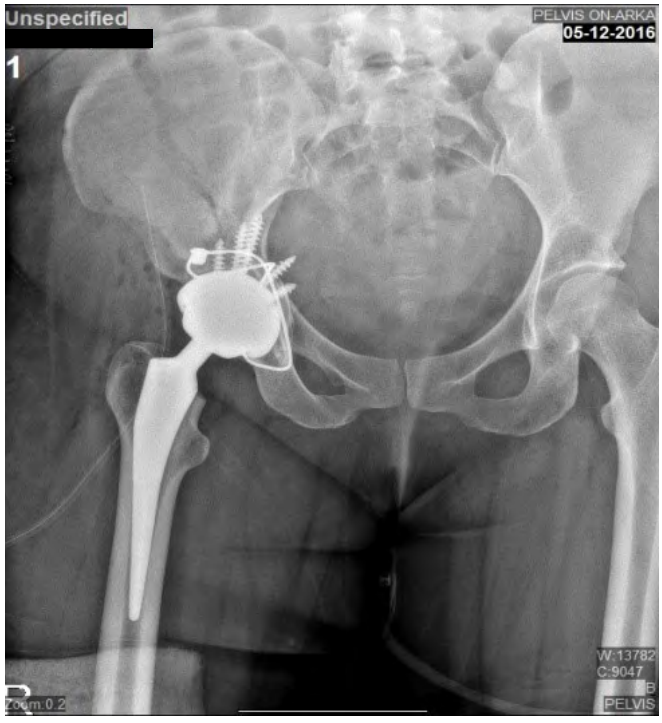

Figure 1. A patient applied with total hip arthroplasty with cable fixation.

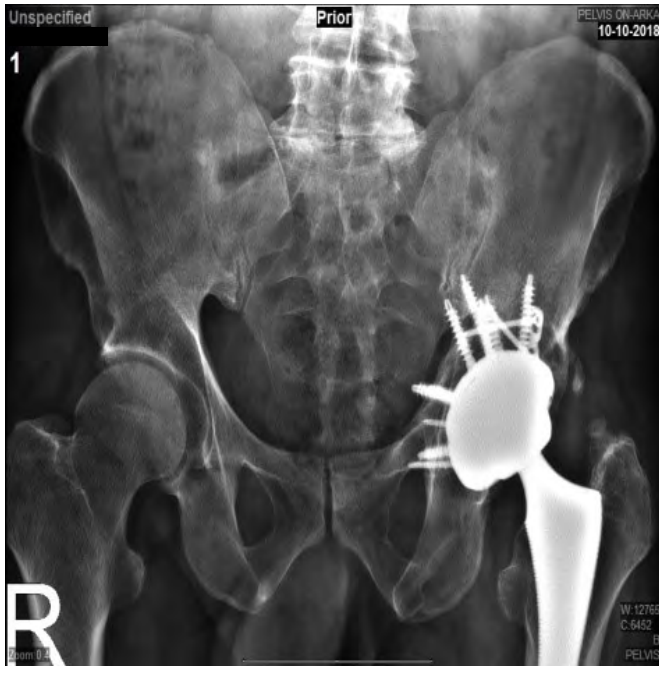

Figure 2. A patient applied with total hip arthroplasty with plate fixation.

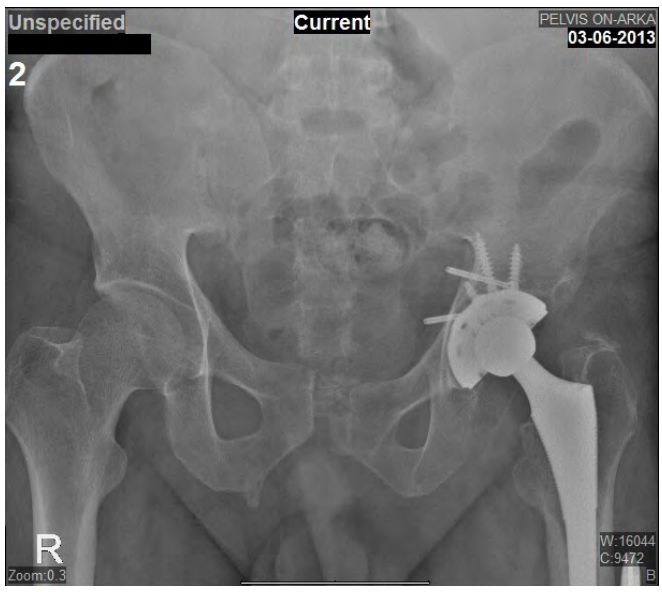

Figure 3. A patient applied with total hip arthroplasty with screw fixation.

Fixation Method

Cable fixation is a preferred method in cases where the fracture line is located at the upper level of the greater sciatic notch. It has proven to be particularly effective for high posterior column fractures, transverse fractures with high anterior or posterior extensions, and complex fractures involving both columns. In addition, cable fixation has been utilized to provide supplementary stability in cases of osteoporosis, where conventional plate and screw applications fail to offer adequate fixation due to poor bone quality.[18,19]

In situations where the anatomical restoration of the joint surface is necessary and stability is of critical importance, plate fixation is applied.[20] This method has played a significant role, particularly in anterior column and posterior hemitransverse fractures. Plate fixation is the preferred approach when maintaining the anatomical integrity of the anterior and posterior columns, as well as the posterior wall, is required to ensure the proper placement of the acetabular component.

Screw fixation, conversely, is employed to secure small fracture fragments or to provide supplementary stability, and it has been particularly beneficial in stabilizing fracture fragments in posterior wall fractures, thereby creating a stable foundation for implant placement.[21]

Surgical Method

The patients underwent surgery under anesthesia, spinal anesthesia, or a combination of spinal and epidural anesthesia. A standard posterolateral approach through Kocher-Langenbeck

incision or a modified Gibson incision was used with the patients in the lateral decubitus position. All patients received antibiotic prophylaxis with first-generation cephalosporins, commencing 12 h preoperatively, administered every 4 h during the operation, and continued for 24–48 h postoperatively.

Pre-operative thromboembolic prophylaxis was initiated, and this was continued up to the 4th week postoperatively. In addition to this, the use of anti-embolic stockings was required for a period of 1 month postoperatively. Drains were removed on the 1st post-operative day, and knee and hip isometric exercises were initiated. With the exception of patients with other fractures that prevented mobilization, all patients were mobilized with a walker, stick, or crutches.

Functional and Radiological Evaluation

Postoperative clinical and radiographic evaluations were conducted at 6 and 12 weeks, 6 months, 1 year, and 2 years. Patients were questioned about satisfaction with the operated hip, use of assistive devices when walking, and any limping. Data on hospital stay length, follow-up period, complications, mortality, and time to return to work were recorded.

The functional assessment of the patients was conducted using the hip joint range of motion (ROM), Harris Hip Score (HHS), and the Postel-Merle d'Aubigné (PMA) score. These scoring systems were used to evaluate pain, mobility, and daily activity levels. Mobility was also assessed as part of the functional evaluation. The assessment was performed preoperatively and at the final follow-up to monitor functional improvements. Patients' movement limitations, pain levels, and walking ability were recorded and analyzed to determine overall functional outcomes.

Radiological evaluations included the measurement of the acetabular and femoral component values on radiographs, with a comparison of early post-operative and final follow-up radiographs using Callaghan's parameters.[22] The acetabular component inclination angle was measured, in conjunction with assessments of medialization, loosening, polyethylene insert wear, vertical and horizontal migration, and osteolysis presence according to Delee and Charnley.[23] The acetabular cup angle was determined by the angle between the line joining both teardrops and the line joining the two ends on the joint side of the acetabular component, with normal values ranging from 35°to 55°.

The vertical migration of the component was evaluated by measuring the distance between the line joining the teardrops and the inferior corner of the acetabular component, while horizontal migration was measured from the Kohler line to the center of the outer wall of the acetabular component. Instability was defined as a change of >2° in the acetabular cup angle, vertical and horizontal migration of >2 mm, and radiolucent lines >2 mm around the component zones, with clinical findings indicating loosening.

The femoral component evaluation process involved the division of the femur into seven zones as defined by Gruen et al.[24] and the assessment of stability employing criteria from Engh et al.[25] The vertical migration of the femoral component was measured by the distance between the superomedial corner of the femoral component and the trochanter minor or the superolateral corner of the femoral stem and the peak of the trochanter major. A change >5 mm was indicative of migration. The angle between the line parallel to the femoral stem axis and the line joining the femoral metaphysis midpoints (the diaphysis angle) was assessed using Berli et al.'s[26] method, and the angle between the line parallel to the femoral stem axis and the line joining the femoral metaphysis midpoints (diaphysis angle) was appraised as varus, valgus, or neutral.

Statistical Evaluation

The data obtained in the study were analyzed statistically using SPSS version 23.0 software (SPSS Inc., Chicago, IL, USA). The Shapiro–Wilk test was employed to assess the conformity of the data to a normal distribution. In instances where more than two groups of independent categories were being compared, the Kruskal–Wallis test was applied. Categorical variables were compared using the Chi-square test or the Fisher–Freeman–Halton test. The kappa agreement analysis was used to evaluate the agreement between the clinical and radiological evaluation results. A value of $p<0.05$ was accepted as the level of statistical significance in all the tests.

RESULTS

The demographic characteristics of the patients are comprehensively detailed in Table 2, which shows that there were no statistically significant differences in height, weight, and BMI among the groups ($p>0.05$). Isolated acetabulum fractures were observed in 10 (17.5%) patients, while the remaining 47 (82.5%) had additional injuries accompanying the acetabulum fracture. The rationale for performing acute THA on 18 elementary fractures is outlined below: Advanced osteoporosis in 11 patients, pathological fracture in 1 patient, pre-operative osteoarthritis in 5 patients, and advanced age-related indications in 1 patient. Intensive care was required for 22 patients, with an average intensive care unit stay of 14 days.

