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Emrah Mah. General Dr. Tevfik Sağlam Cad. No: 2/67, İç Kapı No: 105
Keçiören, Ankara, Turkiye
E-mail: medihealthacademy@gmail.com
Phone: +90 532 061 96 80
www.medihealthacademy.com
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Factors affecting the accuracy of estimated fetal weight in small for gestational age (SGA) fetuses

Nihal Çallıoğlu[1], Işıl Turan Bakırcı[2], Fırat Ersan[2], Selçuk Atalay[3], Güray Tuna[2]

[1]Department of Perinatology, Gaziosmanpaşa Training and Research Hospital, University of Health Sciences, İstanbul, Turkiye
[2]Department of Perinatology, Başakşehir Çam and Sakura City Hospital, İstanbul, Turkiye
[3]Department of Perinatology, Ordu University Training and Research Hospital, University of Health Sciences, Ordu, Turkiye

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ABSTRACT

Aims: To identify factors influencing the accuracy of estimated fetal weight in small for gestational age (SGA) fetuses.

Methods: This retrospective cohort study included 268 women in the third trimester with singleton pregnancies and estimated fetal weight below the 10th percentile. Data were obtained from electronic medical records, and the Hadlock formula was used to estimate fetal weight through ultrasound measurements. Patients with fetal growth restriction due to placental insufficiency, preeclampsia, multiple pregnancies, or fetal anomalies were excluded from the study. The study groups were categorized based on differences between their estimated and actual birth weights.

Results: The analysis showed that 24.3% of the cases had a difference of >10% between estimated and actual birth weights. The mode of delivery was significantly associated with weight difference, with a lower cesarean section rate in the group with a difference >10%. There were no significant differences in clinical and sonographic characteristics between the study groups. Perinatal outcomes did not exhibit significant differences in gestational age at delivery, delivery mode, sex, or meconium-stained amniotic fluid. However, there was a significant difference in birth weight, with higher birth weights observed in the group with a difference >10%. Logistic regression analysis did not reveal any statistically significant associations between the examined factors and weight differences >10%.

Conclusion: This study highlights the challenges of accurately estimating fetal weight in SGA fetuses. Further research is needed to identify additional factors and develop more reliable methods for estimating fetal weight in these cases, aiming to improve prenatal management and reduce the risk of adverse outcomes.

Keywords: Fetal weight estimation, small gestational age (SGA), discrepancy, estimated fetal weight, gestational age

INTRODUCTION

Accurate estimation of fetal weight is essential for monitoring fetal growth and ensuring appropriate obstetric management.[1] One important subset of fetuses that require careful monitoring are those with an estimated fetal weight below the 10th percentile for gestational age (SGA). These fetuses, although small, may be small for gestational age (SGA) rather than growth-restricted, meaning they are small but otherwise healthy.

It is crucial to differentiate between SGA and those with fetal growth restriction (FGR). While SGA fetuses are small due to genetic and familial factors, FGR indicates a pathological condition where the fetus is not growing at a normal rate due to underlying issues such as placental insufficiency or maternal health problems.[2] This study focuses on fetuses that are estimated to be SGA, without evidence of FGR.

Accurate estimation of fetal weight in these SGA is particularly challenging due to the variability in growth patterns and the potential for underlying health issues to affect measurements. Discrepancies between estimated fetal weight (EFW) and actual birth weight can complicate clinical decision-making and impact the management of pregnancies identified as high-risk. Understanding the factors influencing the accuracy of the estimated fetal weight in these fetuses can help improve prenatal management and potentially reduce the risk of adverse outcomes.

Previous studies have indicated challenges in accurately estimating fetal weight in SGA. For example, Cooper et al.[3] reported that estimated fetal weights were more frequently inaccurate at extremes of fetal weight. Stephens et al.[4] found

Corresponding Author: Işıl Turan Bakırcı, isilturan@yahoo.com

that ultrasound estimation of birth weight in small fetuses tended to overestimate birth weight, possibly due to a decrease in fetal weight near delivery. Bardin et al.[5] highlighted that various clinical and ultrasonographic factors influence the accuracy of ultrasound-estimated fetal weight in predicting small size and macrosomia.

This retrospective cohort study aims to identify the factors influencing the accuracy of estimated fetal weight in SGA fetuses. By understanding these factors, we hope to improve prenatal management strategies and reduce the risk of adverse outcomes associated with inaccurate fetal weight estimation.

METHODS

This retrospective cohort study was conducted at a tertiary referral center. This study included 268 women in the third trimester with singleton pregnancies who were referred to the perinatology department between January 2022 and January 2023. Approval for this study was obtained from Başakşehir Çam and Sakura Hospital Clinical Researches Ethics Committee (Date: 24.11.2022, Decision No: KAEK/2022.11.354). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Patients were initially referred from routine antenatal care clinics due to suspicion of fetal growth restriction, specifically when the fetal abdominal circumference was below the 10th percentile. Upon referral to the perinatology department, these cases were further evaluated to differentiate between SGA fetuses and those with FGR.

The study included singleton pregnancies with an estimated fetal weight <10th percentile, normal fetal Doppler findings, and no fetal anatomical abnormalities. Patients were excluded if they had fetal growth restriction owing to placental insufficiency, preeclampsia, chronic maternal disease, multiple pregnancies, or fetal anomalies. We also reviewed the medical history of all eligible patients, including previous pregnancy outcomes and high-risk pregnancies. This information was used to ensure a comprehensive understanding of each case, although it did not form part of the exclusion criteria, unless it coincided with the aforementioned exclusion factors.

Data were obtained from electronic medical records of pregnant women who received prenatal care and delivered at a large tertiary care hospital. The gestational age during sonographic evaluation was determined using either the last menstrual period or first-trimester ultrasound results. Ultrasonography was performed within three days before delivery, and the Hadlock formula, which incorporates nationally accepted standard fetal biometry measurements, was used to calculate the estimated fetal weight. Measurements of biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL) were used to calculate estimated fetal weight using the Hadlock formula.[1]

The following data were collected for each case: maternal age, maternal body-mass index (BMI), parity, previous delivery mode, oligohydramnios, placental location, uterine notch, fetal presentation, fetal movements, fetal sex, estimated fetal weight at the time of ultrasound examination indicating SGA status (below the 10th percentile), and actual birth weight.

The cases were divided into two groups based on the difference between the estimated fetal and actual birth weights. A 10% cutoff was chosen based on previous literature suggesting that differences greater than 10% are clinically significant and may impact obstetric decision making.[6,7] The relative percentage difference was calculated using the following formula: relative difference %=[(EFW birth weight)/birth weight]×100. While we considered using a 5% cutoff, the 10% threshold was chosen to align with the existing literature and account for the inherent variability in ultrasound measurements, especially in the context of SGA fetuses. This decision allows for a more robust classification of significant discrepancies, while minimizing the potential for overclassification owing to minor measurement variations.

Statistical Analysis

Demographics and ultrasound data are presented as medians (interquartile ranges) and numbers (percentages). All statistical analyses were performed using IBM SPSS version 26 (IBM, Armonk, NY, USA), and p<0.05. The normality of the numerical data was examined using the Kolmogorov-Smirnov test. Comparisons between the study groups were made using the Mann–Whitney U test for continuous variables and the chi-square test for categorical variables. Multivariate analysis was conducted using logistic regression, with stepwise inclusion of variables that had the strongest associations with the outcome of interest. This analysis determined the odds ratio (OR) and 95% confidence interval (CI) of each variable.

RESULTS

The study was completed by 268 participants. The difference between birth weight and estimated fetal weight was less than 10% in 203 (75.7%) cases. In comparison, in 65 (24.3%) cases, birth weight was overestimated or underestimated by >10% on ultrasound. Of the 65 cases in which the difference between birth weight and estimated fetal weight was >10%, birth weight was >10% higher than the estimated fetal weight in 49 cases and less than 10% lower in 16 cases. The ultrasound delivery interval was within three days in all cases.

Table 1 presents the selected clinical characteristics, including age, BMI, gravidity, parity, and delivery mode, of the participants with or without a difference of >10% percentile. There were no significant differences between the study groups in terms of maternal age, BMI, gravidity, and parity (p>0.05). Regarding the mode of delivery, the cesarean section rate was significantly lower in the group, with a difference of >10% (p<0.05).

Table 2 presents the selected sonographic characteristics of participants with and without a difference in the >10% percentile. There was no significant difference between the study groups in terms of gestational age, placental location, oligohydramnios, presence of uterine notch, fetal presentation, or fetal movement counting (p>0.05).

Table 3 presents the perinatal outcomes of participants with and without a difference in the >10% percentile. There were no significant differences between the study groups in terms of gestational age, delivery mode, sex, or meconium-stained amniotic fluid (p>0.05). However, birth weight was significantly different between the groups (p<0.01).

Table 1. Clinical characteristics of study groups according to a cutoff of 10% difference between estimated fetal and birth weights			
	Difference ≤10% (n=203)	**Difference >10% (n=65)**	
Age (years)	27 (18-43)	26 (19-43)	0.37
Body-mass index (kg/m²)	27.5 (17.3-44.2)	27.7 (20.4-34.9)	0.47
Gravidity	2 (1-9)	2 (1-4)	0.73
Parity	0 (0-3)	0 (0-3)	0.76
Mode of delivery			
Nulliparous	103 (50.7%)	34 (52.3%)	
Multiparous	100 (49.3%)	31 (47.7%)	0.011
Vaginal	34 (16.7)	20 (30.8%)	
Cesarean section	66 (32.6)	11 (16.9%)a	

Data were expressed as the median with min-max values and count (%). Regarding the mode of delivery of participants, the cesarean section rate was significantly lower in the group, with a difference of >10% (p<0.05)

Table 2. Sonographic characteristics of study groups according to a cutoff of 10% difference between estimated fetal and birth weights			
	Difference ≤10% (n=203)	**Difference >10% (n=65)**	
Gestational age at ultrasound scan	37 (36-38)	37 (36-38)	0.42
Placental location			
Fundal	22 (10.8)	9 (13.8%)	
Anterior	89 (43.8%)	23 (35.4%)	0.621
Posterior	60 (29.6%)	23 (35.4%)	
Other	32 (15.8%9)	10 (15.4%)	
Oligohydramnios			
Yes	35 (17.2%)	19 (29.2%)	0.36
No	168 (82.8%)	46 (70.8%)	
Uterine notch			
Absent	186 (91.6%)	59 (90.8%)	
Unilateral	14 (6.9%)	6 (9.2%)	0.516
Bilateral	3 (1.5%)	0 (0%)	
Fetal presentation			
Cephalic	182 (89.7%)	61 (93.8)	0.312
Non-cephalic	21 (10.3%)	4 (6.2%)	
Estimated fetal weight	2385 (2008-2766)	2315 (2023-2800)	0.17
Fetal movements			
Normal	198 (97.5%)	59 (90.8%)	0.17
Decreased	5 (2.5%)	6 (9.2%)	

Data were given as median (min-max) or count (%)

Table 3. Perinatal outcomes of study groups according to a cutoff of 10% difference between estimated fetal and birth weights			
	Difference ≤10% (n=203)	**Difference >10% (n=65)**	
Gestational age at delivery (weeks)	37 (36-38)	37 (36-38)	0.73
Mode of delivery			
Vaginal	66 (32.5%)	26 (40%)	0.268
Cesarean section	137 (67.5)	39 (60%)	
Birth weight (g)	2400 (1910-2850)	2500 (2010-3080)	0.002
Gender			
Male	88 (43.3%)	29 (44.6%)	0.858
Female	115 (56.7%)	36 (55.4%)	
Meconium-stained amniotic fluid			
Yes	27 (13.3)	6 (9.2)	0.385
No	176 (86.7)	59 (90.8)	

Data were given as median (min-max) or count (%)

Table 4 displays the odds ratio values of the study groups with and without a difference in the >10% percentile. Logistic regression analysis was conducted to determine the factors that could potentially cause the difference between birth weight and estimated fetal weight to be greater than 10 percent. The analysis included BMI, oligohydramnios, placental location, fetal movement, mode of delivery, and uterine notch. The results showed that none of the examined factors had a statistically significant association with weight differences exceeding 10%. Although oligohydramnios (p=0.041) and fetal movements (p=0.052) showed p-values close to the conventional significance threshold of 0.05, they did not reach statistical significance when considering the multiple comparisons performed in this analysis.

Table 4. Odds ratio values of the study groups with or without the difference of >10% percentile		
	Odds ratio (CI 95%)	**p value**
Body-mass index (kg/m²)	1.010	0.796
Oligohydramnios	0.492	0.041
Placental location	1.262	0.676
Fetal movements	0.284	0.052
Mode of delivery	1.038	0.900
Uterine notch	0.703	0.953

DISCUSSION

Accurately estimating fetal weight is crucial for appropriate obstetric management and predicting adverse outcomes. This retrospective cohort study investigated the factors affecting the accuracy of estimated fetal weight in small for SGA fetuses. The results revealed a discrepancy between the estimated fetal and actual birth weights in many cases, highlighting the challenges of accurate estimation. Approximately 24.3% of the cases had a difference of >10% between the estimated and actual weights.

The clinical characteristics analyzed, including maternal age, BMI, gravidity, and parity, did not show significant differences between the study groups. This suggests that these factors may not significantly influence the accuracy of the estimated fetal weight in SGA fetuses. However, the mode of delivery was significantly associated with weight difference, with a lower cesarean section rate in the group with a difference of >10%. Sonographic characteristics, such as gestational age, placental location, oligohydramnios, uterine notch, fetal presentation, and fetal movement counting also did not show significant differences between the study groups, indicating that these parameters may not reliably predict the accuracy of the estimated fetal weight in fetuses with SGA. Analysis of perinatal outcomes showed no significant differences in gestational age at delivery, mode of delivery, sex, or meconium-stained amniotic fluid between the study groups. However, a significant difference was observed in birth weight, with the group with a difference of >10% showing higher birth weights. This finding suggests that inaccurate estimation of fetal weight in fetuses with SGA can lead to deviations from the expected birth weight. Logistic regression analysis did not identify any significant associations between BMI, oligohydramnios, placental location, fetal movements, mode of delivery, uterine notch, and weight differences.

Logistic regression analysis did not identify any statistically significant associations between the examined factors (including BMI, oligohydramnios, placental location, fetal movements, mode of delivery, and uterine notch) and weight differences exceeding 10%. Notably, oligohydramnios ($p=0.041$) and fetal movements ($p=0.052$) showed p-values close to the conventional significance threshold of 0.05. However, these results should be interpreted cautiously because of the multiple comparisons performed and relatively small sample size. Further studies with larger sample sizes are needed to definitively determine the role of these factors in weight estimation discrepancies in SGA fetuses.

These findings underscore the challenges of accurately estimating fetal weight in fetuses with SGA. Further research is needed to identify additional factors that may influence the accuracy of estimated fetal weight fetuses with an estimated fetal weight below the 10^{th} percentile, and to develop more reliable methods for estimating fetal weight in these cases.

Our study aligns with previous findings that highlight the difficulty of accurate weight estimation fetuses with an estimated fetal weight below the 10^{th} percentile. Studies found that EFW often overestimated birth weight (BW) in SGA infants, with a mean percentage difference of 16.2% compared with 6.9% in appropriate for gestational age (AGA) infants.[8,9] This overestimation in SGA infants underscores the need for cautious interpretation of EFW, as it may lead to overestimation of fetal health and underestimation of potential risks.

Moreover, maternal BMI has been shown to significantly affect the accuracy of fetal weight estimation. Sgayer et al.[7] reported that the accuracy of EFW was lower in obese women compared to those with a normal BMI. This finding suggests that maternal BMI should be considered when interpreting ultrasound results to improve the accuracy of fetal weight estimates.

Additionally, advancements in machine learning, such as deep learning-based models, have demonstrated improved accuracy in fetal weight estimation compared to traditional methods such as Hadlock's formula.[9] These models utilize advanced algorithms to provide more precise estimates, which are crucial for clinical decision making. Accurate fetal weight estimation helps to distinguish between SGA fetuses and those with FGR, ensuring appropriate monitoring and intervention strategies.[11]

Furthermore, a study by Benson-Cooper et al.[3] indicated that ultrasound tended to overestimate the weight of SGA fetuses and underestimate the birth weights of large for gestational age (LGA) fetuses. They also noted that a higher maternal BMI was associated with a greater likelihood of underestimating fetal weight, emphasizing the need for careful consideration of maternal characteristics when interpreting ultrasound estimates.

Limitations

Our study had several limitations. The retrospective design may introduce selection bias, and the study was conducted at a single tertiary referral center, which may limit the generalizability of the findings. Additionally, the sample size, while providing valuable insights, may need to be larger to detect smaller differences and to validate the findings in different populations. Operator variability in ultrasound measurements and focusing only on specific clinical and sonographic characteristics without considering other potential influencing factors such as maternal nutrition, genetic factors, and environmental influences are other limitations. Finally, ultrasound measurements taken within three days before delivery may not account for rapid changes in fetal weight in the late stages of pregnancy.

CONCLUSION

In conclusion, the accurate estimation of fetal weight in SGA fetuses remains challenging. Our study identified factors such as mode of delivery and birth weight differences. However, further research is necessary to better understand and improve the accuracy of the estimated fetal weight in these cases.

ETHICAL DECLARATIONS

Ethics Committee Approval

Approval for this study was obtained from Başakşehir Çam and Sakura Hospital Clinical Researches Ethics Committee (Date: 24.11.2022, Decision No: KAEK/2022.11.354).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process
Externally peer-reviewed.

Conflict of Interest Statement
The authors have no conflicts of interest to declare.

Financial Disclosure
The authors declared that this study has received no financial support.

Author Contributions
All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Original Article

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Risk factor for stress incontinence in female patients over 65 years of age: Visceral Adiposity Index

Zeynep Şahiner, Kamile Sılay
Department of Geriatrics, Ankara Bilkent City Hospital, Ankara, Turkiye

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ABSTRACT

Aims: To investigate whether there is a relationship between stress urinary incontinence and Visceral Adiposity Index (VAI) in older women adults.

Methods: Among 498 patients aged over 65 years who applied to the internal medicine-geriatrics outpatient clinic between January 2024 and June 2024, 95 female patients with stress incontinence (group-1) and 94 female control patients without incontinence (group-2) were included in the study. The remaining 309 patients were patients with other types of incontinence and were excluded from the study. Demographic characteristics, biochemical parameters and VAI values of patients (group-1) and (group-2) were compared statistically.

Results: A total of 95 incontinent female cases with a mean age of 71.7±5.7 years and a total of 94 control female cases with a mean age of 72.0±5.2 years were included in the study. No statistically significant difference was found between the groups in terms of mean age distribution (p>0.05). The mean body-mass index (BMI) value of the patients in group 1 was statistically significantly higher than the patients in group 2 (p=0.037). The median VAI value of 3.44 [3.07] in group 1 was 2.00 [1.4] higher than the median VAI value in group 2, and a statistically significant difference was observed between the groups (p<0.001).

Conclusion: We observed that VAI levels showed comparable values in older patients with and without urinary incontinence (UI), suggest a potential association between increased levels of VAI and the presence of stress urinary incontinence (SUI) in the geriatric population.

Keywords: Urinary incontinence, geriatric patients, Visceral Adiposity Index

INTRODUCTION

Urinary incontinence (UI) is one of the most common geriatric syndromes in older adults, especially in women. The urinary system undergoes anatomical and physiological changes as a result of the aging process, the presence of concomitant diseases, cognitive disorders, and the use of medications to aid in the development of UI.[1] Previous births or pelvic area damage pose a risk for stress incontinence, especially in older women.[2] Due to the fact that urinary system diseases induce significant symptoms that impair quality of life, it is crucial to evaluate the processes underlying these disruptions for effective management and treatment.[3] The International Continence Society (ICS) defines stress urinary incontinence (SUI) as the complaint of any involuntary leak of urine during effort or physical exertion (e.g., sporting activities), or when sneezing or coughing.[4]

Overweight and obesity are acknowledged as independent risk factors for the onset of urine incontinence. Body-mass index (BMI) is wrongly regarded a reasonable predictor of body fat percentage,[5] Many factors influence the relationship between BMI and body fat percentage, including gender, race, high muscle mass, and changes in hydration status (particularly in subjects with extracellular fluid retention, which can lead to significant errors in interpretation of BMI). In older individuals, significant changes occur in both the numerator and denominator of BMI.[6,7] However, it has been reported that there are metabolically unhealthy people in the society despite their BMI measurements being within the normal range, and metabolically healthy people despite their increased BMI values, and that these people's cardiometabolic risk levels are different.[8]

The metabolic disorders linked to these different phenotypes are largely caused by visceral obesity. Visceral adiposity has been associated with increased adipocytokine production, increased inflammatory activity, impoverished insulin sensitivity, risk of acquiring diabetes, elevated blood triglyceride (TG) levels, and decreased blood high-density lipoprotein cholesterol (HDL-C) levels, risk of dyslipidemia, hypertension, development of atherosclerosis, and increased mortality.[9]

Visceral adiposity cannot be directly measured without the use of costly imaging methods, which are frequently unavailable.[10]

Corresponding Author: Zeynep Şahiner, zynppyds@hotmail.com

Amato et al.[11] defined the Visceral Adiposity Index (VAI) by developing a mathematical formula that directly reflects visceral adiposity with anthropometric and biochemical measurements. In our study, we examined the association between VAI and stress incontinence in women over 65 years of age.

METHODS

Ethics

Ethics committee approval was obtained from Ankara Bilkent City Hospital Non-interventional Clinical Studies Ethics Committee for this study (Date: 28.08.2024, Decision No: TABED-1 24-542). Since the study was retrospective, consent was not obtained from the participants. The study was conducted following the Declaration of Helsinki.

Study Population

The demographic characteristics of the patients, BMI, comorbidities, smoking status, and the results of the last biochemical analysis before the procedure were recorded. Patients who were male, had urinary system anomalies, were under 65 years of age, smoked, had alcohol or drug addiction, had a history of urinary surgery, and had a history of pelvic trauma were excluded from the study. Among 498 patients aged over 65 years who applied to the internal medicine-geriatrics outpatient clinic between January 2024 and June 2024, 95 female patients with stress incontinence (group-1) and 94 female control patients without incontinence (group-2) were included in the study. The remaining 309 patients with other types of incontinence were excluded from the study to avoid confusion due to differences in etiology (**Figure 1**). Education level is categorized as 0=0-5 years, 1=6-12 years, 2>12 years. BMI was calculated as weight/height^2 (kg/m^2). Waist circumference (WC, cm) was calculated by measuring the circumference of the circle covering through the middle of the lines perpendicularly intersecting the 10th rib and the anterior superior spina iliaca on both sides. Laboratory values, especially triglyceride and HDL levels, were recorded in mmol/lt.

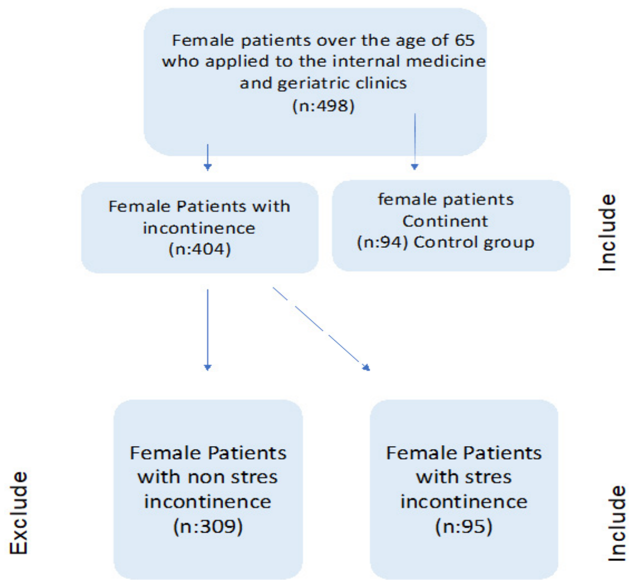

Figure 1. Study design flowchart

Stres Urinary Incontinence Assessment

Self-reporting was used to establish the primary outcome, SUI: "During the previous twelve months, have you spilled or lacked control over any amount of urine with movement like coughing as such, lifting, or exercise?"[4], except for this type of urinary incontinence, they were described as other types of incontinence.

Females VAI Assesment

VAI was calculated as previously described with the formula [Waist circumference/(36.58+(1.89*BMI)]*(TG/0.81)*(1.52/HDL-C) [9]. Values were recorded numerically without any categorization.[11]

Statistical Analysis

The statistical analyses were carried out using the SPSS software package, version 23. The variables were evaluated for normal distribution using visual (histograms, probability charts) and analytical (Kolmogorov-Smirnov test) techniques. Descriptive analyses were introduced by using percentages for categorical variables, mean±standard deviations (SD) for normally distributed variables, and median [IQR] with non-normally distributed quantities. The study employed the Mann-Whitney U test to compare continuous variables and the chi-square test to assess differences between the two types of variables. Every P-value that was released was evaluated against a significance threshold of 5% using two-sided testing. The relationship between SUI and VAI was presented using multivariable binary analysis by logistic regression and receiver operating characteristic (ROC) curve of visceral fat index was made for cut off.

RESULTS

While the average age in women with SUI (group-1) was 71.7±5.7, it was 72.0±5.2 in the control group (group-2) (p=0.71). In group 1, the average height, weight, BMI and waist circumference were 157 [11.0], 75 [22.0], 30.1±6.3, 98.0 [17.0] respectively, while in group 2, they were 160 [11.3], 72 [19.0], 28.5±4.4, 97.0 [13.0]. (p=0.059, p=0.50, p=0.037, p=0.83) respectively. While the VAI average was 3.44 [3.07] in group 1, it was 2.00 [1.4] in group 2, and there was a statistically significant difference (**Table 1**).

Table 1. Baseline characteristics of study population according to groups. Study sample was divided into two groups absent incontinence group and present incontinence groups

	Incontinence (group 1) (n=95)	Continence (group 2) (n=94)	p
Age, years	71.7±5.7	72.0±5.2	0.71
Marital status, married	58 (61.1)	57 (61.3)	0.97
Education level			0.085
0	59 (62.1)	43 (46.2)	
1	20 (21.1)	30 (32.3)	
2	16 (16.8)	20 (21.5)	
Height, cm	157 (11.0)	160 (11.3)	0.059
Weight, kg	75 (22.0)	72 (19.0)	0.50
Waist circumference, cm	98.0 (17.0)	97.0 (13.0)	0.83
Hip circumference, cm	105 (14.0)	102.5 (12.5)	0.33
BMI, kg/m^2	30.1±6.3	28.5±4.4	0.037
VAI, mmol	3.44 (3.07)	2.00 (1.4)	<0.001

*Variables are presented as n (%), mean±SD or median [IQR]
BMI: Body-mass index, cm: Cantimeter, kg: Kilogram, kg/m^2: Kilogram/square meters, VAI: Visceral Adiposity Index, mmol: Milimole

Laboratory parameters of the patients with and without incontinence are in Table 2. Among those with significant differences from laboratory values, the mean values of LDL-C, TG and T cholesterol in group 1 were 118.5±35.9, 160.0 [86.0], 205.0 [54.8] respectively, while in group 2 they were respectively 108.2±32.8, 110.0 [45.3], 190 [50.0] and were higher in group 1 (p=0.042, p<0.001, p=0.084), While the HDL-c average is low in group 1, it is higher in group 2, respectively(45.0 [12.0], 56.0 [19.3](p <0.001).