The etiology of trauma resulting in acetabular fractures was as follows: In-vehicle traffic accidents were responsible in 33 (57.9%) cases, out-of-vehicle traffic accidents in 6 (10.5%) cases, falls from height in 9 (15.8%) cases, simple falls in 6 (10.3%) cases, workplace accidents in 3 (5.3%) cases, and electric shock in 1 (1.8%) case.

Elementary fractures included 6 (10.5%) posterior wall fractures, 3 (5.3%) posterior column fractures, 3 (5.3%) anterior column fractures, 5 (8.8%) transverse fractures, and 1 (1.8%) anterior wall fractures. Complex fractures included 6 (10.5%) T-shape fractures, 2 (3.5%) posterior column and posterior wall fractures, 10 (17.5%) transverse and posterior wall fractures, 2

(3.5%) anterior column or posterior hemitransverse with anterior wall fractures, and 19 (33.3%) both column fractures. The AO classification system categorized the fractures into distinct types, with type C1 being the most prevalent, accounting for 26% of cases, followed by type B1, which accounted for 23%.

The overall mortality rate during the follow-up period was 8% (n=5), with no perioperative mortality. The shortest time to mortality was 21-month post-operation. Among the 31 patients who were employed before the trauma, 25 (81%) returned to work after an average of 9.3 months (range 2–33 months), while 6 patients did not return to work. The outcomes were considered excellent or very good in 83% of patients.

PMA scoring revealed an average pain score of 5.3 in Group 1, 5.4 in Group 2, 5.3 in Group 3, and 5.3 overall. Walking function scores averaged 4.8 in Groups 1 and 2, 4.6 in Group 3, and 4.7 overall. The ROM scores averaged 5.6 in Group 1, 5.1 in Group 2, 5 in Group 3, and 5.1 overall (Table 2). The total scores were 5.2 in Group 1, 5.1 in Group 2, 5 in Group 3, and 5.1 overall.

Table 2. Demographic, trauma mechanism and surgical treatment, patient-reported outcome measure score, complication data

	Group 1	Group 2	Group 3	Total
Patient numbers (n)	11	11	35	57
Age, Range	46 (23–80)	49 (37–75)	57 (39–85)	54 (23–85)
Gender, female %	4 (36)	4 (36)	6 (17)	14 (25)
Side-left	5 (46)	5 (46)	21 (60)	31 (54)
BMI	24.4	27.6	28.1	27.3
Type of trauma	-	1 (9) LET	5 (14.2) LET	6 (10.5) LET
	11 (100) HET	10 (91) HET	30(85.8) HET	51 (89.5) HET
Type of acetabular fracture according to	1 (9) Elementary	1 (9) Elementary	16 (45) Elementary	18 (31) Elementary
Letournel and Judet	10 (91) Complex	10 (91) Complex	19 (55) Complex	39 (69) Complex
Head injuries	2	-	4	6
Dislocation-Displaced fracture of the femoral neck or head	2	4	10	16
Mean time from injury to surgery (day)	14	21	20	20
Operation time (min)	162	169	152	157
Follow-up (months, range)	22.0	53.1	62.7	53.0
Hospitalization (days)	6.2	11.7	14.4	12.3
HHS-Mean±SD/ (range)	89.2±6.4	86.2±14.6	84.2±13.9	85.5±12.9
PMA Mean±SD/ (range)	5.2±0.73	5.1±0.74	5±0.77	5.1±0.72
Mobility (%)	81.8	90.9	85.7	86.0
Complication rate n (%)	2 (18.1)	3 (27.2)	10 (28.5)	15 (26.3)
Dislocation	-	-	4	4 (7)
İnfection-DAİR	2	1	2	5 (8.7)
Neurological deficit	-	-	4	4 (7)
Periprosthetic fracture	-	2	-	2 (3.5)
HO (any grade)	5	9	21	35 (61)
HO (grade III or IV)	-	3	13	16 (28)
Revision n (%)	2	-	2	4 (7)
Mortality (%)	-	-	14.3	8.7

BMI: Body mass index; PMA: Merle d'Aubigne-Postel Scoring System; HO: Heterotopic ossification; DAİR: Debridement, antibiotics, and implant retention; SD: Standard deviation; LET: Low-energy trauma; HET: High-energy trauma; HHS: Harris Hip Score.

Radiological evaluations confirmed complete bone union in all acetabular fractures. HO was absent in 22 (39%) hips. According to the Brooker classification, HO was observed at Type 1 in 11 (19%) hips, Type 2 in 8 (14%), Type 3 in 6 (10%), and Type 4 in 10 (18%). The mean acetabular inclination angle was 44° (range 23°–65°). Excluding patients who underwent revision for inclination changes, seven patients exhibited alterations: Two demonstrated a 3° decrease, three a 3° increase, and two a 5° increase. No acetabular loosening was detected.

Four patients underwent revision surgeries. Excluding these patients, radiolucent areas surrounding the acetabular component were examined. Radiolucent areas measuring >2 mm were identified in Zone 2 in two hips (3.7%) and Zone 3 in two hips (3.7%). No clinical signs of loosening were observed in these patients, and no radiolucent areas were identified in 46 hips. Vertical migration of the acetabular component was absent in 50 patients, with 1mm migration observed in two patients and >2 mm in one patient. Horizontal migration was absent in 51 patients, with 1 mm migration recorded in one patient and >2 mm in another.

Analysis of the femoral component using Gruen zones showed cortical thickening of 1 mm in 2 hips and >2 mm in 3 hips in Zone 1, 1 mm in 1 hip and >2 mm in 3 hips in Zone 2, 1 mm in Zone 3 and Zone 5, and the femoral component exhibited radiolucent areas of 1 mm and 2 mm, respectively. In addition, Zone 6 showed a 1 mm radiolucent area, while Zone 7 revealed a 1 mm radiolucent area and a 2 mm area. Acetabular vertical migration was observed to be <5 mm in six patients and more than 5 mm in one patient. No varus or valgus changes were detected in any femoral component.

Five patients underwent debridement for infection, while one patient exhibited early post-operative serous discharge at the wound site, which was successfully treated with antibiotics and dressings. Revision surgery due to infection was necessary for four patients. Sciatic nerve damage resulted in dropfoot in 11 patients, with spontaneous recovery in seven cases. Dislocation occurred in four patients, all treated with closed reduction without further issues. Two patients with late post-operative periprosthetic fractures were treated with plate fixation (Table 2).

DISCUSSION

The primary objective of treatment for acetabular fractures is to prevent complications such as post-traumatic osteoarthritis and functional loss. Although the gold standard treatment is considered to be ORIF, acute THA is preferred in specific patient groups during the early period. A study conducted by Salar et al.[27] demonstrated that acute THA provides favorable functional and radiological outcomes and is associated with high patient satisfaction when performed under appropriate indications. Tannast et al.[28] developed a set of criteria to predict survival after surgical treatment and identify the need for THA within 2 years (Table 3). According to these criteria, patients who undergo ORIF often present with complications such as post-traumatic arthritis, acetabular malreduction, femoral head AVN, and AVN of the acetabulum.[3]

The CHP is a surgical intervention that combines the principles of acute THA and ORIF, with the objective of providing a comprehensive solution to acetabular fractures that are deemed to have a poor prognosis. The primary benefits of this approach include the facilitation of expeditious post-operative mobilization, the initiation of rehabilitation processes in a more timely manner, and the circumvention of the necessity for further major revision surgery. However, challenges associated with CHP include high transfusion rates, prolonged anesthesia times, and technical difficulties.[29] CHP is a complex intervention that can result in significant complications and may be challenging even for experienced surgeons. In treating acute acetabular fractures, one disadvantage of using THR is the difficulty in achieving adequate stability of the acetabular fracture to minimize the risk of aseptic cup loosening.[8] Consequently, some authors advocate the use of cable fixation[8,30] or plates and screws[29] to ensure adequate implant stability. This study evaluated the outcomes of fixation methods used during CHP and determined the most suitable option for patients.

Despite the elevated risk of complications, including wound infection, soft tissue scarring, HO, and iatrogenic sciatic nerve injury, acute THA has been demonstrated to yield superior outcomes in comparison to delayed THA performed after ORIF.[5,17,31] Studies comparing ORIF and CHP applications have demonstrated that CHP provides enhanced outcomes, improved HHSs, and reduced reoperation rates in comparison to ORIF alone. However, patients undergoing CHP have reported experiencing more post-operative physical pain.[32]

Table 3. Negative outcome predictors following fixation for acetabular fractures[28]

Related to Injury	Related to surgery
Age over 40 years	Non-anatomic reduction
Anterior dislocation	Post-operative acetabular roof incongruence
Femur head cartilage loss (full thickness)	Use of extended iliofemoral approach
Posterior wall involvement	
Marginal impaction (40% acetabular cartilage)	
Initial displacement >20 mm	

In the present study, no statistically significant differences were observed between the groups with regard to age and BMI. Similarly, no significant differences were found between the groups with respect to operative time, hospital stay, and follow-up duration. In addition, no statistically significant differences were identified between the groups in functional assessments, including the HHS, PMA, and mobility score, in patients undergoing the CHP. This finding suggests that functional outcomes may be similar regardless of the method used, provided a stable hip is achieved.

In the present study, the single-incision technique was favored over the double-incision method on the grounds of its ability to reduce operative times, minimize blood loss, and decrease the necessity for transfusions.[17,33] The mean operative time for surgeries conducted using the single-incision technique was 157 min/patient, which is comparable to the operative times reported in similar CHP cases in the literature, ranging from 159 to 232 min.[34] The average follow-up period in our study was 53 months, which closely resembles the average reported in the literature (53.7 months).