Table 2. Laboratory parameters of the patients with and without incontinence

	Incontinence (group 1) (n=95)	Continence (group 2) (n=94)	p
Glucose	15.0 (72.0)	30.5 (75.0)	0.24
Urea	34.0 (15.0)	36.0 (15.0)	0.26
Urate	5.4±2.2	4.7±1.8	0.043
Serum creatinine	0.77 (0.21)	0.76 (0.17)	0.072
GFR	76.0 (22.0)	77.0 (20.0)	0.062
Total protein	7.1±0.4	7.2±0.5	0.56
Albumin	4.4±0.3	4.4±0.3	0.32
AST	16.0 (8.0)	17.0 (11.0)	0.54
ALT	19.5 (11.0)	19.0 (11.3)	0.61
Total cholesterol	205.0 (54.8)	190 (50.0)	0.084
LDL cholesterol	118.5±35.9	108.2±32.8	0.042
HDL cholesterol	45.0 (12.0)	56.0 (19.3)	<0.001
Triglyceride	160.0 (86.0)	110.0 (45.3)	<0.001
TSH	2.1 (1.8)	1.7 (1.6)	0.12
HbA1c	6.3 (1.0)	6.0 (0.95)	0.083
WBC	6.7 (0.3)	6.7 (0.2)	0.95
Hb	12.5 (2.5)	13.2 (1.9)	0.005

*Variables are presented as n (%), mean±SD or median [IQR]
GFR: Glomerular filtration rate, AST: Aspartate aminotransferase, ALT: Alanine aminotransferase, LDL: Low-density lipoprotein, HDL: High-density lipoprotein, TSH: Thyroid stimulating hormone, HbA1c: Hemoglobin A1c, WBC: White blood count, Hb: Hemoglobin

In Figure 2, ROC curves were made to determine the cut off for VAI and SUI. VAI values were more significant, cut-off value was 2.70, and the area under the curve was area under curve (AUC); 0.827 (95%CI: 0.769-0.886), (p=<0.001) (Table 3).

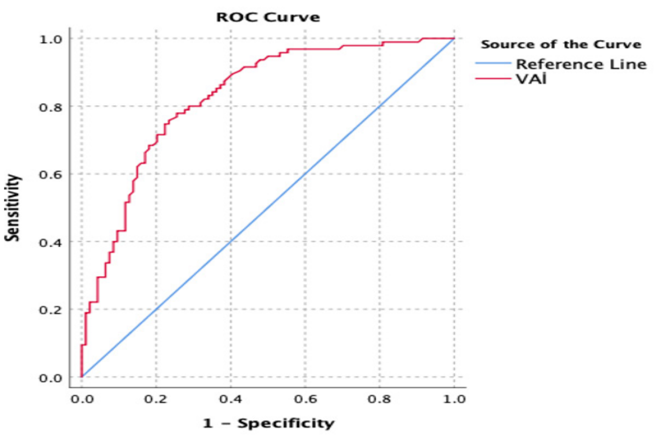

Figure 2. The receiver operating characteristic (ROC) Curve of the Visceral Adiposity Index (VAI)

Table 4 show the binary logistic regression analysis of possible factors influencing VAI. Since there was no difference in univariate analysis, these factors were determined with known factors. VAI had no relationship with changes in age, HBA1C, HB, GFR and TSH levels.

Table 4. Binary regression analysis of the VAI

	OR	95 % CI	p
Unadjusted model			
VAI, mmol	2.10	1.60-2.77	<0.001
Model 1			
VAI, mmol	2.29	1.65-3.17	<0.001
Age, years	0.99	0.93-1.07	0.91
Hb	0.99	0.98-1.00	0.14
HbA1c	0.86	0.64-1.16	0.33
GFR	0.98	0.96-1.01	0.23
TSH	1.0	1.00-1.01	0.42

OR: Odds ratio, CI: Confidence interval, VAI: Visceral Adiposity Index, mmol: Milimole, HbA1c: Hemoglobin A1c, Hb: Hemoglobin, GFR: Glomerular filtration rate, TSH: Thyroid stimulating hormone

DISCUSSION

This study revealed the importance of VAI in older women with stress incontinence. According to our results, the VAI value of those with stress incontinence was found to be significantly higher than those without. The author interpreted this result as reducing VAI can be considered an effective option in the management of stress incontinence.

VAI has been considered and evaluated as a risk factor for some pathologies in many studies. Visceral fat index has been considered and evaluated as a risk factor for some pathologies in many studies. For instance, in hypertensive populations, the VAI was more prevalent in non-hypertensive women than in males and was significantly correlated with a higher risk of type 2 diabetes.[12] In a national cohort of 9028 outcomes with data from China, Xiaomei Ye et al.[13] found that VAI is a reliable biomarker with strong aiming capability for cardiometabolic multiple medical conditions and could be used for early detection, avoidance, and treatment in by primary health care in the future.

Another study evaluating the association of VAI with all-cause mortality in the older was a population-based cohort study with large sample sizes and long-term follow-up in older individuals, showing a J-shaped association between VAI levels and all-cause mortality. Understanding the independent roles of VAI in the association between BMI and mortality was found to be significant for understanding the obesity paradox phenomenon.[14] In a study examining the association with VAI and lung function impairment, a relationship was found between these two conditions.[15]

In the cross-sectional study by Wang et al.[16] the VIA values of those who exercised for 150 minutes per week were shown to be lower than those of those who did not.

In a research involving people over 60, VIA was found to be a risk factor for later-life cognitive deterioration.[17] In a retrospective

Table 3. ROC analysis of the Visceral Adiposity İndex

	Cut-off	AUC	Sensitivity	Specificity	95% CI	p
VAI	2.70	0.827	80.0%	71.3%	0.769-0.886	<0.001

ROC: Receiver operating characteristic, VAI: Visceral Adiposity İndex, AUC: Area under curve study conducted in a urology clinic in Turkey, the relationship between overactive bladder and VAI was examined and although the study was not statistically significant, the median VAI level was found to be higher in patients with overactive bladder. However, it was conducted with participants over the age of 18.[18] Another study similarly found a high correlation between obesity and overactive bladder.[19]

Our study examined the relationship between stress urinary incontinence in older female patients over the age of 65 and it was found to be statistically significant. Similarly, in another study examining the relationship between stress urinary incontinence and VAI in young women, it was reported that, unlike our study, VAI levels were higher in patients over the age of 30 with stress urinary incontinence.[20]

There is an on going debate about the effect of excess weight on urinary incontinence. Similar to our study, Al-Shaiji and Radomski[21] studied 113 obese patients with a mean age of approximately 55 years and found that a BMI over 30 was associated with an increased incidence of mixed incontinence. Because of the simplicity of WC and BMI measurements, in addition to TG and HDL assessments, the VAI is a useful index for assessing visceral fat dysfunction. The VAI could serve as an effective index for assessing and calculating the risk of stress urinary incontinence There are some limitations of our study: the concept of sarcopenia, which has begun to be included in the etiology of incontinence in the current literature[22], was not evaluated, the diagnosis of incontinence was given according to the patient's self-declaration, the number and type of birth that caused stress incontinence, and patients with pelvic surgery or trauma were excluded in the design of the study.

CONCLUSION

In our study evaluating the VAI parameter in individuals aged 65 and over with and without stress UI, VAI levels demonstrated comparable values in older patients with and without UI and were found to be statistically significant, suggest a potential association between increased levels of VAI and the presence of SUI in the geriatric population. In addition to the underlying mechanisms and causal factors responsible for this observed relationship, it is imperative for future research to investigate the potential therapeutic implications of targeting triglyceride, HDL, BMI and waist circumference included in the VAI calculation to the safe range in the management of stress UI in geriatric individuals. Future research is needed to evaluate the relationship between the two and to elucidate the mechanisms underlying this relationship.

ETHICAL DECLARATIONS

Ethics Committee Approval

Ethics committee approval was obtained from Ankara Bilkent City Hospital Non-interventional Clinical Studies Ethics Committee for this study (Date: 28.08.2024, Decision No: TABED-1 24-542).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Original Article

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Predictive value of platelet/albumin ratio in coronary slow-flow patients

Yunus Emre Yavuz[1], Sefa Tatar[2], Muzaffer Aslan[1]

[1]Department of Cardiology, Siirt Training and Research Hospital, University of Health Sciences, Siirt, Turkiye
[2]Department of Cardiology, Meram Faculty of Medicine, Necmettin Erbakan University, Konya, Turkiye

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ABSTRACT

Aims: The pathophysiology of coronary slow flow is not yet fully understood, and it is thought to be related to multiple mechanisms such as endothelial dysfunction, microvascular disorder, and atherosclerosis. In this study, we aimed to investigate the predictive value of platelet/albumin ratio (PAR) in coronary slow flow patients (CSF). In addition, we compared it with other current parameters containing albumin.

Methods: The study was designed retrospectively. The study population included a review of the medical records of 260 people who underwent coronary angiography from 2020 to 2023. The study groups consisted of 108 patients with coronary slow flow and 101 patients with normal coronary arteries who met the inclusion criteria. Various parameters such as demographic data, Platelet/Albumin Ratio and prognostic nutritional index were compared between these two groups. ROC analysis was performed on these parameters.

Results: There was no significant difference between the coronary slow flow and control groups in terms of basic demographic characteristics such as age, gender and smoking, but BMI ($p<0.001$), LDL (p:0.026) and total cholesterol (p:0.041) ratios were higher in the coronary slow flow group. PAR showed a significant difference between the coronary slow flow group and the control group (p:0.022). Prognostic nutritional index was not significant (p:0.142). ROC curve analysis for the PAR showed a moderate discriminatory ability with an area under the curve (ROC) of 0.592 (95% CI: 0.517-0.667). Conversely, the prognostic nutritional index exhibited limited diagnostic performance with an AUC of 0.441 (95% CI: 0.365-0.522).

Conclusion: These findings suggest that easily measurable PAR may be a valuable biomarker in assessing coronary slow flow, especially in resource-limited settings. Not only does PAR demonstrate a discriminatory ability, but it also outperforms other traditional biomarkers like the prognostic nutritional index (PNI) in this specific patient population.

Keywords: Coronary angiography, blood platelets, albumin, coronary slow flow

INTRODUCTION

Coronary slow flow (CSF) is a condition in which there is a delay in the visualization of the distal blood vessels in the heart, despite the arteries appearing normal in an angiogram. This condition can lead to serious health concerns such as angina, acute coronary syndrome, and sudden death. It is more commonly seen in young male smokers and has a prevalence of 1-5% on coronary angiograms. This condition is linked to microvascular disease and increased resting coronary vasomotor tone.[1-4]

There is no evidence of obstruction in the coronary arteries; however, a delay in the contrast flow is observed in the distal blood vessels. This delay is identified in at least one major coronary artery or confirmed by a TIMI-2 flow (requiring at least three cardiac beats for complete vessel opacification) or a corrected myocardial infarction (TIMI) frame count exceeding 27 frames.[5,6] After excluding other potential etiologies, a diagnosis of CSF should be established.

Patients with CSF experience impaired endothelium-dependent flow-mediated dilatation and resting coronary vasomotor tone, which indicate the presence of microvascular spasm and endothelial dysfunction.[7,8] Furthermore, CSF could potentially lead to atherosclerosis, as it is often linked with elevated resistance in the coronary arteries due to widespread atherosclerotic disease and a greater frequency of metabolic syndrome, which can cause microvascular dysfunction.[9]

Some studies conducted in the past have indicated a potential association between inflammation and serum albumin.[10,11] In a study in which ischemia-modified albumin (IMA) was evaluated in patients with CSF, it was concluded that serum IMA levels increased in the CSF group and IMA may be related to the pathogenesis of CSF.[12] Abnormalities in platelet function may be pathogenetically important in patients with coronary artery disease. Functional abnormalities such as increased spontaneous aggregation and increased release of

Corresponding Author: Yunus Emre Yavuz, yemre91@icloud.com

beta-thromboglobulin, fibrinopeptide A, and platelet factor 4 have been described in these patients.[13]

Platelet/albumin ratio (PAR), which stands for platelet and serum albumin ratio, has been proposed as a dependable index for assessing systemic inflammation and immune nutrition status.[14] The reason behind choosing PAR as a marker is that it provides greater consistency in physiological and/or disease types compared to its individual components, namely platelet and serum albumin. In another recent study, PAR independently predicted the risk of MACE in PCI-treated NSTE-ACS patients.[15]

Ultimately, the precise mechanism behind CSF phenomena remains unclear, although inflammation and endothelial dysfunction are believed to be significant factors contributing to its development. In this phenomenon, which cardiologists now encounter more frequently, the PAR can predict important outcomes. In this study, the effects and potential predictive value of PAR on CSF were investigated, which had not been examined before in this patient group.

METHODS

This study is a single-center retrospective study. The ethical guidelines of the 1975 Declaration of Helsinki were followed to prepare the study protocol. The study received ethical approval from the Siirt Training and Research Hospital Ethics Committee (Date: 14.12.2023, Decision No: 2023/12/01/12). Experimental group; 2000 patients who applied to the cardiology outpatient clinics of Siirt Training and Research Hospital between January 2020 - December 2023 and underwent coronary angiography were retrospectively screened and 260 patients were included in the study. Then, the PAR was measured in patients with a coronary slow flow. The study included 108 patients who were diagnosed with CSF and 101 control groups who had normal coronary blood flow, after applying the exclusion criteria.

The study recorded the basic demographic, clinical, and angiographic characteristics of the patients. Hypertension was defined as having a blood pressure of at least three measurements of ≥140/90 mm/Hg or taking antihypertensive drugs. A diagnosis of diabetes was determined by either knowing the diagnosis or having a fasting blood glucose level of ≥126 mg/dl. Smoking status was considered positive for current smokers and those who quit smoking in the last year with a history of smoking more than ten packs of cigarettes.