The present study's limited number of patients precluded the execution of statistically significant comparisons between fixation methods, which is considered a significant limitation of the research. However, the data obtained provide valuable insights into the technique's effectiveness.

A comparison of the results of the present study with those from other research indicates that HHS for functional outcomes was found to be 85.5 in the present study, in comparison to reported values of 87 for acute THA, 86.7 for delayed THA, 85.3 for CHP, and 81.7 for ORIF alone. With regard to mobility rates, acute THA was reported at 74%, delayed THA at 77%, and our study observed a mobility rate of 86%. Meta-analyses examining complication rates reported ranges of 0–59% (20.1%) for acute THA, 0–25% (13.8%) for delayed THA, 0–36.8% (12.2%) for CHP, and 6.5–74% (50.3%) for ORIF alone. The complication rate of 26.3% observed in the present study is consistent with the reported range but exceeds the mean for analogous acute THA procedures. It is noteworthy that the complication rate associated with CHP remains high. With regard to HO rates, a meta-analysis reported 51% for acute THA and 59.3% for delayed THA, while another meta-analysis indicated 20% for acute THA and 24% for delayed THA. The overall HO rate in this study was 61%. The highest incidence of HO was observed in patients treated with plate-combined procedures, while the lowest incidence was observed in those treated with cable-combined procedures, suggesting that HO tends to occur at high rates following these surgical interventions. The observed variations in HO rates may be attributed to differences in acetabular fracture types, injury severity, and surgical approaches. Revision rates in this study were 7%, compared to reported rates of 4.3% for acute THA, 17.1% for delayed THA, and 8.4% for CHP. Meta-analyses of mortality rates reported values of 17.9% for acute THA, 10.8% for delayed THA, and 11.9% for CHP. The mortality rate of 8.7% observed in the present study is consistent with the findings reported in the extant literature.[5,17,18,34] A comparative analysis of the results obtained in the present study with those reported in the literature reveals that similar outcomes are generally observed. Mears et al.[8] recently reported the 8-year outcomes of 57 patients treated with ORIF and primary THA using cementless acetabular components. The study reported an average HHS of 89 and concluded that acute THA is a promising treatment option for selected acetabular fracture cases.

In the present study, 31% of patients underwent surgery for elementary fractures, while 69% were treated for complex fractures. A review study reported that among patients undergoing acute THA, 43% had elementary fractures and 57% had complex fractures.[34] However, this does not imply that THA is appropriate for elementary fractures. The decision to perform THA should be based on a careful evaluation of appropriate indications and negative predictors.

A further limitation of the present study is the inclusion of patients in younger age groups, despite the fact that this decision was taken on the basis of suitable indications, as previously mentioned. The literature generally indicates that THA is more frequently preferred in older patients, although some studies have reported its use in younger populations.

The present study is subject to several limitations. First, it is retrospective in design, which relies on the accuracy of medical records. Second, more extended follow-up periods are required to assess the long-term survival of hip arthroplasties. Third, the limited number of patients included in the study restricts the generalizability of the results.[35-37]

The CHP procedure carries significant risks, including high complication rates, HO, revision surgery, and mortality, even for experienced surgeons. Therefore, the CHP procedure should be approached with caution, and a thorough pre-operative evaluation and patient preparation are essential to ensure optimal outcomes.

CONCLUSION

This study provides valuable insights into the management of acetabular fractures requiring acute THA. The findings emphasize the paramount importance of achieving stable fixation, irrespective of the method employed, as the primary determinant of clinical and functional outcomes. The investigation encompassed a range of fixation techniques, including cables, plates, and screws, and revealed no statistically significant disparities in post-operative functional scores, complication

rates, or radiological outcomes. However, certain trends, such as the lower rates of HO observed with cable fixation and the higher mobility rates seen in plate fixation, require further investigation.

Despite the relatively high complication rate (26.3%) and the presence of HO in 61% of cases, the overall outcomes were satisfactory. The mean HHS of 85.5 and a mobility rate of 86% are consistent with findings from analogous studies, underlining the feasibility of acute THA as a treatment option.

However, the retrospective design and limited sample size of the study restrict the generalizability of the findings. Future research should aim to validate these results through larger, prospective studies and explore the long-term durability of the implants used in these procedures. Furthermore, the choice of fixation method should be tailored to patient-specific factors, such as bone quality and fracture complexity, to enhance outcomes and reduce complications.

In conclusion, acute THA represents a promising treatment option for selected acetabular fractures, particularly in cases where ORIF alone may not provide adequate stability or satisfactory functional outcomes. The decision to adopt this approach should be informed by meticulous patient selection, meticulous surgical planning, and consideration of individual patient needs. This study contributes to the growing body of evidence supporting acute THA as a viable and effective strategy for managing complex acetabular fractures.

DECLARATIONS

Ethics Committee Approval: The study was approved by Uludağ University Faculty of Medicine Clinical Research Ethics Committee Ethics Committee (No: 2018-13/23, Date: 16/07/2018).

Author Contributions: Concept – M.S.B., K.D.; Design – M.S.B., K.D.; Supervision – M.S.B., K.D.; Fundings – E.İ; Materials – E.İ.; Data collection &/or processing – E.İ., K.D.; Analysis and/or interpretation – E.İ., A.E.Y., K.D.; Literature search – E.İ., A.E.Y.; Writing – E.İ., A.E.Y.; Critical review – E.İ., A.E.Y., M.S.B., K.D.

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Comparative Outcomes of First Metatarsophalangeal Arthrodesis in Hallux Valgus Versus Hallux Rigidus

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ABSTRACT

Objective: This study aimed to compare the functional and radiological outcomes of first metatarsophalangeal (MTP) joint arthrodesis in patients with hallux valgus (HV) and hallux rigidus (HR).

Materials and Methods: This retrospective cohort study included 78 feet (39 HV and 39 HR) that underwent first MTP arthrodesis between 2015 and 2023. Data collected included demographic information, surgical technique, radiological measurements (hallux valgus angle and intermetatarsal angle), union rates, and clinical outcomes assessed by the American Orthopaedic Foot and Ankle Society (AOFAS) score and Visual Analog Scale for pain. Statistical analyses compared outcomes between the HV and HR groups.

Results: Post-operative AOFAS scores demonstrated no significant difference between the HV and HR groups (p=0.236). Union rates were comparable (87.2% in HV vs. 89.7% in HR, p=0.500). Complication rates, including implant failure and superficial infection, were low and similar between the groups. One symptomatic non-union was observed.

Conclusion: The findings indicate that first MTP arthrodesis yields comparable functional outcomes, union rates, and low complication rates in patients with both HV and HR. These outcomes support the efficacy of the procedure irrespective of the underlying pathology.

Keywords: Fixation techniques, Hallux rigidus, Hallux valgus, Metatarsophalangeal arthrodesis, Post-operative outcomes

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INTRODUCTION

First metatarsophalangeal (MTP) joint arthrodesis is a well-established surgical intervention aimed at alleviating pain and restoring function in patients suffering from advanced degenerative conditions or deformities of the first MTP joint.[1] Among the most common indications for this procedure are hallux rigidus (HR) and severe hallux valgus (HV), two pathologies with distinct etiologies and clinical manifestations.[2,3] HR is characterized by osteoarthritis of the first MTP joint, resulting in pain and limited range of motion, while HV involves lateral deviation of the great toe, leading to deformity, functional limitations, and discomfort.

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Although both conditions can be effectively treated with MTP arthrodesis, the functional and radiological outcomes may vary depending on the underlying pathology. Previous studies have highlighted differences in union rates, complication profiles, and post-operative function between patients with HV and HR. However, a direct comparison of these outcomes between the two groups is still limited in the literature (Table 1).[4-7] Understanding these differences is crucial for optimizing surgical planning and patient counseling and identifying potential challenges specific to each pathology.

This study aimed to provide a comprehensive comparison of the functional and radiological outcomes of first MTP arthrodesis in patients with HV and HR. By examining union rates, radiographic alignment, and patient-reported functional outcomes, this research seeks to elucidate the impact of the underlying pathology on the success of MTP arthrodesis and provide insights that may guide clinical decision-making in foot and ankle surgery. Given the structural complexity and deformity associated with HV, we hypothesize that functional outcomes and complications may be more pronounced in patients with HV compared to those with HR.

MATERIALS AND METHODS

Study Design and Participants

This retrospective cohort study included patients who underwent first MTP arthrodesis between 2015 and 2023 at the authors' institution. Patient data, including clinical and demographic information, were obtained from the hospital's digital medical records, and radiological assessments were retrieved from the Picture Archiving and Communication System. Eligible patients were classified into two groups based on the underlying pathology leading to the need for MTP arthrodesis. The first group (Group HV) comprised patients with HV, while the second group (Group HR) included patients with HR.

Inclusion criteria required patients to have undergone first MTP arthrodesis and completed at least 1 year of follow-up. Patients with incomplete clinical or radiological data, inadequate radiological follow-up, or insufficient final follow-up evaluations were excluded from the analysis. The study protocol was approved by the Clinical Research Ethics Committee of Antalya Training and Research Hospital (Approval Date: June 13, 2024; Approval Number: 189-9/18). Informed consent was obtained from all participants before their inclusion in the study. The research adhered to the ethical standards outlined in the Declaration of Helsinki, and the study methodology followed the Strengthening the Reporting of Observational Studies in Epidemiology guidelines to ensure transparency, accuracy, and methodological rigor.

Indications of MTP Arthrodesis

Among the 39 feet that underwent arthrodesis in the HR group, 36 patients presented with primary HR (grade 3 or 4). One patient underwent arthrodesis due to post-traumatic osteoarthritis of the MTP joint following a fracture dislocation, while another patient required the procedure after the failure of a total MTP joint replacement. Another patient underwent revision surgery following failed arthrodesis with bioabsorbable screws. In the HV group, 26 patients exhibited deformities with a hallux valgus angle (HVA) of 40° or greater. In addition, the group included two patients with rheumatoid arthritis, two patients with failed primary HV surgeries, two patients with juvenile-onset HV, and 17 patients with HV accompanied by osteoarthritis of the MTP joint.