The study examined various basic biochemical tests and whole blood values of patients who underwent coronary angiography. Lymphocyte, leukocyte, monocyte, platelet, albumin, hemoglobin, creatinine, eGFR, triglyceride, and high-density lipoprotein, total cholesterol, low-density lipoprotein, plasma atherogenic index, systemic inflammatory index, and PAR ratios were recorded. To determine PAR, the study evaluated the platelet count (×109/L) and serum albumin (mg/dL) levels. The calculation involved dividing the platelet count by the serum albumin level and then dividing it by 10 to derive the PAR value. Prognostic nutritional index (PNI) was calculated as follows. PNI=serum albumin (g/L)+0.005×total lymphocyte count (109/L).

The decision to perform coronary angiography was based on the presence of unstable angina and coronary ischemia that were confirmed through an exercise stress test or myocardial perfusion imaging. During the procedure, a standard Judkins technique was used with a 6 Fr Judkins diagnostic catheter and iopromide contrast agent. The coronary arteries were viewed from different angles and positions, ensuring that a standardized dye injection rate was maintained for all patients. At least two angles for the right coronary system and four angles for the left coronary system were recorded on cine using the resulting images.

Three invasive cardiologists evaluated coronary angiograms blindly. The measurement of the sluggish movement in the coronary arteries was accomplished via the Thrombolysis in TIMI flow method. The TIMI value recommended by Gibson et al. for diagnosing CSF was accepted as >27. For every coronary vessel, TIMI values were quantified. To find the corrected TIMI value, the number of TIMI values attributed to the left anterior descending (LAD) artery was divided by 1.7. The control group included patients with stenosis of 10% or less in one or more coronary arteries. Thus, the participants of the study were split into two categories, namely the group with slow flow in the coronary artery and the group with normal flow in the same artery.

The study excluded individuals who had previously experienced undergone percutaneous coronary intervention, acute myocardial infarction, had moderate or low ejection fraction heart failure, hereditary hyperlipidemia, severe kidney or liver dysfunction, severe valvular heart disease, congenital heart disease or pulmonary HT.

Statistical Analysis

The SPSS 22.0 program, created by SPSS Inc. in Chicago, IL, USA, was used to conduct statistical analysis on the data. The dispersion of the data was examined using the Kolmogorov-Smirnov test. Numerical data that had a normal distribution were presented as the mean±standard deviation, while data that did not follow a normal distribution were presented as the median and 25-75% range. Categorical data were expressed as numbers and percentages. Spearman correlation analysis was used to determine the correlation between PAR, SII, and AIP. To evaluate the sensitivity and specificity of PAR and to determine the optimal cut-off point for predicting CSF, the receiver operating characteristic (ROC) curve was utilized. A statistically significant result was considered when the p value was less than 0.05.

RESULTS

The baseline characteristics of the CSF and control groups were compared; there was no significant difference in terms of baseline demographics such as age, gender, and smoking, but the CSF group had higher BMI (p<0,001), LDL (p:0,026), and total cholesterol (p:0,041) ratios. Other data and their results are shown in **Table**.

Our study results revealed that the PAR value significantly differed between the normal coronary and the CSF groups (p: 0.022) (**Figure 1**). PNI showed no significant differences between the CSF group and normal group (p:0.142) (**Table**).

Table. Main demographic, clinical and laboratory characteristics of the coronary slow flow and control group

	Normal group (n=108)	Slow flow (n=101)	p value
Age	56.3 (±9)	57.1 (±10.7)	0.196
Sex (female)	44 (%40)	47 (%46)	0.163
BMI	27.5 (20.5-37.5)	30.5 (18.4-42)	**<0.001**
DM	26 (%25)	31 (%28)	0.740
HT	42 (%41.5)	48 (%44)	0.783
Smoker	26 (%25)	33 (%30)	0.536
Creatinine (mg/dl)	0.86 (0.58-1.6)	0.82 (0.46-1.45)	0.053
Na (mmol/L)	140.0 (131.0-146.0)	139.0 (133.0-145.0)	0.077
K (mmol/L)	4.25 (±0.36)	4.29 (±0.42)	0.532
Albumin	41.5 (34.0-50.0)	43.0 (35.0-48.0)	0.163
Hgb (g/dl)	13.75 (±1.55)	13.35 (±1.46)	0.054
Wbc (10^3/µl)	7.25 (4.13-14.74)	7.3 (4.05-16.2)	0.711
Lymphocyte (10^3/µl)	4.62 (±1.55)	4.62 (±1.55)	0.997
Neutrophil (10^3/µl)	4.55 (2.19-8.6)	4.3 (2.42-9.9)	0.586
Platelet (10^3/µl)	259.5 (147.0-534.0)	249.0 (102.0-409.0)	0.052
LDL (mg/dl)	104.0 (43.5-238.0)	113.6 (49.0-268.0)	**0.026**
HDL (mg/dl)	45.3 (±10.9)	46.4 (±11)	0.469
Total cholesterol	181.0 (112.0-349.0)	173.0 (112.0-304.0)	**0.041**
Triglyceride	156.5 (75.7-399.0)	165.0 (91.0-369.0)	0.359
PAR	6.32 (3.06-12.71)	5.77 (2.35-9.29)	**0.022**
PNI	41.5 (34.0-50.0)	43.0 (35.0-48.0)	0.142

The student t test was applied to those who showed normal distribution, and the Mann Whitney U test was applied to those who did not distribute. The mean standard deviation of the normally distributed and the median min-max values of the non-dispersive ones are given. A p-value< of 0.05 indicates statistical significance.
Abbreviations: PAR: Platelet/albumin ratio, PNI: Prognostic nutritional index, BMI: Body-mass index

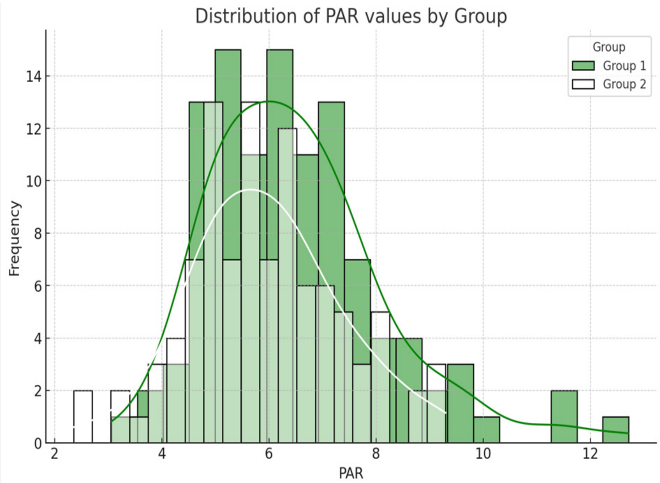

Figure 1. Distribution of the platelet/albumin ratio value in both groups.

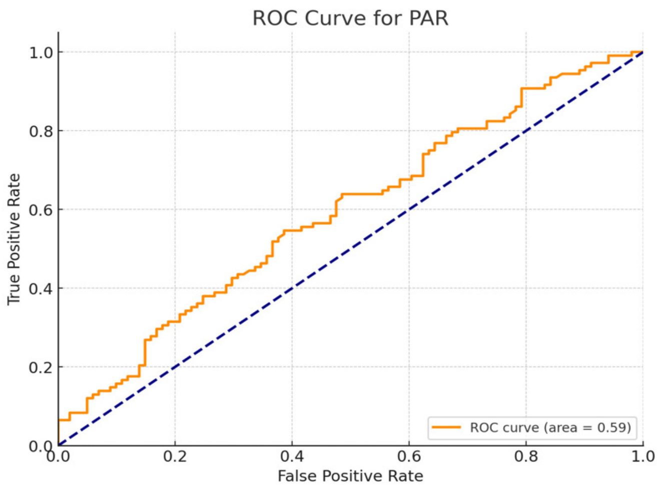

Figure 2. Receiver operating characteristic curve plotted for platelet/albumin ratio

The ROC curve analysis for PAR demonstrated a moderate discriminatory ability with an area under the curve (AUC) of 0.592 (95% CI: 0.517-0.667) (**Figure 2**). Conversely, PNI displayed limited diagnostic performance with an AUC of 0.441 (95% CI: 0.365-0.522) (**Figure 3**).

DISCUSSION

In our study, we investigated the predictive value of PAR in CSF patients who had not been previously examined in this patient group. In the literature, it was stated that the PAR is associated with inflammation and thrombosis and can be used as a prognostic indicator in various cardiovascular conditions. The results of our study show that PAR shows a significant difference among CSF patients, which may be a useful biomarker for the understanding and management of

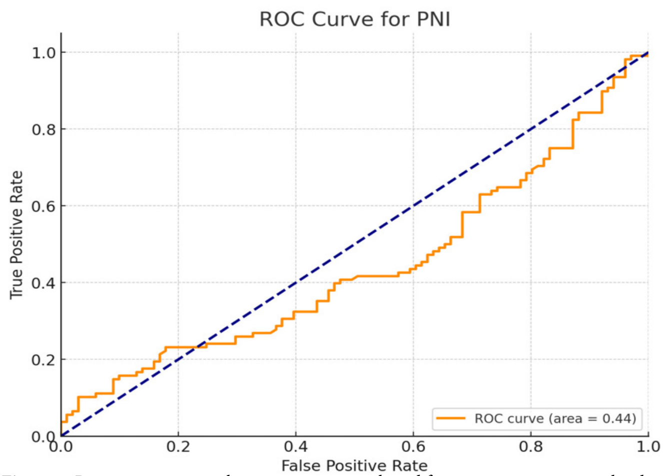

Figure 3. Receiver operating characteristic curve plotted for prognostic nutritional index

CSF. In addition, the difference between the two groups was not observed in the PNI value, which is a relatively new index containing the albumin.

Mean platelet volume (MPV) reflects platelet size and is an indicator of platelet function. High MPV levels may reflect the presence of platelets, which are larger and have a higher tendency to aggregate. In one study, high MPV in patients with stable coronary artery disease (CAD) was associated with chronic inflammation, diabetes, and aortic distenciability.[16] Another study examined the relationship between platelet distribution width and coronary slow flow. CSF was associated with increased PDW, neutrophil-lymphocyte ratio (NLR), hemoglobin (Hb), and red cell distribution width (RDW).[17] In another study investigating the relationship between albumin and CSF, a high uric acid/albumin ratio was found to be an independent predictor of CSF.[18] Some parameters, such as platelet/lymphocyte ratio, have been frequently investigated in non-cardiac conditions and significant results have been obtained.[19] Our study was inspired by these studies and investigated the PAR value in coronary slow flow.

When we look at the latest current studies with PAR, the platelet-albumin ratio has been shown to have a predictive value for cardiac surgery-associated acute kidney injury and in-hospital mortality in intensive care patients.[20] In another study, a higher platelet-albumin ratio was associated with increased rates of adverse cardiovascular events in patients with acute coronary syndrome without ST-segment elevation who underwent percutaneous coronary intervention. It was concluded that the PAR value was directly associated with an increased risk of adverse cardiovascular events, that PAR has moderate capacity as a predictor of MACE incidence, and that PAR can be used as an appropriate and ready prognostic factor for patients with ASCVD, especially patients with ACS.[15] In some non-cardiac conditions, ischemia-modified albumin value was investigated, and significant results were obtained.[21,22]

In our study, PNI was calculated and evaluated to see other outcomes that may be affected by albumin. The PNI has been extensively studied in the context of CAD and prognostic value.[23] Studies show that low levels of PNI are associated with increased mortality and major adverse cardiac events in CAD patients.[24] In addition, in patients with acute myocardial infarction, PNI has been shown to be an independent predictor of all-cause mortality, especially in critical patients admitted to intensive care.[25] Overall, PNI serves as a valuable tool in assessing the nutritional and inflammatory status of CAD patients, helping with risk stratification, and predicting negative outcomes. In our study, PNI did not give significant results in patients with coronary slow flow. It is important that this coronary slow current shows its versatile nature, unlike coronary artery disease.

The pathophysiology of CSF is not yet fully understood, and it is thought to be related to multiple mechanisms such as endothelial dysfunction, microvascular disorder, and atherosclerosis. PAR has not been previously investigated in the group of patients with CSF. It can be hypothesized that PAR may reflect these aspects of CSF, as it is associated with platelet function and inflammation, and this may explain why PAR appears as a potential indicator. In our study, PAR was statistically higher in the coronary slow-flow group. The PAR, composed of two simple measurements, is a valuable prognostic tool for clinicians working with CSF patients. When assessed together, these parameters yield significant and robust results. In conclusion, PAR plays a pivotal role in the diagnosis and management of CSF, reflecting the combined effect of inflammation and platelet activation, and is thus a significant indicator that will guide future research in this area. These findings shed light on how PAR could be integrated into clinical practices and utilized in the management of CSF, providing direction for future studies to better understand its application.

Limitations

This study has some limitations. First of all, since it is a retrospective study, there are restrictions such as choice bias and lack of knowledge. Secondly, the study population is specific to a specific geographic region, and the generalization of the findings to other populations is limited. Third, the role of other potential biomarkers other than PAR and PNI was not studied in this study. Finally, long-term clinical results and their relationship with PAR were excluded from the scope of this study.

CONCLUSION

The findings of this study highlight that the PAR, although composed of a combination of two simple measurements, stands as a valuable prognostic tool for clinicians dealing with CSF patients. Individually, these parameters do not provide meaningful insights into the complex nature of CSF, yet when assessed together, they yield significant and robust results. Furthermore, the lack of a significant difference between the two groups in another albumin-based index, the PNI, underscores the specificity of PAR and its potential importance in the evaluation of albumin in CSF patients.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study received ethical approval from the Siirt Training and Research Hospital Ethics Committee of (Date: 14.12.2023, Decision No: 2023/12/01/12).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Original Article

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A retrospective analysis of 500 ERCP procedures: outcomes, adverse events, and risk factors over two years

Yunus Halil Polat, Ahmet Yozgat

Department of Gastroenterology, Ankara Training and Research Hospital, University of Health Sciences, Ankara, Turkiye

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ABSTRACT

Aims: Endoscopic retrograde cholangiopancreatography (ERCP) is a widely used procedure for both the diagnosis and management of biliary and pancreatic ductal diseases. While it has been largely replaced by non-invasive imaging techniques for diagnostic purposes, ERCP remains the gold standard for therapeutic interventions. This study aims to retrospectively analyze the outcomes, adverse events, and success rates of ERCP procedures performed on 500 patients over two years.