Surgical Technique and Post-operative Rehabilitation

All procedures were performed under spinal anesthesia with a tourniquet, with the patient positioned supine. A medial approach was utilized to expose the first MTP joint. Osteophytes on both the metatarsal and phalangeal sides were carefully excised. The joint cartilage was debrided using curettes and rongeurs, ensuring removal down to the subchondral bone. Multiple perforations were made in the subchondral bone using a Kirschner wire (K-wire), extending into the intramedullary cavity to enhance union. Temporary fixation with a K-wire was applied, and the desired arthrodesis position (neutral rotation, 0–15° HVA, 0–15° dorsiflexion) was confirmed using fluoroscopy. Three different fixation constructs were employed: [1] Plate fixation alone, [2] Plate fixation with a single interfragmentary compression screw, and [3] Plate fixation with crossed interfragmentary screws. For constructs involving compression screws, they were inserted before plate fixation. All plates were secured using locked screws to ensure optimal stability. In HV patients, lateral tenotomy was not performed. Arthrodesis was achieved solely through joint preparation and fixation techniques without additional soft-tissue interventions. In 14 cases with insufficient bone apposition, an autograft harvested from the distal tibia was applied to the fusion site to promote bone healing. In addition, in 12 patients, concurrent procedures were performed on the second or fifth toes, addressing conditions such as hammer or claw toe deformities and bunionectomy.

Following the procedure, a short-leg splint was applied for immobilization. Postoperatively, patients remained immobilized with the splint for 3 weeks to allow soft-tissue healing and edema control, adhering to strict non-weight-bearing instructions with crutches. After 3 weeks, the splint was removed, and partial weight-bearing was initiated using a range-of-motion walker. Full weight-bearing was gradually introduced based on clinical and radiological evaluations, considering the outcomes of any additional procedures performed.

Table 1. List of previous studies that compared the outcomes of 1st MTP arthrodesis in HV versus HR cases

Author	Year	# Procedures	Fixation technique	Union rate	Functional outcome	Complications	Conclusion
Korim and Allen[4]	2015	134 (49 HV, 46 HV, 34 Inflammatory, 5 salvage)	Flat cut surfaces, crossed screws (92.5%), dorsal plate w/wo screws (7.5%)	91.8% (radiographic)	Not Reported	14% non-union in the HV group, 12% in Inflammatory, None in the HR nd Salvage groups	HV group may require a stronger construct to achieve union rates comparable to HR
Chien et al.[5]	2017	112 (65 HR, 47 HV)	Cup and cone preparation, single compression screw and dorsal plate	98.5% (HR), 100% (HV)	Not Reported	1.5% non-union in HR group	Cup and cone with screw and plate provides strong fixation for both HV and HR
Chodaba et al.[6]	2023	98 (61 HV, 37 HR)	Cup and cone preparation, interfragmentary screws, and dorsal locking plate	93% (HV), 95% (HR)	PROMIS and FFI scores are comparable to the general population	4% wound complications, 6% non-union (1 asymptomatic)	MTP fusion is reliable for both hallux valgus and hallux rigidus, with similar patient-reported outcomes
Roth et al.[7]	2023	148 (57 HR, 47 HV, 44 Combined)	Not Reported	86% overall	PROMIS improved for all groups (FAOS, FAAM, VAS)	Overall, 34% complications, 14% non-union, 20% eoperations	Comparable outcomes between HR and HV groups; HR shows greater long-term improvement in PROMs.
Current Study	2024	78 (39 HR, 39 HV)	Plate fixation, plate + compression screws, crossed screws	87.2% (HV), 89.7% (HR)	AOFAS and VAS scores comparable between groups	11.5% Non-union, 6.4% implant failure, 3.8% implant removal. 4.3% superficial infection	Comparable union rates; HV group shows higher residual HVA; autografting more common in HR group.

HV: Hallux valgus, HR: Hallux rigidus, PROMIS: Patient-reported outcomes measurement information system, FFI: Foot function index, FAOS: Foot and ankle outcome score, FAAM: Foot and ankle ability measure, VAS: Visual Analog Scale, AOFAS: American Orthopaedic Foot and Ankle Society, HVA: Hallux valgus angle, MTP: Metatarsophalangeal.

Radiological Evaluations

Radiological evaluations were conducted preoperatively and during follow-up using standard weight-bearing radiographs. The HVA was measured as the angle between the longitudinal axes of the first metatarsal and the proximal phalanx, while the intermetatarsal angle (IMA) was determined as the angle between the longitudinal axes of the first and second metatarsals.[8] Both measurements were performed by an orthopedic surgeon specializing in foot surgery (Senior author MBE). Measurements were made according to the guidelines established in foot and ankle surgery literature, ensuring consistency and accuracy across all evaluations. The radiographic grading of osteoarthritis in the first MTP joint was classified using the Coughlin and Shurnas classification system.[9] This system categorizes osteoarthritis based on joint space narrowing, osteophyte formation, and subchondral sclerosis observed on radiographs, ranging from mild to severe. Union was assessed through radiographic evidence of bridging bone across at least three cortices on orthogonal views. Non-union was defined as the absence of fusion on the final follow-up radiographs or persistent pain at the arthrodesis site. These radiological assessments were consistently performed at follow-up intervals to evaluate the progression of bone healing and joint alignment.

Clinical Outcomes

Clinical outcomes were assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) Hallux MTP-Interphalangeal Scale, which evaluates pain, function, and alignment. Pain levels at the final follow-up were quantified using the Visual Analog Scale (VAS). Throughout the follow-up period, all complications were meticulously recorded, including early and late post-operative issues such as infection, delayed union, non-union, and hardware failure. For patients who were unable to attend their final follow-up appointments in person, clinical outcomes were collected through a structured telephone interview. These interviews were conducted by one of the authors (MY), and the same AOFAS and VAS scoring systems were used to ensure consistency in the data collected through phone.

Statistical Analysis

All statistical analyses were performed using Statistical Package for the Social Sciences software (version 27.0; IBM, Armonk, NY). Continuous variables were expressed as mean±standard deviation, and categorical variables were presented as frequencies and percentages. The normality of the data was assessed using the Shapiro–Wilk test. Comparisons between the two groups were conducted using appropriate statistical tests based on the distribution of the variables. Continuous variables were analyzed using either the Mann–Whitney U test for non-normally distributed data or the Student's t-test for normally distributed data. Categorical variables were compared using the Chi-square test. A $p<0.05$ was considered statistically significant, and all p-values were two-tailed. Bold p-values in the tables indicate statistically significant differences between the groups.

RESULTS

The cohort consisted of 32 patients in the HV group and 37 in the HR group. Seven patients in the HV group and two patients in the HR group underwent bilateral sequential MTP arthrodesis. Thus, 78 (39 feet in each group) were evaluated. There were no significant differences between the groups in terms of age at operation (p=0.682), sex distribution (p=0.397), smoking status (p=0.395), diabetes mellitus (p=0.5042), and American Society of Anesthesiologists score (p=0.627). However, the HR group had a significantly higher body mass index (27.8±3.1 kg/m^2 vs. 26.1±3.0 kg/m^2, p=0.018). Pre-operative radiographic assessments revealed a significantly higher HVA and IMA in the HV group compared to the HR group (p=0.0011 for both). Pre-operative VAS scores were higher in the HR group (7.8±1.8 vs. 6.8±2.0, p=0.0401), while pre-operative AOFAS scores showed no significant difference (p=0.7751). The distribution of fixation techniques did not differ significantly between the groups (p=0.872). Concomitant procedures were similar between the groups (25.6% vs. 5.1%, p=0.058), while autografting was more common in the HR group (25.6% vs. 10.3%, p=0.069). The summary of patient characteristics is presented in Table 2.

The clinical follow-up duration was significantly longer in the HV group compared to the HR group (71.5±32.1 months vs. 54.8±34.6 months, p=0.019). However, radiographic follow-up durations did not differ significantly (p=0.131). Post-operative radiographic measurements showed a significantly higher HVA in the HV group (15.3±5.6° vs. 11.8±5.2°, p=0.006). Post-operative IMA and AOFAS scores were comparable between the groups (p=0.113 and p=0.236, respectively). Although the HV group had a slightly lower post-operative VAS score, this difference was insignificant (p=0.166).

Union rates were comparable between the HV and HR groups (87.2% vs. 89.7%, p=0.500). Although non-union was observed in nine cases, eight were asymptomatic (Fig. 1), and only one case was evaluated as symptomatic. Among the five non-union cases in the HV group, none had a history of prior HV correction surgery. This indicates that previous surgical intervention was not associated with non-union in our study population. Implant failure, painful implant removal, and superficial infection rates were low in both groups and showed no significant differences. A summary of clinical and radiographic outcomes is presented in Table 3.

Table 2. Demographic and clinical characteristics of patients in the cohort

Variables	Group HV	Group HR	p
Age at operation (years±SD)	56.7±14.9	60.4±7.6	0.682[1]
Sex (n, %)			0.397[2]
Female	26 (81.2)	28 (75.7)	
Male	6 (18.8)	9 (24.3)	
Weight (kg±SD)	66.8±8.8	73.0±10.2	**0.005[3]**
Height (cm±SD)	160.0±8.4	161.8±6.6	0.320[1]
BMI (kg/m^2)	26.1±3.0	27.8±3.1	**0.018[3]**
Side (n, %)			0.450[2]
Right	23 (59.0)	22 (56.4)	
Left	16 (41.0)	17 (43.6)	
Diabetes (n, %)			0.504[2]
Yes	6 (18.8)	8 (21.6)	
No	26 (81.3)	29 (78.4)	
Smoking (n, %)			0.395[2]
Active smoker	6 (18.8)	5 (13.5)	
None/Quitted	26 (79.5)	32 (86.5)	
ASA Score (n, %)			0.627[2]
ASA I	8 (20.5)	5 (12.8)	
ASA II	29 (74.4)	32 (82.1)	
ASA III	2 (5.1)	2 (5.1)	
Pre-operative HVA (°±SD)	41.5±8.9	18.6±6.1	**0.001[1]**
Pre-operative IMA (°±SD)	13.3±4.6	10.0±2.1	**0.001[1]**
Radiographic Stage for HR (n, %)			NA
Grade I			
Grade II			
Grade III	-	21 (53.8)	
Grade IV	-	18 (46.2)	
Pre-operative AOFAS (score ±SD)	43.0±10.3	40.6±13.4	0.775[1]
Pre-operative VAS (score ±SD)	6.8±2.0	7.8±1.8	**0.040[1]**
Fixation technique (n, %)			0.872[2]
Plate	9 (23.1)	11 (28.2)	
Plate and single screw	19 (48.7)	18 (46.2)	
Plate and crossed screw	11 (28.2)	10 (25.6)	
Concomitant procedures (n, %)			0.058[2]
Yes	10 (25.6)	2 (5.1)	
No	29 (74.4)	37 (94.9)	
Autografting			0.069[2]
Yes	4 (10.3)	10 (25.6)	
No	35 (89.7)	29 (74.4)	

[1]Mann–Whitney-U Test; [2]Chi-Square Test. [3]T-test, Bold p-values are statistically significant. SD: Standard deviation; HV: Hallux valgus; HR: Hallux rigidus; HVA: Hallux valgus angle; IMA: Intermetatarsal angle; AOFAS: American Orthopaedic Foot and Ankle Society; NA: Not applicable.

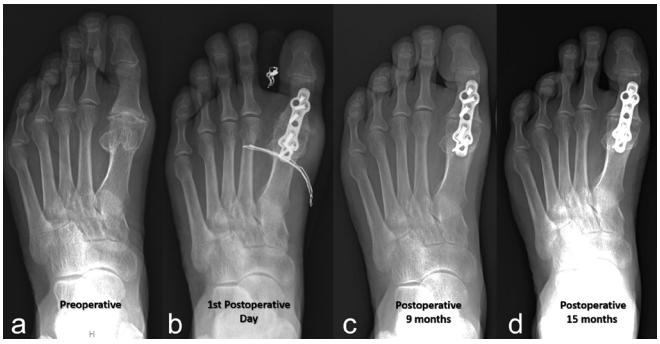

Figure 1. Asymptomatic non-union case in a 57-year-old female patient. **(a)** Pre-operative radiograph showing the Grade 4 Hallux Rigidus. **(b)** The radiograph on the 1st post-operative day, demonstrating fixation with a dorsal plate. **(c)** Nine-month post-operative radiograph showing evidence of delayed healing and non-union signs. **(d)** Fifteen-month post-operative radiograph confirming persistent non-union. However, the American Orthopaedic Foot and Ankle Society score was 77 points (good), and the Visual Analog Scale was 2 points at the 65th-month final follow-up.

DISCUSSION

This study highlights the reliability of the first MTP joint arthrodesis as an effective treatment for both HV and HR. Our union rates of 87.2% for HV and 89.7% for HR closely align with the high success rates reported in studies, confirming the consistent outcomes of this procedure across different cohorts.[5-7,10-14]

Furthermore, studies by Chodaba et al.[6] and Roth et al.[7] emphasized comparable functional outcomes and low complication rates for HV and HR, which closely match our findings. Their reported union rates exceeding 90% align with the consistency observed in our study, further validating the use of robust fixation techniques, such as compression screws and plates, in achieving successful outcomes. In addition, Roth et al.[7] highlighted the importance of patient-reported outcomes, such as Patient-Reported Outcomes Measurement Information System and Foot Function İndex scores, which provide a nuanced perspective on functional recovery. Although these specific metrics were not assessed in our study, the comparable AOFAS scores between HV and HR groups in our cohort support the notion of similarly favorable functional outcomes. These results are consistent with the literature.[2,11,15-20]

Table 3. Clinical and radiographic outcomes

Variables	Group H	Group HR	p
Clinical Follow-up (months±SD)	71.5±32.1	54.8±34.6	0.019*
Radiographic Follow-up (months±SD)	30.0±18.1	25.5±18.6	0.131*
Post-operative HVA (°±SD)	15.3±5.6	11.8±5.2	**0.006****
Post-operative IMA (°±SD)	10.5±2.6	9.6±1.9	0.113*
Post-operative AOFAS (score±SD)	83.6±8.6	81.3±10.4	0.236*
AOFAS Outcome			0.479***
Excellent	-	-	
Good	34 (87.2)	31 (79.5%)	
Fair	5 (12.8)	7 (17.9%)	
Poor	-	1(2.6%)	
Post-operative VAS (score ±SD)	1.4±0.6	1.9±1.4	0.166*
Radiographic union (n, %)			0.500***
Yes	34 (87.2)	35 (89.7)	
No	5 (12.8)	4 (10.3)	
Implant failure (n, %)			0.179***
Yes	3 (7.7)	1 (2.6)	
No	36 (92.3)	38 (97.4)	
Painful implant removal (n, %)			0.500***
Yes	1 (2.6)	2 (5.1)	
No	38 (97.4)	37 (94.9)	
Superficial ınfection (n, %)			0.500***
Yes	2 (5.1)	1 (2.6)	
No	37 (94.9)	38 (97.4)	

**Mann–Whitney-U test; **Student-T TEST; ***Chi-square test. Bold p-values are statistically significant. SD: Standard deviation; HV: Hallux valgus; HR: Hallux rigidus; HVA: Hallux valgus angle; IMA: Intermetatarsal angle; AOFAS: American Orthopaedic Foot and Ankle Society; NA: Not applicable.

Another observation in our study was the more frequent need for autografting in HR cases (25.6% vs. 10.3% in HV). Although this difference was not statistically significant, it reflects the greater bone loss typically associated with advanced osteoarthritis in HR patients, requiring grafts to support deformity correction and ensure stable fixation. This finding reflects the greater bone loss typically associated with advanced osteoarthritis in HR patients, requiring grafts to support deformity correction and ensure stable fixation.

The wound complication rates in our study, 5.1% for HV and 2.6% for HR, are consistent with the low rates reported in the literature. Chodaba et al.[6] similarly observed minimal wound-related issues across their patient population. This reinforces the efficacy of meticulous surgical technique and perioperative care in minimizing risks.

Our findings, particularly the comparable union rates between HV (87.2%) and HR (89.7%), our comparable union rates between HV (87.2%) and HR (89.7%) align with the general trends in the literature, yet differ from some studies.[2,4,21-24] Korim and Allen, who reported a significantly lower union rate for HV cases (86%) compared to HR (100%).[4] One potential explanation for this difference is the variation in surgical techniques. Korim and Allen employed flat cuts and crossed screw fixation, which may not effectively address the deforming forces associated with severe HV deformities or osteopenic bone quality.[4] By contrast, the use of compression screws and plates in our study likely provided enhanced stability, mitigating these challenges and contributing to our consistent union rates.

Another key factor may be differences in patient populations. Korim and Allen's cohort included a higher proportion of severe deformities and comorbid conditions such as inflammatory arthropathy, which can negatively impact bone healing.[4] Our study population, defined by standardized inclusion criteria, may represent a less heterogenous group, allowing for more controlled outcomes. These factors underscore the importance of tailoring surgical techniques and fixation methods to the specific demands of HV cases, ensuring robust constructs to achieve successful union outcomes.

Our study has several limitations. The retrospective design and relatively small sample size may limit the generalizability of the results. In addition, the lack of long-term follow-up may underestimate the true rate of complications and non-union. However, the study's strengths include the direct comparison of HV and HR groups using consistent surgical techniques and objective outcome measures. The inclusion of both clinical and radiographic evaluations enhances the reliability of our findings.

CONCLUSION

First MTP joint arthrodesis is an effective treatment for both HV and HR, providing comparable union rates, functional outcomes, and low complication rates. While HV cases may pose additional challenges due to deformity severity, appropriate surgical techniques can mitigate these risks. Future prospective studies with larger cohorts and long-term follow-up are needed to further validate these findings.

DECLARATIONS

Ethics Committee Approval: The study was approved by Antalya Training and Research Hospital Ethics Committee (No: 189-9/18, Date: 13/06/2024).

Author Contributions: Concept – M.B.E., M.Y., Ö.K.; Design – M.B.E., M.Y., Ö.K.; Supervision – Ö.K.; Data collection &/or processing – V.B., M.Y., M.B.E., Ö.K.; Analysis and/or interpretation – V.B., Ö.K., M.Y.; Literature search – M.B.E., M.Y., İ.E., Ö.K.; Writing – M.B.E., M.Y., İ.E., Ö.K.; Critical review – İ.E., Ö.K., M.B.E.

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The Comparison of Arthroplasty and Internal Fixation for Proximal Femur Fractures

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ABSTRACT

Objective: Increasing life expectancy has led to an increase in the incidence of femoral neck and intertrochanteric fractures. These fractures are becoming a major health problem with high mortality and morbidity rates. The aim of treatment is to enable early mobilization of the patient and to reduce complications. Today, arthroplasty and internal fixation are the most commonly used treatments. The choice of treatment depends on the patient's age, fracture stability, and bone quality. The aim of this study was to compare the functional and radiological outcomes of patients treated with arthroplasty or internal fixation for femoral neck and intertrochanteric femoral fractures.