Methods: A retrospective review of 500 ERCP procedures performed at a single center over 24 months was conducted. Patient demographics, indications for ERCP, procedural outcomes, and adverse event rates were collected and analyzed. Success rates for therapeutic interventions, as well as risk factors for post-procedural adverse events, were identified.

Results: The study revealed that 448 (89.6%) of ERCP procedures were successful in achieving the primary therapeutic goal (e.g., stone extraction, stent placement). Adverse events occurred in 93 (18.6%) of cases, with post-ERCP pancreatitis being the most common adverse event (n: 73, 14.6%). Risk factors associated with adverse events included previous cholecystectomy ($p<0.001$), difficult cannulation ($p<0.001$), and prolonged procedure time (p:0.003).

Conclusion: ERCP remains a highly effective treatment tool for treating biliary and pancreatic diseases, although it carries the risk of many adverse events. The identification of key risk factors may help to minimize the incidence of adverse events and improve patient outcomes. The data collected in this study provide valuable insight into the current practice of ERCP and the role it plays in modern gastroenterology.

Keywords: ERCP, biliary diseases, therapeutic endoscopy, post-ERCP pancreatitis, adverse event rates, retrospective study

INTRODUCTION

Endoscopic retrograde cholangiopancreatography (ERCP) is an invasive endoscopic procedure that is used in the diagnosis and treatment of diseases affecting the bile ducts and the pancreatic duct. First developed in 1968, ERCP has an important role in diagnosing conditions such as bile duct stones, strictures, malignancies, pancreatitis, and bile duct obstructions.[1] Today, the use of ERCP is on the rise, particularly in elderly populations with high comorbidity and in regions where the prevalence of biliary diseases is rising.[2]

In recent years, the diagnostic use of ERCP has become more limited, as less invasive techniques like magnetic resonance cholangiopancreatography (MRCP) have gained favor.[3] However, ERCP remains the gold standard for therapeutic interventions including stone extraction, stenting, dilating biliary strictures, and palliating malignant lesions.[4]

In this retrospective study, 500 patients who underwent ERCP over two years were analyzed. The study focused on demographic data, diagnostic distribution, adverse event rates, and treatment outcomes. This study aims to update data on the efficacy and safety of ERCP and the identification of risk factors for adverse events during the procedure.

METHODS

Ethics

This study was conducted in accordance with the Declaration of Helsinki and approved by the Scientific Research Ethics Committee of Health Sciences University Ankara Training and Research Hospital (Date: 08.05.2024, Decision No: 107/2024). Informed consent was not required due to the retrospective nature of the study.

Study Design and Population

This retrospective study was conducted at Ankara Training and Research Hospital, reviewing all ERCP procedures performed over two years from January 2022 to December 2023. A total of 500 patients undergoing ERCP for various indications, such as biliary stones, strictures, malignancy, cholangitis, and other biliary or pancreatic diseases were included. Patients with incomplete medical records or who underwent ERCP for diagnostic purposes only were excluded (23 patients).

Data Collection

Data were collected from patient medical records and procedure reports. The following variables were documented:

Corresponding Author: Yunus Halil Polat, yunushpolat@gmail.com

patient demographics (age, gender), comorbidities (diabetes, hypertension, etc.), indication for ERCP (e.g., biliary stones, malignancy, cholangitis), type of therapeutic intervention (sphincterotomy, stone extraction, stent placement), procedural success rate, and immediate or delayed adverse events (e.g., post-ERCP pancreatitis, bleeding, perforation, infection).

ERCP Procedure

All procedures were performed by experienced gastroenterologists using standard endoscopic equipment. Conscious sedation or general anesthesia was administered by an experienced anesthesiologist depending on the clinical condition of the patient. Cannulation of the common bile duct or pancreatic duct was achieved using standard catheterization techniques. Therapeutic interventions, such as biliary or pancreatic sphincterotomy, stone extraction, balloon dilatation and stent placement were performed as indicated. Fluoroscopy was used to guide the procedures and to confirm successful interventions. In all procedures, 100 mg rectal indomethacin was administered before the procedure for pancreatitis prophylaxis.

Cholangitis Diagnosis and Severity

Cholangitis was diagnosed based on the Tokyo Guidelines requiring evidence of systemic inflammation (fever, elevated white blood cell count) along with biliary obstruction.[5] The severity of cholangitis was categorized as mild, moderate, or severe based on clinical presentation, including organ dysfunction and response to treatment.

Post-ERCP Pancreatitis

Post-ERCP pancreatitis was defined using the Cotton criteria.[6] This includes the presence of new or worsening abdominal pain occurring within 24 hours after ERCP, accompanied by a serum amylase or lipase level at least three times greater than the upper limit of normal. Imaging findings are not required for the diagnosis, except in severe cases where clinical signs are consistent with pancreatic inflammation.

Outcomes

The primary outcomes were the success rate of therapeutic interventions, defined as the successful completion of the intended therapeutic procedure, and the occurrence of procedure-related adverse events. Secondary outcomes included long-term clinical success, defined as the resolution of symptoms and absence of disease recurrence over a 6-month follow-up period.

Assessment of Adverse Events

Adverse events were categorized as immediate (e.g., bleeding, perforation) or delayed (e.g., post-ERCP pancreatitis, infections). Post-ERCP pancreatitis was diagnosed based on the criteria outlined above. The severity of adverse events, including cholangitis and pancreatitis, was classified according to established clinical guidelines (e.g., Tokyo Guidelines for cholangitis and Cotton criteria for pancreatitis).

Statistical Analysis

Data were recorded into a database for statistical analysis. Descriptive statistics summarized patient characteristics and procedural outcomes. Continuous variables were expressed as means with standard deviations, while categorical variables were expressed as frequencies and percentages. Chi-square tests were used to compare categorical variables, and independent t-tests were used to analyze continuous variables. A p-value of <0.05 was considered statistically significant.

RESULTS

The study was designed to include 523 patients, 23 were excluded due to missing data, and 500 were included. A total of 500 ERCP procedures of these 500 patients were evaluated in the study. 101 patients underwent ERCP for the 2nd time, 21 for the 3rd time, 5 for the 4th time and 1 each for the 5th, 6th and 7th time.

Of these patients included in the study, 271 (54.2%) were female, and the mean age of patients was 62.1 years. In these 500 ERCP procedures, most patients (n: 351,70.2%) presented to the hospital with abdominal pain. The most common comorbidity was hypertension (n: 225, 45%), followed by coronary artery disease (n: 133,26.6%), and diabetes mellitus (n: 123, 24.6%). The baseline characteristics of the patients are shown in Table 1.

Table 1. The baseline characteristics of patients

Patients	n (%)	SD
Age	62.1	±18.5
Female gender	271 (54.2)	
History of cholecystectomy	147 (29.4)	
History of previous ERCP	174 (34.8)	
Comorbid diseases		
Cardiac disease	133 (26.6)	
Hypertension	225 (45)	
Diabetes mellitus	123 (24.6)	
Chronic kidney disease	16 (3.2)	
COPD / astma	43 (8.6)	
Neurological disease	26 (5.2)	
Presentation		
Abdominal pain	351 (70.2)	
Jaundice	178 (35,6)	
Fever	80 (16)	
Dark urine color	61 (12.2)	
Weight loss	19 (3.8)	
Pruritis	19 (3.8)	
Antiaggregant medication use	136 (27.2)	
Anticoagulant medication use	32 (6.4)	

SD: Standard deviation, ERCP: Endoscopic retrograde cholangiopancreatography, COPD: Chronic obstructive pulmonary disease

Of the total ERCP procedures, 147 patients had a history of cholecystectomy prior to ERCP, while 174 patients had a history of previous ERCP. Six patients had a history of gastric surgery. ERCP procedure time ranged from 10 to 65 minutes (mean 31.19 minutes±10). While 166 (33.2%) of the patients had a sphincterotomized papilla prior to the procedure, cannulation was successful in 458 (91.6%) of the total procedures. The most common technique used in cannulated patients was the use of guidewire (n: 375, 75%), followed by precut (n: 40, 8%) and double guidewire (n: 29 and 5.8%). While only 10 (2.2%) of 458 cannulated patients had a normal ERCP result, 448 (97.8%) patients had a pathological result. The most common indication for ERCP was choledocholithiasis with 86.8% (n: 434), followed by malignant biliary stricture (n: 36, 7.2%) and bile leakage due to bile duct injury (n: 12, 3.2%).

The indication for ERCP was determined by USG in 61.2% of the patients, by CT in 18.2%, and by MRCP in 20.6%. ERCP revealed no stones in 13.2% (n:66) of patients, a single stone in 39.1% (n:193), and multiple stones in 48.2% (n:241). While stones in 17 patients (3.9%) could not be removed by ERCP e, stones in 387 patients (89.1%) were removed using a stone extraction balloon. In patients with malignancy, the most common cancer was pancreatic cancer with 25 patients, followed by cholangiocellular cancer (n: 4) and ampullary cancer (n: 3).

Prior to the procedure, 33.2% (n: 166) of our patients undergoing ERCP had no cholangitis, 43.4% (217) had mild cholangitis, 19.2% (n: 96) had moderate cholangitis, and 4.2% (n: 21) had severe cholangitis. A post-procedural adverse event occurred in 93 (18.6%) of 500 ERCP procedures. Post-ERCP pancreatitis developed in 73 (14.6%) of these patients. Other adverse events included bleeding in 10 patients, ascending cholangitis in 7 patients, and cardiovascular adverse events in 3 patients. Adverse event rates in patients are shown in Figure 1.

Endoscopic sphincterotomy was performed in 276 (55.2%) of the ERCP procedures, balloon dilatation was performed in 181 (36.2%), and a stent was placed in the common bile duct in 274 (54.8%) procedures. Patients who experienced adverse events during ERCP took longer to treat than those who did not (p:0.003).The use of anticoagulant and antiaggregant therapy was not associated with the risk of adverse events after ERCP. Total procedure time was significantly longer in patients who experienced adverse events after ERCP (p:0.003). In addition, previous sphincterotomy significantly reduced the risk of adverse events (p<0.001). Among patients who could be cannulated, those who were difficult to cannulate had a significantly higher rate of adverse events than those who were easy to cannulate (p<0.001). Table 2 compares patients about adverse events.

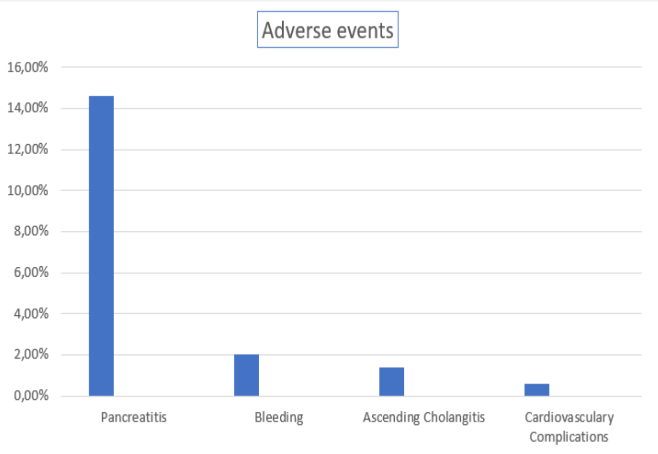

Figure 1. Adverse event rates in patients

When the laboratory results of the patients were evaluated; mean total bilirubin was 3.2 mg/dl (+ 3.17), direct bilirubin was 2.5 mg/dl (+2.7), gamma glutamyl transtransferase was 366 IU/ml (+367), alanine aminotransferase was 145 IU/ml (+159), aspartate aminotransferase was 124 IU/ml (+147), and white blood cell count was 9300 IU/ml (+4500).A statistically significant higher rate of post-ERCP pancreatitis was observed in patients who underwent endoscopic sphincterotomy during ERCP (22.8%) compared to thosewho did not (4.5%), (p<0.001).

When the patients who underwent the procedure were divided into two groups as elderly (>65 years old) and young, 268 (53.6%) patients were young and 232 (46.4%) patients were elderly . The rate of successful cannulation in elderly patients was statistically significantly lower than in younger patients, 87.1% and 95.5%, respectively, (p:0.001).

Additionally, when the risk of developing post-ERCP pancreatitis was evaluated in elderly and young patients, iit was found to be higher in younger patients (17.2%) than in older patients (11.6%), but this value did not reach a statistically significant level, p: 0.081. ERCP procedure time was longer in patients who developed post-ERCP pancreatitis (34.9 min) than in patients who did not develop pancreatitis (30.5 min), (p:0.007). Procedure-related variables and adverse events in older and younger patients are shown in Table 3.

DISCUSSION

This study evaluated 500 ERCP procedures over two years, providing significant insights into patient demographics, indications, adverse events, and associated risk factors. The mean age of the patients was 62.1 years, with a notable predominance of females (54.2%). This finding aligns with previous literature suggesting that ERCP procedures are frequently performed in older populations with complex medical histories. The most common presenting symptom was abdominal pain (70.2%), which is in line with existing studies suggesting that biliary obstruction is often associated with pain.[7]

Table 2. Comparison of variables associated with patients and procedure in terms of adverse events

Variables	Adverse events (n, range, %)	Non-adverse events (n, range, %)	p
Age	59.7 (20-94)	62.7 (20-97)	0.17
Gender Female Male	 46 (17) 47 (20.5)	 225 (83) 182 (79.5)	0.31
History of cholecystectomy Non- cholecystectomy	13 (8.8) 80 (22.7)	134 (91.2) 273 (77.3)	**<0.001**
Antiaggregant medication use Antiaggregant medication non-use	27 (19.9) 66 (18.1)	109 (80.1) 298 (81.9)	0.66
Anticoagulant medication use Anticoagulant medication non-use	9 (28.1) 84 (17.9)	23 (71.9) 384 (82.1)	0.15
Total procedure time (min)	34.3	30.4	**0.003**
History of sphincterotomy Non-sphincterotomy	12 (7.2) 81 (24.2)	154 (92.8) 253 (75.8)	**<0.001**
Difficult cannulation Easy cannulation	50 (64.9) 43 (11.2)	27 (35.1) 338 (88.8)	**<0.001**

Table 3. Comparison of variables in terms of age

Variables	Young patients (%)	Elderly patients (%)	p
Patients	268 (53.6)	232 (46.4)	0.44
Successful cannulation	256 (95.5)	202 (87.1)	0.001
Adverse events	57 (21.3)	36 (15.5)	0.1
Post-ERCP pancreatitis	27 (11.6)	46 (17.2)	0.081
Total procedure time (minute)	31.8	30.4	0.13

ERCP: Endoscopic retrograde cholangiopancreatography

The predominance of choledocholithiasis as an indication for ERCP (86.8%) is in line with established findings and reaffirms the necessity for timely intervention in patients presenting with biliary stones.[8] It has been emphasized in the literature that the early diagnosis and treatment of choledocholithiasis can significantly reduce the morbidity and mortality rates associated with adverse events resulting from untreated conditions.[9] In this study, the overall adverse event rate of 18.6% is in line with previous studies and confirms that although ERCP is an important intervention, it is not without risk.[10]

The observed incidence of post-ERCP pancreatitis (PEP) in our study was 14.6%, which is considered a relatively high rate compared to typical reports in the literature. While this rate aligns with some published data, it exceeds the threshold suggested by ESGE guidelines. Several factors may contribute to the elevated incidence observed in our cohort. One potential explanation is the higher proportion of patients undergoing balloon dilation procedures, which are known to be associated with increased risk of PEP. Additionally, the extended duration of ERCP procedures in some cases could have contributed to a higher likelihood of pancreatitis. These procedural factors, combined with patient-specific risk factors, might explain the increased PEP rate in our study. It is important to consider these variables when evaluating our results in the context of the broader literature.[11]

In particular, we identified several risk factors associated with adverse events. Previous studies have indicated that patients with a history of sphincterotomy experience fewer adverse events.[3] In our cohort, prior sphincterotomy significantly reduced the risk of post-procedural adverse events, which may reflect the benefits of prior interventions in optimizing biliary drainage and preventing subsequent adverse events. Moreover, the duration of the procedure was significantly longer in patients who developed adverse events, suggesting that prolonged procedures may increase the risk of adverse outcomes, further emphasizing the importance of efficient technique and procedural timing in ERCP management.[12]

In contrast, the use of anticoagulants and antiaggregant medications did not appear to correlate with increased adverse event rates in our study, challenging some existing assumptions about their safety in ERCP procedures.[13] This many practitioners remain wary of performing procedures in patients receiving these medications due to potential bleeding risks, this finding is particularly relevant to clinical practice. However, our results may suggest that using such drugs could be safely incorporated into ERCP protocols if managed appropriately.[14] Furthermore, consistent with the understanding that operator skill and technique play a critical role in minimizing adverse outcomes,[8,10] our analysis showed that difficult cannulation was associated with a higher rate of adverse events.[8,10]

Analysis by age showed that younger patients had a higher rate of post-ERCP pancreatitis than their older counterparts, although this finding did not reach statistical significance. This observation is consistent with the hypothesis that younger patients may have a stronger physiological response to procedural stressors.[15] Indeed, younger individuals may have different anatomical and physiological characteristics that may predispose them to increased risks during the procedure.[16] This finding warrants further investigation to better understand the underlying mechanisms at play.

CONCLUSION

As a result, this study highlights the complexities and risks associated with ERCP procedures. A thorough understanding of the demographics of the patients, the presenting symptoms, and the nuances of the procedure can help healthcare professionals refine their approach to ERCP and ultimately improve patient safety and outcomes. As ERCP continues to evolve with advancements in technology and techniques, ongoing education and training for endoscopists is paramount to minimizing risks and optimizing patient care. Future studies should continue to explore the interplay of these factors, with a focus on large, multicenter trials to improve our understanding of ERCP-related adverse events and develop evidence-based guidelines for practice.[17]

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was conducted with the permission of the Health Sciences University Ankara Training and Research Hospital Clinical Researches Ethics Committee (Date: 08.05.2024, Decision No: 107/2024).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

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Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Original Article

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Analyzing the efficacy of transforaminal lumbar interbody fusion (TLIF) surgery for degenerative spondylolisthesis based on clinical outcomes and spinopelvic metrics

Fahri Eryılmaz
Department of Neurosurgery, Faculty of Medicine, Yozgat Bozok University, Yozgat, Turkiye

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ABSTRACT

Aims: Transforaminal lumbar interbody fusion (TLIF) is an increasingly used approach for treating degenerative spondylolisthesis, but limited data exist regarding its impact on spinopelvic alignment (SA) and related functional outcomes.

Methods: 150 patients who underwent TLIF were enrolled and evaluated pre-operatively and post-operatively in this study. Radiographic analysis was used to measure spinopelvic parameters, including lumbar lordosis (LL), pelvic tilt (PT) and sacral slope (SS). Oswestry disability index (ODI) and visual analog scale (VAS) functional outcomes were assessed. Methods statistical analyses included paired t-tests, Pearson correlation coefficients, and multivariate regression for differences in parameters before and after surgery, associations between changes in spinopelvic parameters and functional outcomes, and predictors of greater improvement in the ODI, respectively.

Results: Changes in LL, PT and SS from pre- to post-operative day 10, 30-points posterior pelvic plane re-orientation score. Functional output assessments showed improvement in mean ODI (34 to 20) and VAS (6.5 to 3.2) scores ($p<0.001$). Pre-operative ODI, post-operative change in LL, PT and SS predicted recovery above chance by multivariate regression ($p<0.001$).

Conclusion: TLIF provides correction to SA and functional outcomes, supporting the importance of pre-operative assessment and targeted surgical planning to optimize quality of life at maximum value for each patient. Longer-term recovery and other pertinent outcome variables should be conducted.

Keywords: Transforaminal lumbar interbody fusion, interbody fusion, spine surgery, spondylolisthesis

INTRODUCTION

Degenerative spondylolisthesis (DS) is one of the most prevalent forms in an elderly age group that happens when degeneration changes prevent one vertebrae from sliding over the top of another. Persistent low back pain, radiculopathy, and loss of function also occur as a result of spinal instability and neural element compression frequently seen in this disorder.[1]

These symptoms may adversely affect the quality of life, requiring pain management and mechanical stability therapy plans. Transforaminal lumbar interbody fusion (TLIF) has become a popular surgical approach for the treatment of DS. The goal of TLIF is to fuse damaged vertebrae to decompress neural structures, restore spinal alignment, and increase stability. This can help patients with their pain and functional results.[2]

The restoring spinopelvic alignment (SA) restoration of SA, an important element of spinal biomechanics is vital to surgery parameters of the spinopelvic coordinate system, such as lumbar lordosis (LL), sacral slope (SS), pelvic tilt (PT), and pelvic incidence (PI), play an important role in spinal stability and posture. Alteration of these properties may result in further degeneration, irreparable pain, and disability, especially in patients with DS. TLIF aims to modify these parameters, thereby possibly enhancing functional outcomes. Ideally, alignment is attained through TLIF as a function of the correction obtained after surgery, patient-specific anatomy, and pre-existing spinal degeneration.[3]

Spinopelvic factors play an important role in spinal function, stabilization, and biomechanics. The posture is balanced as long as the SA is appropriate, allowing gravity to pass vertically through the center of mass of the body over the pelvis and spine. Perfect alignment minimizes stress on these structures and prevents degenerative changes as the burden on facet joints and intervertebral discs of back is reduced. Furthermore, how the spine connects to the pelvis plays a huge role in stability during dynamic tasks, such as walking and lifting. Compensatory mechanisms due to misalignment can create stress in certain regions of spine leading into pain/injury.[4]

Moreover, in disorders, such as spondylolisthesis, wherein vertebrae may slip over one another and cause neurological deficits, proper alignment of the spinopelvic region serves to reduce nerve compression that can arise from either degenerative change or malalignment. Studies have suggested

Corresponding Author: Fahri Eryılmaz, drfahrier@hotmail.com

that rear spine operations would be more functional in patients with little spinopelvic malalignment improved. Thus, it stresses the need for correction of any misalignment to enhance quality of life of the patient.[5]

Key parameters, such as SS, PT and LL, are important when evaluating SA.[6] One of the significant features of our structure is LL, simply the inward curve of the lumbar spine, which allows for shock absorption to be distributed throughout your spine.

Adequate LL reduces the risk of back pain and maintains stability. Optimal pelvic tilt allows for proper load transfer through the pelvis and lumbars. PT assesses the position of pelvis. Finally, the SS (the angle formed between the sacral plate and a horizontal plane) affects LL and stability. Because surgical options, such as TLIF, can drastically affect spinal balance, alleviate pain, and improve patient-reported outcomes, an appreciation of these spinopelvic parameters is essential in the management of DS.[7]

In addition, the relationship between improvement in SA after TLIF with patient-reported outcomes has been explored. However, the extent to which changes in alignment correlate with improvement in pain and disability remains to be established; taking into consideration these results between TLIF and spinopelvic parameters and clinical outcomes, more studies are of great importance.[8]

Functional outcome measures are often evaluated using standardized patient-reported outcome measures, such as the visual analog scale (VAS) for pain and the oswestry disability index (ODI). The VAS assesses a patients pain level, whereas the ODI takes a more comprehensive view of back pain-related dysfunction. These methods help quantify the impact of TLIF in terms of improvements in patient-reported functional and pain end-points and hence facilitate an assessment of surgical success from a patient-centered perspective.[9]

METHODS

The study was conducted with the permission of Hitit University Faculty of Medicine Researches Ethics Committee (Date: 17.05.2022, Decision No: 2022-25). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. All patients provided informed consent, and were assured confidentiality and the right to withdraw from the research at any time with no consequences.

This study design was a prospective cohort that assessed sagittal spinopelvic parameters and functional outcomes before and after TLIF in patients with DS. Conducted at Department of Neurosurgery of Erol Olçok Training and Research Hospital, the study period from Jully 2022 to Jully 2023. 150 patients aged 40 years or older who were diagnosed with DS and are scheduled for TLIF surgery were enrolled. Patients who had failed conservative treatment for a minimum of 6 months were excluded if they had had previous surgery to the spine, active infections or malignancies or significant comorbidities affecting potential surgery or rehabilitation. The sample size was calculated using a formula for comparing means, $n=(Z\alpha/2+Z\beta)2\cdot 2\sigma 2/d2$, assuming an effect size of 5 points, a significance level of 0.05, and a power of 80% ($Z\beta=0.84$) and standard deviation (σ): estimated from previous studies or pilot data (e.g., 10), resulting in a requirement of approximately 150 patients. Data collection occurred preoperatively and 6 months post-operatively, including demographic information (age, sex) as well as body-mass index (BMI), smoking status, comorbidities that were collected through patient interviews and their medical chart. Standardized X-ray images were taken to measure spinopelvic parameters, such as the PI, PT and LL.

Statistical Analysis

ODI and VAS for pain the demographic data and clinical characteristics were analysed by SPSS 23. Inferential statistics consisted of paired t-tests to compare pre-operative and post-operative outcomes, Pearson correlation analysis to evaluate the relationship between changes in spinopelvic parameters with functional outcomes, as well as multivariate regression modelling determining factors associated with greater improvement in patients-reported outcome. Statistical significance was considered at a level of $p<0.05$.

RESULTS

The demographic and clinical characteristics of the study population revealed a sample of 150 patients with an average age of 63 years, comprising 54.7% females and 45.3% males. The average BMI was 28.5 kg/m², indicating a predominance of overweight individuals. Smoking history varied, with 20% current smokers, 30% former smokers, and 50% never smokers. Comorbidities included hypertension (36.7%), diabetes mellitus (26.7%), and osteoporosis (13.3%). Spinopelvic parameters showed a PI of 53°, PT of 22°, and LL of 40°. Functional outcomes showed moderate disability, with an ODI score of 34 and a VAS pain score of 6.5. These results underscored the heterogeneity of this cohort in terms of demographic factors and comorbid conditions, which can impact surgical outcomes and recovery see Table 1.

Table 1. Baseline demographic and clinical characteristics of patients

Characteristic	Value
Demographic characteristics	
Age (years), mean±SD	63±10
Gender, n (%)	
- Male	68 (45.3%)
- Female	82 (54.7%)
Clinical characteristics	
BMI (kg/m²), mean±SD	28.5±4.2
Smoking status, n (%)	
- Current smoker	30 (20%)
- Former smoker	45 (30%)
- Never smoker	75 (50%)
Comorbidities	
Hypertension, n (%)	55 (36.7%)
Diabetes mellitus, n (%)	40 (26.7%)
Osteoporosis, n (%)	20 (13.3%)
Spinopelvic parameters	
Pelvic incidence (PI) (°), mean±SD	53±9
Pelvic tilt (PT) (°), mean±SD	22±5
Lumbar lordosis (LL) (°), Mean±SD	40±8
Functional outcomes	
ODI score, mean±SD	34±12
VAS pain score, mean±SD	6.5±2.3

BMI: Body-mass index, SD: Standard deviation, ODI: Oswestry disability index, VAS: Visual analog scale

The findings showed marked enhancements in all areas of the different domains of health survey following TLIF surgery. Patients had moderate physical and mental well-being as assessed by pre-operative scores, with 50.0 for physical functioning and 49.0 for mental health. Post-operatively, the scores increased significantly, with physical functioning reaching 75.0 and mental health 73.0 Similar increases were also seen in all domains (role–physical, bodily pain, and vitality), with mean changes between 24 and 28 points. All changes were significant (p<0.001) and it appears that TLIF substantially improves physical function but has a positive impact on mind and adds to the emotional and social aspects resulting in an enhanced quality of life all together see Figure 1.