Materials and Methods: Between 2007 and 2009, 62 patients treated for femoral neck and intertrochanteric fractures were retrospectively evaluated. Functional outcomes were analyzed using the Harris Hip Score and bone quality using the Singh Index.

Results: The mean age of the patients included in the study was 67.8 years for intertrochanteric fractures and 60.5 years for femoral neck fractures. The Harris Hip Scores of patients who underwent arthroplasty for femoral neck fractures were statistically higher than those who underwent arthroplasty for intertrochanteric fractures ($p<0.05$). Harris Hip Scores of patients with femoral neck fractures were statistically higher than those with intertrochanteric femoral fractures in patients who underwent internal fixation ($p<0.05$).

Conclusion: This study evaluates the efficacy of arthroplasty and internal fixation in different patient groups. The results are generally consistent with the literature. Arthroplasty may be a more appropriate option for femoral neck fractures than for intertrochanteric fractures based on functional outcomes. However, given the limitations of the study, the results should be supported by more comprehensive and prospective studies.

Keywords: Arthroplasty, Femoral neck fracture, Internal fixation, Intertrochanteric femur fracture

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INTRODUCTION

Proximal femur fractures have become a significant public health concern due to their high prevalence and the mortality and morbidity they cause. In the elderly population, these fractures typically result from low-energy trauma, while in younger patients; they are often caused by high-energy trauma. The primary objective in the management of these fractures is to minimize complications by facilitating early mobilization of

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the patient. Treatment approaches are tailored to the patient's age, fracture stability, general health, and bone quality. The most common treatment options currently include internal fixation and arthroplasty. However, the literature is inconclusive regarding the superiority of one method over another.[1-3]

Our hypothesis is that the choice of treatment method significantly impacts functional and radiological outcomes in patients treated with internal fixation or arthroplasty for intertrochanteric femoral and collum femoris fractures. The primary objective of this study was to systematically compare the functional and radiological outcomes of these two treatment methods in patients with femoral neck and intertrochanteric femoral fractures.

MATERIALS AND METHODS

This retrospective study included patients who underwent internal fixation and arthroplasty for a collum femoris fracture and an intertrochanteric femur fracture between 2007 and 2009 at the 1st Orthopaedics and Traumatology Clinic of the Ministry of Health Dışkapı Yıldırım Beyazıt Training and Research Hospital. Patients lacking regular follow-up and those with incomplete data were excluded from the study. The clinical data and radiological images of all patients were evaluated retrospectively.

Pre-operative Preparation

All patients were treated with low molecular weight heparin for the prophylaxis of deep vein thrombosis and antibiotic prophylaxis with a first-generation cephalosporin was initiated before the surgical procedure. The antibiotic prophylaxis was continued for a further two post-operative days.

Surgical Technique

All fractures were treated with internal fixation or arthroplasty. The arthroplasty was performed in the lateral decubitus position with a posterior approach. The choice of cemented or uncemented prostheses was made according to the status of the patient. In the internal fixation group, collum femoris fractures were stabilized with 6.5 mm cannulated screws, while intertrochanteric femur fractures were stabilized with dynamic hip screw or proximal femoral nail (PFN), depending on the fracture type.

Post-operative Evaluation

All patients were evaluated with their radiological and functional results at 12 months post-operatively. Radiographic evaluation was performed with hip and pelvis radiographs. Harris Hip Score was used to evaluate function. The extent of osteoporosis was quantified using the Singh index.

Statistical Analysis

The variables were expressed as a percentage and the mean. For data sets that exhibited normality, an independent sample t-test was employed for intergroup comparisons, whereas for data sets that did not exhibit normality, a Mann–Whitney U-test was used. Before analysis, a sample size calculation was not performed, as this study sample comprised all eligible patients with data collected from 2007 to 2009.

The ethics committee of our institution approved the study protocol (Protocol number: 2827), and the study was conducted in accordance with the principles of the Declaration of Helsinki.

RESULTS

Demography and Trauma Mechanism

Twenty-one patients were excluded from the study because they did not attend regular follow-up assessments, and 15 patients were excluded because they died for various reasons.

A total of 62 patients were included in the study. Of these patients, 32 were male and 30 were female. The mean age of patients with an intertrochanteric femur fracture was 67.8 years, while the mean age of patients with a collum femoris fracture was 60.5 years (Table 1).

The most common mechanism of trauma was a simple fall, occurring in 83.9% of cases. The remaining causes were traffic accidents, occupational accidents, and falls from height.

Table 1. Results summary table: Comparison of intertrochanteric and femoral neck fractures

Category	Intertrochanteric fractures (%)	Femoral neck fractures (%)	p
Total patients	42 patients	20 patients	
Mean age	67.8 years	60.5 years	
Treatment (arthroplasty)	53	60	
Treatment (internal fixation)	47	40	
Mean Harris Hip Score (arthroplasty)	67.41	74.75	<0.05
Mean Harris Hip Score (internal fixation)	75.8	83	<0.05

Fracture Types and Surgical Procedures

The most prevalent types of femoral neck fractures were classified as Garden type 3 (40%) and type 4 (40%). For patients with collum femoris fractures, 60% underwent arthroplasty, while 40% underwent internal fixation. According to the Evans classification, intertrochanteric femur fractures were considered unstable in 52% of cases. In the case of intertrochanteric femur fractures, arthroplasty was performed in 53% of patients, while internal fixation was performed in 47%.

Complications and Revisions

Three patients who had undergone internal fixation subsequently required revision surgery. The fractures were successfully stabilized with internal fixation. One patient developed deep vein thrombosis in the post-operative period.

Functional Results

The mean Harris Hip Score was 74.75 in patients who underwent arthroplasty for a femoral neck fracture. In patients who underwent arthroplasty for intertrochanteric femur fracture, the mean score was 67.41, with a statistically significant difference between the two groups ($p<0.05$) (Table 1). The mean Harris Hip Score for patients who underwent internal fixation was 83 for those with a collum femoris fracture and 75.8 for those with an intertrochanteric femur fracture. The Harris Hip Scores for patients who underwent arthroplasty following intertrochanteric femur fractures were found to be lower than those who underwent internal fixation ($p<0.05$) (Table 2). No statistically significant difference was observed in Harris Hip Scores between patients who underwent arthroplasty and internal fixation after a collum femoris fracture ($p>0.05$) (Table 2). The mean Singh index of the patients was 2.7. Patients with a low Singh index exhibited significantly lower Harris Hip Scores compared to those with a high Singh index ($p<0.05$).

DISCUSSION

The objective of our study was to compare the functional results of arthroplasty and internal fixation methods applied for collum femoris and intertrochanteric femur fractures. The findings indicate that the selection of treatment modality has a substantial impact on the functional recovery trajectory and the ultimate outcomes for patients.

It has been documented in the existing literature that the posterior approach is associated with a higher incidence of dislocation compared to the anterior and lateral approaches following total hip arthroplasty.[4] Furthermore, the incidence of hip dislocation or instability was reported to be 2.4% in patients who underwent hemiarthroplasty, irrespective of the approach employed.[5] The literature indicates that the risk of dislocation after arthroplasty increases with age.[1] However, no dislocation was observed in arthroplasties performed with the posterior approach in our study. This result suggests that the careful application of surgical technique plays an important role in preventing dislocation.

Previous studies have indicated that between 40 and 70% of patients with hip fractures are able to perform basic daily activities with minimal assistance.[6] The functional outcomes assessed using the Harris Hip Score in our study are in alignment with these findings.

In the study conducted by Cheng and Sheng, which compared various surgical techniques for treating intertrochanteric femur fractures, it was observed that the PFN antirotation procedure resulted in lower blood loss and superior functional outcomes.[7] It has been documented in the literature that the incidence of reoperation is higher in patients with intertrochanteric femur fractures who have undergone intramedullary nailing than in those who have received hemiarthroplasty.[8] Despite the preference for internal fixation as the primary treatment for intertrochanteric femur fractures, arthroplasty may be considered for patients with multi-segmented, unstable fractures and poor bone quality.[8] In our study, the Harris Hip Scores of patients who underwent arthroplasty for intertrochanteric fractures were found to be lower than those of patients who underwent internal fixation.

In their meta-analysis, published in 2020, Deng et al. compared the results of arthroplasty and internal fixation in elderly patients with displaced femoral neck fractures.[9] The findings indicated a reduced risk of reoperation and diminished post-operative discomfort in the arthroplasty cohort. Bonnevialle et al. conducted a comparative analysis of trochanteric nailing and arthroplasty in patients aged 75 years and above with unstable trochanteric fractures.[10] The study revealed that mechanical complications were more prevalent in patients who underwent nailing. The authors reported that the functional outcomes were superior in the arthroplasty group. In a study conducted by Parker and Grusamy in 2006, it was reported that the necessity for reoperation was greater in patients who

Table 2. Results summary table: Comparison of mean Harris Hip Score arthroplasty and internal fixation

Category	Mean Harris Hip Score (arthroplasty)	Mean Harris Hip Score (internal fixation)	p
Intertrochanteric fractures	67.41	75.8	<0.05
Femoral neck fractures	74.75	83	>0.05

underwent arthroplasty than in those who underwent internal fixation in patients operated on for femoral neck fracture.[2] In our study, when all patients were evaluated, the reoperation rate was found to be lower in the arthroplasty group than in the internal fixation group.

It is important to note that this study is subject to a number of limitations. The first limitation of this study is that it is retrospective and based on a limited sample size. The absence of age-based categorization may have an impact on the study's findings. Furthermore, no differentiation was made between the various internal fixations techniques employed in patients who underwent such procedures. In patients who underwent arthroplasty, the evaluation of both hemiarthroplasty and total hip arthroplasty together has an effect on the results, which must be considered when interpreting the findings. A further limitation is the failure to evaluate fracture types according to their classification. It is evident that these findings require confirmation through prospective studies involving larger sample groups.