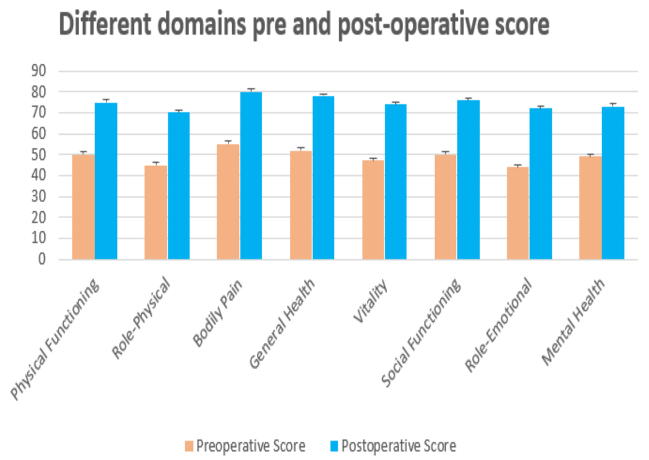

Figure 1. Different domains pre and post-operative score

Table 2 shows significant changes in spinopelvic parameters and functional outcomes after TLIF surgery. Notably, PT decreased from 22° to 18°, while the SS increased from 31° to 35°, and LL improved from 40° to 48°. These changes reflect better alignment of the spine. Additionally, functional outcomes also showed marked improvement: the ODI score decreased from 34 to 20, indicating less disability, and the VAS pain score dropped from 6.5 to 3.2, signifying a substantial reduction in pain. All changes were statistically significant, with p-values fewer than 0.001, demonstrating that TLIF effectively enhances spinal alignment and significantly improves patient-reported outcomes see Figures 2 and 3.

Correlations between change in spinopelvic parameters (PT, SS and LL) with change in functional outcomes (ODI and VAS scores). Changes are defined as post-operative score-preoperative score. Functional improvement was significantly and positively correlated with all of the parameters. Specifically, a higher increase of LL correlated with greater ODI score (r=0.65, p<0.001) and VAS score improvement (r=0.65, p<0.001), indicating that better SA positively correlates with improved functional outcomes as well. Changes in PT and SS also demonstrated significant associations with improvement in functional disability score and pain severity levels, highlighting the importance of spinopelvic parameters for improving both components of functional recovery following TLIF surgery, as seen in Table 3.

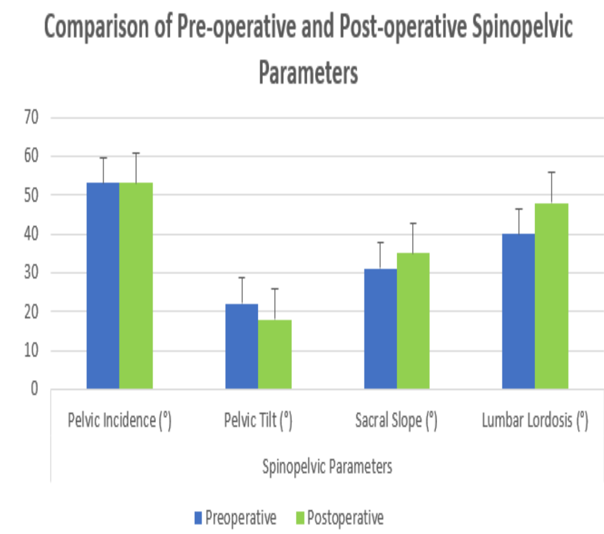

Figure 2. Comparison of pre-operative and post-operative spinopelvic parameters

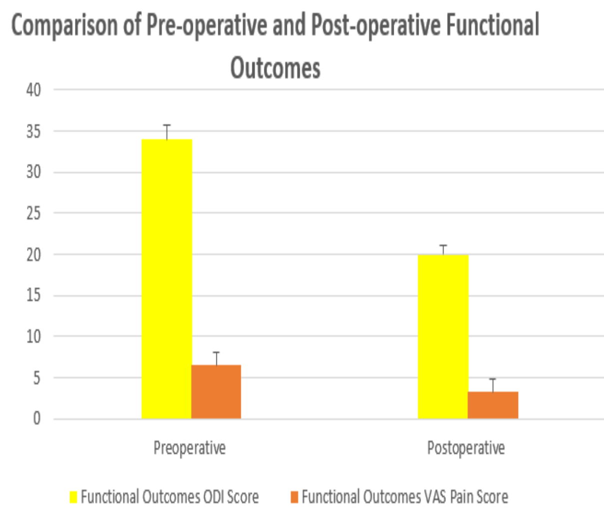

Figure 3. Comparison of pre-operative and post-operative functional outcomes

Table 2. Comparison of pre-operative and post-operative spinopelvic parameters and functional outcomes

Parameter	Pre-operative mean±SD	Post-operative mean±SD	Mean difference (post-pre)	t-value	p-value
Spinopelvic parameters					
Pelvic incidence (PI) (°)	53±9	53±9	0	-	-
Pelvic tilt (PT) (°)	22±5	18±4	-4	5.10	<0.001
Sacral slope (SS) (°)	31±6	35±5	+4	4.75	<0.001
Lumbar lordosis (LL) (°)	40±8	48±7	+8	6.15	<0.001
Functional outcomes					
ODI score	34±12	20±10	-14	7.80	<0.001
VAS pain score	6.5±2.3	3.2±1.8	-3.3	8.50	<0.001

SD: Standard deviation, ODI: Oswestry disability index, VAS: Visual analog scale

Table 3. Correlation between changes in spinopelvic parameters and functional outcomes

Parameter	Change in spinopelvic parameter (°)	Change in ODI score	Change in VAS score	Pearson correlation coefficient (r)	p-value
Change in pelvic tilt (PT)	-4	-14	-3.3	0.55	<0.001
Change in sacral slope (SS)	+4	-14	-3.3	0.60	<0.001
Change in lumbar lordosis (LL)	+8	-14	-3.3	0.65	<0.001

ODI: Oswestry disability index, VAS: Visual analog scale

Table 4. Predictors of improved patient-reported outcomes

Predictor variable	Regression coefficient (β)	Standard error (SE)	p-value	95% Confidence interval
Pre-operative ODI score	-0.45	0.10	<0.001	(-0.65, -0.25)
Change in lumbar lordosis (LL) (°)	-1.20	0.30	<0.001	(-1.80, -0.60)
Change in pelvic tilt (PT) (°)	-0.90	0.25	<0.001	(-1.40, -0.40)
Change in sacral slope (SS) (°)	-0.75	0.20	<0.001	(-1.15, -0.35)
Age (years)	-0.05	0.02	0.025	(-0.09, -0.01)
Gender (female vs. male)	1.20	0.50	0.020	(0.20, 2.20)

ODI: Oswestry disability index

Table 4 represents the characteristics and univariate outcomes for TLIF surgery a (n=59) b of predictors associated with the improvement in patient-reported outcome measure scores at 3 months post-op after TLIF Important predictors were the preoperative ones: ODI and changes of spinopelvic parameters. Of note, more severe disability (ODI) preoperatively was associated with greater post-operative gains: (β=-0.45 p<0.001). Specifically, greater increases in LL (β=-1.20, p<0.001), PT (β=-0.90, p<0.001), and SS (β=-0.75, p<0.001) were all significant predictors of functional improvements at the latest follow-up visit after surgery. Moreover, both younger age and the female sex predicted more recovery (β=-0.05, p=0.025; β=1·20, p=0.020, respectively). The underlying results suggest that SA and pre-operative disability are important determinants for TLIF surgery to achieve quality of life improvement.

DISCUSSION

This study sought to evaluate the impact of TLIF on spinopelvic parameters and self-reported patient outcomes in those with DS. The results suggest that TLIF not only rectifies spinal alignment but markedly amplifies functional restoration, as evidenced by increases in both VAS and ODI scores.[10]

In our research, post-operative modifications in spinopelvic parameters were substantially significant concerning LL, PT, and SS. An increase in LL is often needed to keep the curvature of the spine intact. Proper LL would lessen the risk of adjacent segment degeneration by improving load distribution across vertebrae and intervertebral discs.[11] The more optimal lordotic angles lead to a balanced posture with less demand on paravertebral muscles, which may have an effect on functional outcomes. The post-operative increase in LL noted in our study suggests that the TLIF may be an effective means of restoring this important biomechanical characteristic, with potential benefits for biomechanical function. The significant reduction in PT seen in our study may indicate a more optimal alignment of the pelvis and spine.[12] TLIF may help reduce PT, allowing for a more neutral pelvic posture and improving load transmission while reducing mechanical stress on the lumbar spine. The increased ODI and VAS scores observed in our results support the concept that this modification may improve functional mobility and decrease pain.[13] Previous investigations have documented similar findings. Kothari et al.[14] demonstrated that surgery for spondylolisthesis corrects sagittal spinal orientation. Certain studies have also linked improved SA to enhanced psychological and quality-of-life metrics following such corrective procedures.

Another important change associated with improved SA after TLIF is the increase in SS. In addition, increased SS allows for increased LL while requiring less pelvic compensation overall. Many studies, including Aldebeyan, indicated that utilizing a positive SS improves patient-reported outcomes and reduces lumbar loads. The enhancement of this variable in our study is not surprising, as functional improvements have been observed, suggesting that the commonly regarded optimal SS may aid in recovery.[15]

In our study, the range of LL (8 degrees) was higher than that in Jacob et al.[16] average gains of nearly 6 degrees, it wrote. That discrepancy may be due in part to patient selection criteria or specific surgical techniques. The functional outcome improvements seen in our study compare well with previously reported outcomes. TLIF noted that ODI and VAS significantly improved after TLIF surgery. The findings reflect considerable functional improvement, as denoted by the decrease in ODI from 34 to 20 and VAS scores from 6.5 to 3.2, respectively. The ODI is one of the most widely used questionnaires for measuring disability in lower back pain.[16] Similar trends have consistently been demonstrated in prior investigations, reporting a meaningful improvement in ODI scores post-TLIF. For example, previous works have reported that post-operative patients experienced better mobilization and reduced pain, disability which is consistent with our findings.[17] This profound reduction in ODI demonstrates not only was the procedure accomplished successfully but both spinal rod placement and subsequent spine alignment and stability were achieved, which are prerequisites to functional rehabilitation.[18]

Both ODI and VAS scores demonstrate that the improvements after TLIF represent a major enhancement in the health state of the patients. Such functional rehabilitation is important, particularly in older populations or those with degenerative illness, where greater independence and mental health outcomes are contributing factors. They also emphasize the importance of proper pre-operative assessments and properly tailored surgical procedures that meet every individual patient's needs to achieve optimal outcomes in recovery. In contrast, Friedman et al.[19] reported an improvement from ODI 40 to 25, suggesting that our cohort presented with a more marked healthcare impact at baseline. This may come from more intense post-operative rehab protocols or differences in pre-operative levels of disability.

Our analysis identified several important predictors of improved outcomes, including preoperative ODI scores and changes in LL, PT, and SS. Pre-operative ODI scores measure a patient's functional impairment related to lower back pain. A higher ODI may also be associated with substantial, more significant disease progressions, the journey of which relates directly to greater disability. This baseline assessment aids in the extent to which recovery may be possible after surgery and provides a measure of baseline dysfunction. Higher pre-operative ODI scores are indicative of more significant pain and functional impairments experienced by patients. Consequently, patients are likely to demonstrate greater improvements as they move from a state of severe disability pre-operatively to improved functional status post-operatively. TLIF has overall good efficacy for patients with different grades of pre-operative symptoms, but those who had more severe ones got better effects, so TLIF is even more efficacious for the former group. This association emphasizes the significance of targeted rehabilitation for high-disability individuals to achieve optimal functional recovery.[20]

LL refers to the curvature of the lumbar spine, an intrinsic feature of spinal biomechanics and overall spinal health. Similarly, alterations in LL after TLIF reflect the restoration of normal spinal alignment essential for stability and movement. A higher improvement in LL following surgery was associated with better functional results, per our findings. Nerve compression relief decreased spinal tension, and more favorable load distribution of the lumbar spine all help explain this improvement. SA has an evident relationship with patient-reported outcomes; patients often experience less pain and more functional improvement when lordosis is adequately restored.[21]

PT and SS are essential components of SA that influence the overall biomechanics of the pelvis and lumbar spine. These factors influence postural strategies, gait, and loading patterns in the spine during activities. Less pelvic flexing means potentially better stability and alignment of the pelvis, leading to more efficient posture and gait. Following similar reasoning, an advantageous alteration in SS may facilitate lumbar spine mechanics for the betterment of spinal health and discomfort. Patients who notice these fixes to their alignment often report less pain and improved function because the changes allow better load-bearing mechanics while distributing stress more evenly.[22]

Larger multicentre trials should be organized to be a major focus of further research. The long-term effects of TLIF must be evaluated in these trials, including what different surgical approaches lead to and how they compare with each other in terms of patient-oriented outcome measures. This is an urgent need. We also need further experiments to show the impact that rehabilitation methods have on SA and patient-reported quality of life. Not only that but how comorbidities and psychological factors affect rehabilitation might provide us with deeper insights into just what works best for patients whose main condition is DS.

CONCLUSION

Our study suggests that DS patients show significant improvements in TLIF for spinopelvic parameters as well as functional outcomes. There were statistically significant improvements in LL, PT and SS, and clinically significant reductions in VAS and ODI scores, providing evidence of drastic impairments. The results are also an argument for the relevance of tailored pre-operative assessments since pre-op ODI scores and changes in SA were shown to be major recovery predictors. The results show how effective TLIF is at restoring the spine and improving a patient's resurfacing and that targeted interventions can lead to significant improvements in function. Further studies should focus on longer-term outcomes and the influence of other variables on TLIF recovery.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was conducted with the permission of Hitit University Faculty of Medicine Researches Ethics Committee (Date: 17.05.2022, Decision No: 2022-25).