CONCLUSION

The objective of this study is to evaluate the efficacy of arthroplasty and internal fixation methods in different patient groups. The findings are in general agreement with the existing literature, indicating that arthroplasty may be a more favorable option for treating femoral neck fractures than intertrochanteric fractures in terms of functional outcomes. Nevertheless, in light of the study's inherent limitations, it is imperative to substantiate these findings through more comprehensive and prospective investigations.

DECLARATIONS

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Ethics Committee Approval: The study was approved by Sisli Hamidiye Etfal Training and Research Hospital Ethics Committee (No: 2827, Date: 03/12/2024).

Author Contributions: Concept – O.F.K., E.D., E.A.; Design – O.F.K., E.D., E.A.; Supervision – O.F.K., E.D., E.A.; Fundings – O.F.K., E.D., E.A.; Materials – O.F.K., E.A., E.D.; Data collection &/or processing – O.F.K., E.D., E.A.; Analysis and/or interpretation – O.F.K., E.D., E.A.; Literature search – O.F.K., E.A., E.D.; Writing – O.F.K., E.A., E.D.; Critical review – O.F.K., E.A., E.D.

Conflict of Interest: The authors declare that there is no conflict of interest.

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Pain and Neurologist: A Comprehensive Evaluation of Patterns, Management, and Training Implications

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ABSTRACT

Objective: A large number of patients with chronic pain are admitted to neurology clinics. In Türkiye, the pain specialty is included in the pain management fellowship program. The aim of this study was to determine the patients presenting to neurology outpatient clinics with pain complaints, to examine the role of neurologists in the management of chronic pain, and to discuss the arrangements that can be made in this regard.

Materials and Methods: Retrospectively, a total of 2000 patients were included in the study who presented to the neurology outpatient clinic at Yenimahalle Training and Research Hospital between April 2024 and June 2024. In patients with pain lasting more than 3 months, the type of pain was determined by medical history, clinical examination and laboratory tests.

Results: Among 418 patients with chronic pain, 201 (48.1%) had neuropathic pain, predominantly caused by diabetic polyneuropathy (47%). The neuropathic pain group was older (59.08±13.92 vs. 52.02±16.55 years, $p<0.001$) and had higher referral rates to specialized care ($p<0.001$). Headaches were significantly less frequent in the neuropathic pain group compared to the non-neuropathic group (2% vs. 40.1%, $p<0.001$).

Conclusion: We believe that there is a deficiency in the diagnosis, treatment, and referral of patients to algology when necessary, particularly for non-neuropathic pain. In this regard, the revision of the main educational program and the addition of an algology rotation will guide neurologists in their choice of specialty.

Keywords: Algology, Chronic pain, Neuropathic pain, Non-neuropathic pain, Pain management

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INTRODUCTION

Pain is a common symptom reported by patients worldwide. It significantly increases healthcare costs and reduces productivity. Pain also impacts individuals emotionally and socially. The International Association for the Study of Pain defines pain as an unpleasant experience linked to actual or potential tissue damage.[1] It can be classified as acute or chronic, depending on its duration and characteristics.[2]

Neurology clinics frequently encounter patients with chronic pain. Chronic pain can be nociceptive or neuropathic. Nociceptive pain results from tissue damage and is mediated by pain receptors (nociceptors).[3] Neuropathic pain arises from damage to the somatosensory system, presenting with symptoms such as burning, paresthesia, and hyperalgesia. Common causes include diabetic neuropathy, post-herpetic neuralgia, and radiculopathy.[4]

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In Türkiye, pain specialization has been subject to a pain specialty which is included in the pain management fellowship program since 2012. Algology (pain specialty) is a subspecialty of neurology, physical medicine, and anesthesiology. Neurologists often diagnose and treat patients with chronic pain, reflecting their critical role in pain management.

This study aims to analyze the types and number of patients presenting with chronic pain to neurology outpatient clinics. It also evaluates the role of neurologists in pain management and provides recommendations for improving patient care.

MATERIALS AND METHODS

This retrospective study included 2000 patients who visited the neurology outpatient clinic at Yenimahalle Training and Research Hospital between April and June 2024. Ethical approval was obtained from the ethics committee of the Antalya Training and Research Hospital (September 26, 2024, Decision Number: 14/9). Literature analyses were performed using the PubMed database, searching for the keywords "pain management," "neuropathic pain," "algology," "chronic pain," "nociplastic pain," "neuromodulation." This study was conducted in accordance with the Declaration of Helsinki and relevant ethical standards. As the study is retrospective in design, informed consent from participants was not required. However, participant confidentiality was maintained, and all ethical guidelines were strictly followed.

Patients

Patients with pain lasting more than 3 months were evaluated based on medical history, clinical examination, and laboratory tests. Demographic data, including age and gender, were collected from 418 patients with chronic pain. Patients were grouped according to the clinics where they were treated. The presence of headache was recorded separately.

Inclusion Criteria

- Patients aged 18 and older with pain lasting more than 3 months.

Exclusion Criteria

- Patients with pain lasting <3 months
- Patients with isolated headache and patients with isolated trigeminal neuralgia
- Patients under 18 years of age.

Statistical Analysis

Data were analyzed using the Statistical Package for the Social Sciences version 25.0 software. The normality of continuous variables was assessed using the Shapiro–Wilk test. Continuous variables were presented as mean±standard deviation, while categorical variables were expressed as frequencies and percentages. Comparisons of categorical variables between groups were performed using the Chi-square test or Fisher's exact test as appropriate. Independent samples t-test was used to compare continuous variables between groups. P<0.05 was considered statistically significant.

RESULTS

Of the 2000 patients who visited the neurology outpatient clinic over a 3-month period, 418 presented with chronic pain. Among these, 201 patients were diagnosed with neuropathic pain based on clinical examination and laboratory tests. The douleur neuropathique 4 (DN4) test was used to assess neuropathic pain.[5] Patients with a DN4 score of 4 or higher, or a prior diagnosis of neuropathic pain, were classified as having neuropathic pain. The remaining 217 patients reported pain without a neuropathic component lasting more than 3 months. Treatment distribution between the groups was also evaluated using the Chi-square test (Fig. 1).

The gender distribution between the neuropathic and non-neuropathic pain groups was compared using the Chi-square test. No significant difference was found (p=0.522). The age difference between the groups was analyzed with an independent samples t-test. A significant difference was found, with the mean age of the neuropathic pain group being 59.08±13.92, compared to 52.02±16.55 in the non-neuropathic pain group (p<0.001).

In the neuropathic pain group, 173 patients were treated by neurology, ten were referred to algology, and 18 were referred to physical medicine and rehabilitation (PMR). In the non-neuropathic pain group, 210 patients were treated by neurology, two were referred to algology, and five were referred to PMR. A significant difference in treatment distribution was found (p<0.001). Referral rates were higher in the neuropathic pain group (Table 1).

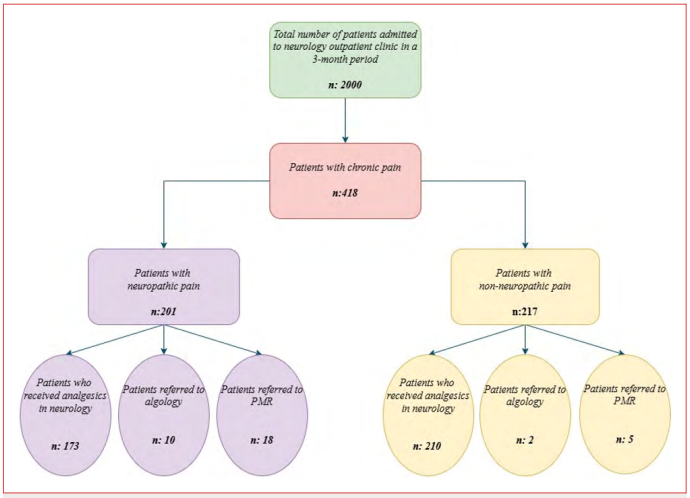

Figure 1. Flow-chart of chronic pain management and referral in neurology.

Table 1. Comparison of gender, treatment clinic and age of patients with neuropathic and non-neuropathic pain

Variables	Neuropathic pain n=201 (48.1%)	Non-neuropathic pain n=217 (51.9%)	p
Female/male	134/67	151/66	0.522
Age	59.08±13.92	52.02±16.55	**<0.001**
Treatment clinics neurology/ PMR/algology	173/18/10	210/2/5	**<0.001**

PMR: Physical medicine and rehabilitation.

Table 2. Comparison of headache presence with gender and pain type

Variables	Neuropathic pain n=201 (48.1%)	Non-neuropathic pain n=217 (51.9%)	p
Female/male	134/67	151/66	0.522
Age	59.08±13.92	52.02±16.55	<0.001
Treatment clinics neurology/PMR/algology	173/18/10	210/2/5	<0.001

PMR: Physical medicine and rehabilitation.

Headache presence was analyzed using Fisher's exact test. In the neuropathic pain group, 2% had headaches, while in the non-neuropathic pain group, 40.1% reported headaches. This difference was statistically significant (p<0.001). The gender distribution between the groups with and without headaches was assessed by Chi-square test, and no significant difference was found (p=0.619).

Age differences between the groups with and without headaches were analyzed with an independent samples t-test. A significant difference was found, with the mean age of the headache group being 58.09±14.86, compared to 45.81±15.09 in the non-headache group (p<0.001) (Table 2).

The most common cause of neuropathic pain was diabetic polyneuropathy (47%, n=94). Other causes included central neuropathic pain (Multiple sclerosis, stroke, and spinal cord injury), post-herpetic neuralgia, radiculopathy, plexopathy, polyneuropathies, and advanced carpal tunnel syndrome (Table 3).

The most common cause of non-neuropathic pain was spinal pain without radiculopathy (38%, n=82), followed by osteoarthritis, fibromyalgia, and other musculoskeletal disorders (Table 4).

Table 3. Causes of neuropathic pain

Neuropathic pain	n	Percentage
Diabetic polyneuropathy	94	47
Central neuropathic pain	32	16
Post-herpetic neuralgia	22	11
Radiculopathy	21	10
Carpal tunnel syndrome	19	9
Other polyneuropathies	9	5
Plexopathy	4	2

Table 4. Causes of non-neuropathic pain

Non-neuropathic pain	n	Percentage
Spinal pain without radiculopathy	82	38
Osteoarthritis	62	29
Fibromyalgia	51	23
Other musculoskeletal disorders	22	10

DISCUSSION

Neuropathic pain is a complex disorder caused by lesions or diseases in the somatosensory system. It presents a major challenge in clinical practice. This study examines the prevalence of neuropathic pain, its common causes, and treatment effectiveness, comparing our findings with existing literature. Furthermore, we will explore the differences between neuropathic and non-neuropathic pain, treatment approaches, and referral rates. Based on the findings, we will provide recommendations for clinical practice.

Neuropathic pain is a complex condition caused by lesions or diseases in the somatosensory system, including peripheral nerves (Aβ, Aδ, and C fibers) and the central nervous system.[6] It is a major health concern that complicates clinical practice.

In our study, 201 patients (10.05%) out of 2000 were diagnosed with neuropathic pain. The literature reports a prevalence of 7–10%, and our findings align with this range.[7]

The mean age of patients with neuropathic pain was 59.08±13.92 years, with 66.7% being female. The most common cause was diabetic polyneuropathy (47%, n=94). Other causes included various polyneuropathies, post-herpetic neuralgia, radiculopathy, plexopathy, central neuropathic pain, and advanced carpal tunnel syndrome. Neuropathic pain was diagnosed based on clinical and laboratory findings. In 173 patients (86.1%), treatment was initiated or approved by a neurologist. Eighteen patients (9%) were referred to PMR. Ten patients (5%) were referred to algology.

Among patients with neuropathic pain, only 4 (2%) reported chronic headaches. Headache frequency was significantly higher in those with non-neuropathic pain. This suggests that the severity of neuropathic pain may mask the presence of headaches in these patients.

In our study, diabetic neuropathy was the most common cause of neuropathic pain. Distal symmetric polyneuropathy, the most common type of diabetic neuropathy, typically affects both small and large nerve fibers. Small fiber neuropathies often develop early and may remain undetected due to a lack of objective signs or electrophysiological evidence. Diagnosing diabetic neuropathy relies mainly on a comprehensive history and physical examination.[8] These patients often experience a significant decline in quality of life, with sleep disturbances due to chronic pain being common.[9] Treatment for neuropathic pain includes glycemic control, gabapentinoids, antidepressants, physiotherapy, and various interventional options.[10-12]

Post-herpetic neuralgia is a challenging pain syndrome, particularly in elderly patients. These patients are typically assessed by dermatologists and neurologists during the acute phase. During this phase, interventional treatments such as erector spinae plane block, paravertebral blocks, and lumbar sympathetic neurolysis can be used to prevent the pain from becoming chronic. Lumbar sympathetic neurolysis is recommended for severe, inoperable ischemic rest pain in the lower limbs, such as that caused by peripheral vascular disease, post-herpetic neuralgia, and amputation stump pain.[13,14] These blocks, commonly used in algology clinics, are highly effective in pain control. The majority of patients with neuropathic pain were diabetic polyneuropathy and post-herpetic neuralgia, while only ten patients were referred for interventional treatments. We found that neurologist referred patients for interventional treatments at a low rate, suggesting that referral rates to algology should be increased.

The mean age of patients with non-neuropathic pain in our study was 45.81±15.09 years, with 69.6% being female. The most common cause of non-neuropathic pain was spinal pain without radiculopathy (38%, n=82), followed by osteoarthritis, fibromyalgia, and other musculoskeletal disorders. Fibromyalgia syndrome (FMS) is a common primary pain condition, with a global prevalence of 2–4%. FMS is recognized as a distinct pain type called nociplastic pain, which is separate from both neuropathic and nociceptive pain.[15,16] Therefore, we included patients with FMS in the non-neuropathic pain group in our study.

In the non-neuropathic pain patient group, the proportion of patients referred to algology has remained quite low, although these patients with chronic pain have conditions that may benefit from interventional treatments to be performed in algology. We would like to highlight the role of the neurologist. In our country, it is not possible for the patient to get an appointment without a referral to the algology unit. Therefore, neurologists should refer patients.

Neurologists in our country have demonstrated considerable competence and success in diagnosing and managing neuropathic pain. However, in some cases, it may be difficult to control symptoms with medical treatment alone. In such cases, referral to interventional pain management may be necessary. Spinal and musculoskeletal pain is also common reasons for consultation in neurology outpatient clinics. Although these symptoms are often seen as manifestations of neurological disorders, underlying spinal and musculoskeletal pathologies are often the primary causes. For instance, shoulder pain, an early symptom of Parkinson's disease (PD), is often overlooked, and its treatment tends to be inconsistent. Pain is a common and debilitating symptom in PD patients, affecting their quality of life, but it remains underdiagnosed and inadequately treated.[17] Furthermore, pain management is particularly challenging in multiple sclerosis patients, who are often associated with painful syndromes. Opioids and cannabinoids may sometimes be required for effective pain control in these patients.[18] Pain is also linked to various other neurological syndromes.[19] However, addressing pain as a primary symptom rather than an additional symptom of neurological conditions could improve treatment outcomes.

Recently, the use of neuromodulation in the treatment of neurological disorders has gained momentum. Neuromodulation is increasingly employed in managing conditions such as epilepsy, movement disorders, and chronic pain. Many chronic pain syndromes are now treated with neuromodulation, focusing on symptom management rather than eliminating the underlying etiology.[20] While neurologists are well-experienced in cortical neuromodulation, their role in peripheral and spinal

neuromodulation remains less prominent in our country.

It would be beneficial to include more topics related to algology, including spinal and peripheral neuromodulation, in neurology specialty training. No similar study was found in the literature review.

This study highlights the absence of algology rotations in the main educational program as an important deficiency. Therefore, this study will contribute to future regulatory changes in neurology education.

Limitations

This study has several limitations. Its retrospective design and reliance on a single institution may restrict the generalizability of the findings. In addition, the diagnosis of neuropathic pain was based solely on clinical evaluation and the DN4 test, which may limit diagnostic accuracy compared to more objective tests. The study focused on patients aged 18 and older, which means that the results may not be applicable to pediatric populations. Furthermore, the treatment approaches evaluated in this study may be influenced by individual preferences and patient compliance, potentially introducing variability in the findings.

CONCLUSION

There is a noticeable gap in the diagnosis, treatment, and referral of patients, especially those with non-neuropathic pain. Neurologists need to be knowledgeable about pain syndromes, available treatments, and referral protocols. To address this issue, we suggest updating the main educational program to include an algology rotation. This arrangement will make neurologists more effective in providing comprehensive patient care and making informed decisions about pain management.

DECLARATIONS

Ethics Committee Approval: The study was approved by Antalya Training and Research Hospital Ethics Committee (No: 14/9, Date: 26/09/2024).

Author Contributions: Concept – C.A., P.O.; Design – C.A., P.O..; Supervision – C.A., P.O.; Materials – P.O.; Data collection &/or processing – P.O.; Analysis and/or interpretation – C.A.; Literature search – C.A., P.O.; Writing – C.A.; Critical review – C.A., P.O.

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LETTER TO THE EDITOR

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Are we Prepared for Disasters?

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Dear Editor,

Disasters pose significant health risks and require the intervention of a large number of injured individuals with limited resources. Disaster triage is the process of sorting the injured based on their health conditions and prioritizing them for treatment. This system aims to increase survival chances and ensure the effective management of health services. Triage is done in four main categories: Red (Immediate), Yellow (Delayed), Green (Minor), and Black (Deceased). These categories help identify patients who require rapid intervention and ensure the efficient use of resources.[1]

The Simple Triage and Rapid Treatment (START) system, which is commonly used for adults, quickly sorts individuals requiring urgent intervention during disasters and prioritizes those with the highest chance of survival.[2] However, the JumpSTART system was specifically developed for children and takes into account their physiological differences. Unlike adults, children experience respiratory failure and circulatory problems more rapidly, which requires quick assessment.[2]

JumpSTART evaluates three key parameters appropriate for children's age: Consciousness (AVPU), Respiration, and Heart Rate. Children are categorized into red (immediate), yellow (delayed), green (minor), and black (deceased) groups. If a child is in need of immediate intervention, they are placed in the red category. This system ensures that children are rapidly assessed and directed to the most appropriate treatment during disasters.[2]

While JumpSTART provides a more accurate intervention for children, START is the more commonly used approach for adults. Both systems allow for rapid assessment, but JumpSTART specifically evaluates children's respiratory and consciousness status differently. In addition, other systems, such as Sort, Assess, Lifesaving Interventions, Treatment and/or Transport (SALT) and Medical Priority Triage (MPT), are also incorporated into triage processes during disasters.[3]

SALT facilitates the quick sorting of the injured and identifies life-saving interventions. MPT provides a more detailed evaluation and prioritizes treatment. The Triage Sieve is used to sort the injured individuals requiring immediate intervention before a more detailed evaluation is conducted during large-scale disasters.[4]

The effectiveness of disaster triage systems depends on the ability of health professionals to provide accurate and timely intervention. Systems such as JumpSTART and START enhance survival rates by determining appropriate sorting and treatment methods. The effective use of these systems will improve the efficiency of health services during disasters and ensure that limited resources are used more effectively. Therefore, disaster triage training and implementation are of great importance for healthcare professionals.

Sincerely

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