Informed Consent

All patients signed and free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Original Article

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Analysis of coronary artery anomalies in adults: morphology, atherosclerosis, and cardiovascular risks

Serpil Çilingiroğlu Anlı[1], Ramazan Atak[2]

[1]Department of Anatomy, Faculty of Medicine, Kırıkkale University, Kırıkkale, Turkiye

[2]Department of Cardiology, Private Practice Physician, Ankara, Turkiye

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ABSTRACT

Aims: Despite their rarity, coronary artery anomalies (CAAs) warrant careful consideration during percutaneous or surgical interventions due to their potential influence on clinical outcomes. The objective of this study was to ascertain the prevalence and characteristics of CAAs in adult patients undergoing coronary angiography.

Methods: A retrospective analysis was conducted on 12.457 coronary angiography records from a tertiary hospital, encompassing the period from May 2007 to October 2010. The classification of anomalies adhered to the system proposed by Dr. Angelini and approved by the Congenital Heart Surgery Committee. Statistical comparisons were performed through the application of Student's t-test, Pearson's chi-square test, and Fisher's exact test.

Results: An analysis of angiographies identified CAAs in 134 cases, consisting of 89 males and 45 females, with an age range spanning from 21 to 87 years . Myocardial bridging was identified in 62 instances (0.49%), coronary artery exit anomalies in 17 instances (0.14%), coronary artery aneurysms in 30 instances (0.24%), coronary artery fistula in 18 instances (0.14%) , and coronary artery atresia in one instance (0.01%). There were no substantial gender variations observed among the different types of anomalies.

Conclusion: The findings of this study align closely with previous research concerning the prevalence and characteristics of CAAs. Prompt diagnosis and angiographic assessment of congenital CAAs are essential for optimal management and minimizing procedural risks. Anatomical knowledge is indispensable in elucidating pathophysiological mechanisms, optimizing surgical strategies, and advancing diagnostic imaging techniques.

Keywords: Coronary angiography, coronary artery anomalies, myocardial bridging, sudden death, congenital anomalies

INTRODUCTION

The prevalence of coronary artery anomalies (CAAs) within the general population is estimated to be between 0.2% and 1.2%.[1,2] Though rare and usually asymptomatic, CAAs can lead to angina, myocardial infaction (MI), heart failure, heart attacks, and sudden death.[3,4] Myocardial bridge (MB), a condition typically seen in the left anterior descending coronary artery (LAD), can be managed using both medical and surgical approaches.[5]

The occurrence of an exit anomaly of the circumflex artery, exhibiting an anomalous coronary artery outflow originating from the right coronary sinus, is documented at a rate of 0.32-0.67%.[6] This anomaly represents the most frequently observed coronary artery outflow variation. Recognition of the anomaly is essential to avoid potential arterial injury during surgical procedures.[7] The presence of a single coronary artery, a congenital anomaly characterized by a single opening in the aorta supplying the entire heart, also poses a serious risk of sudden death.[8]

Accurate assessment of abnormal coronary artery anatomy, based on data obtained through coronary angiography or other imaging modalities, is paramount in clinical follow-up, treatment regimens, and the avoidance of complications during surgical interventions. The study aimed to ascertain the incidence of congenital CAAs through an examination of coronary angiographies.

METHODS

Study Design

This retrospective study involved the examination of 12.457 coronary angiography records obtained from a tertiary hospital during the period from May 2007 to October 2010. A cardiologist and an anatomist undertook the assessment of the data , with the goal of identifying any irregularities in the coronary arteries. Ethical approval for this retrospective study has been obtained from the Kırıkkale University Non-interventional Clinical Researches Ethics Committee (Date: 02/25/2021, Decision No: 2021.01.24). All procedures were

Corresponding Author: Serpil Çilingiroğlu Anlı, serpilblue@gmail.com

carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

The study included 134 cases diagnosed with CAAs through coronary angiography and 139 cases in the control group. However, patients with CAAs who had other potential causes of angina, such as heart transplantation, coronary artery bypass surgery, pulmonary hypertension, hypertrophic cardiomyopathy, liver or kidney failure, congestive heart failure, acute coronary syndrome, or valvular heart diseases, were excluded from the study.

The study's focus was on exploring various abnormalities present in the coronary arteries. These anomalies encompassed abnormal drainage into the coronary sinus, drainage structures near the aortic root or the sinus of Valsalva, and coronary arteries positioned above the heart's apex. Furthermore, the study addressed other cardiovascular anomalies including MB, coronary artery fistula (CAF), coronary artery aneurysms, and coronary artery atresia. The defects observed in this study were classified using the Angelini system, which is approved by the Congenital Heart Surgery Committee and is more frequently utilized than other classification systems due to its comprehensive approach and broad acceptance.[9]

Imaging Procedure

Coronary angiograms were performed using the Judkins technique. Images were acquired using a Philips Allura Xper FD10 angiography unit equipped with a Flat Image Detector, a Philips TG 21 monitor, and a 40-85kW Philips MRC 200 x-ray tube. Radiographic angles were adjusted to achieve the optimal image for every case, ensuring flexibility in image acquisition. The data was processed utilizing the Philips digital heart imaging system integrated with the angiography equipment

Statistical Analysis

Descriptive statistics were utilized to summarize the demographic and clinical features of the study population. Continuous variables with normal distributions were summarized using means and standard deviations. Categorical variables are reported as frequencies (n) and percentages (%).

Appropriate statistical analyses comparing the CAAs and control groups were performed using tests chosen based on the nature of the variables. Continuous variables, such as age, were compared across groups using Student's t-test, assuming normality. Categorical variables-gender, hypertension, and family history of cardiovascular disease-were analyzed using Pearson's chi-square test. To preserve statistical validity in instances of categorical variables with small cell counts, such as those pertaining to CAF or aneurysms, the Fisher's exact test was utilized. Statistical significance was defined as a p-value below 0.05. R software, version 4.4.0, was utilized for statistical analysis.

RESULTS

An in-depth analysis of 12,457 coronary angiography cases was conducted to evaluate the prevalence and clinical presentation of CAA, with 134 patients (1.08%) exhibiting the anomaly. Myocardial bridging was the most prevalent anomaly, observed in 62 patients (0.49% of the total cohort). Coronary artery aneurysms were the second most prevalent anomaly, observed in 30 patients (0.24%), while CAF were identified in 18 patients (0.14%). Coronary artery exit anomalies were also identified in 17 participants (0.14%). Less prevalent anomalies included right coronary artery atresia (n=1, 0.01%) and a single coronary artery (n=1, 0.01%) (Table 1).

Table 1. Frequency and percentage of congenital coronary artery anomalies in the study population

	Number of cases (n)	Percentage (%)
Myocardial bridge	62	0.49
Aneurysm	30	0.24
Fistulae	18	0.14
Atresia (right coronary)	1	0.01
Exit anomalies	17	0.14
LMCA-to-RS (type IV)	2	0.02
LAD-to-RS (type I)	2	0.02
Cx-to-RS (type IV)	11	0.09
RCA-to-LS (type I)	2	0.02
Single coronary artery (type III)	1	0.01

Categorical variables are represented as count and percentage. LMCA-to-RCS: Left main coronary artery originating from the right coronary sinus, LAD-to-RCS: Left anterior descending artery originating from the right coronary sinus, Cx-to-RCS: Circumflex artery originating from the right coronary sinus, RCA-to-LCS: Right coronary artery originating from the left coronary sinus

Comparison of Clinical and Demographic Characteristics of Anomaly and Control Groups

For comparative analysis, a control group, matched by age and gender to the anomaly group, was randomly selected from the remaining non-CAA patients. Both groups exhibited similar age distributions; the anomaly group's mean age was 52.86±12.6 years, and the control group's mean age was 52.43±12.43 years. Both groups had similar male proportions (66.42% vs. 66.19%), confirming successful matching (p>0.999). The clinical and demographic characteristics for the CAA group (n=134) and the control group (n=139) are presented in Table 2.

Compared to the anomaly group, the control group exhibited a significantly higher prevalence of diabetes mellitus (11.94% vs. 21.58%, p=0.049), hyperlipidemia (9.70% vs. 24.46%, p=0.002), and a family history of cardiovascular disease (25.37% vs. 41.01%, p=0.009). These findings suggest a potentially weaker association between diabetes, hyperlipidemia, family history of heart disease, and the occurrence of CAA.

While the anomaly group exhibited nearly double the rate of atherosclerosis (20.15%) compared to the control group (12.95%), this difference was not statistically significant (p=0.150). Between the groups, there were no statistically significant differences in other major cardiovascular risk factors including hypertension (35.82% vs. 29.50%, p=0.324), smoking (41.79% vs. 30.22%, p=0.062), and MI (29.85% vs. 25.90%, p=0.553).

Gender-Specific Analysis of Coronary Artery Anomalies with in the CAA Group

Gender-based stratification of the CAA group (n=134) was performed to analyze potential differences in the type and frequency of anomalies. Of the anomalies observed, myocardial bridging constituted the most frequent, affecting 41.04% of the CAA cohort.

Table 2. Demographic and clinical characteristics: case (coronary artery anomaly) vs. control (normal) groups

	Overall (n=273)	Normal (n=139)	Anomaly (n=134)	p
Age				0.777
Mean (SD)	52.65±12.5	52.43±12.43	52.86±12.6	
Median (IQR)	53 (19-87)	52.5 (19-82)	53 (21-87)	
Gender				>0.999
Male	181 (66.30%)	92 (66.19%)	89 (66.42%)	
Female	92 (33.70%)	47 (33.81%)	45 (33.58%)	
Hypertension	89 (32.60%)	41 (29.50%)	48 (35.82%)	0.324
Diabetes mellitus	46 (16.85%)	30 (21.58%)	16 (11.94%)	**0.049**
Hyperlipidemia	47 (17.22%)	34 (24.46%)	13 (9.70%)	**0.002**
Smoking history	98 (35.90%)	42 (30.22%)	56 (41.79%)	0.062
Family history	91 (33.33%)	57 (41.01%)	34 (25.37%)	**0.009**
Atherosclerosis	45 (16.48%)	18 (12.95%)	27 (20.15%)	0.150
Myocardial infarction	76 (27.84%)	36 (25.90%)	40 (29.85%)	0.553

Continuous variables are presented as mean±standard deviation (SD), while categorical variables are represented as count (percentage). For skewed continuous variables, the median and interquartile range (IQR) are presented. Statistical comparisons between genders employed t-tests for continuous data and chi-square or Fisher's exact tests for categorical data. P-values below 0.05 were bolded to indicate statistical significance

Myocardial bridges were present in 44.94% of males, compared to a slightly lower prevalence of 33.33% in females. The left anterior descending artery was the predominant location for myocardial bridges, with the circumflex and right coronary arteries (RCA) exhibiting a lower frequency; gender did not significantly influence occurrence or location (p=0.532).

In 15 cases (11.19%), aneurysms were detected most often in the LAD, with almost identical rates in males (11.24%) and females (11.11%) (p=0.733). Aneurysms in other coronary arteries, like the left main coronary artery (LMCA), circumflex (Cx), and RCA, were rare and did not exhibit any notable gender variations.

CAF analysis indicated the LMCA (5.22%), LAD (2.99%), and RCA (5.22%) as the most involved sites, with no significant gender disparity in frequency (p=0.696). The analysis of exit anomalies showed a male-exclusive presence of rare events, namely LMCA-to-RCS, LAD-to-RCS, and RCA-to-LCS. Because of the low frequency of these events (two occurrences per event), meaningful statistical analysis was not possible. No significant difference (p>0.999) was detected in the prevalence of the Cx-to-RCS anomaly between males (7.87%) and females (8.89%). The observed single coronary artery anomaly and atresia were present in only one male patient, limiting the statistical significance of the findings (Table 3).

The comparison of atherosclerosis and MI occurrence between CAA patients and the control group (Table 4). Among the control group (n=139), 25.9% exhibited atherosclerosis, and 12.95% had a history of MI. In CAA patients, a significantly

Table 3. Coronary artery anomalies and structural findings by gender in anomaly group

	Overall (n=134)	Male (n=89)	Female (n = 45)	p
Myocardial bridge				0.532
LAD	55 (41.04%)	40 (44.94%)	15 (33.33%)	
Cx	6 (4.48%)	4 (4.49%)	2 (4.44%)	
RCA	1 (0.75%)	1 (1.12%)	0 (0.00%)	
Aneurysm				0.733
LMCA	2 (1.49%)	2 (2.25%)	0 (0.00%)	
LAD	15 (11.19%)	10 (11.24%)	5 (11.11%)	
Cx	3 (2.24%)	1 (1.12%)	2 (4.44%)	
RCA	10 (7.46%)	7 (7.87%)	3 (6.67%)	
Fistulae				0.696
LMCA	7 (5.22%)	4 (4.49%)	3 (6.67%)	
LAD	4 (2.99%)	2 (2.25%)	2 (4.44%)	
RCA	7 (5.22%)	4 (4.49%)	3 (6.67%)	
Atresia (right coronary)	1 (0.75%)	1 (1.12%)	0 (0.00%)	>0.999
Exit anomalies				>0.999
LMCA-to-RCS (type IV)	2 (1.49%)	2 (2.25%)	0 (0.00%)	
LAD-to-RCS (type I)	2 (1.49%)	1 (1.12%)	1 (2.22%)	
Cx-to-RCS (type IV)	11 (8.21%)	7 (7.87%)	4 (8.89%)	
RCA-to-LCS (type I)	2 (1.49%)	1 (1.12%)	1 (2.22%)	
Single coronary artery	1 (0.75%)	1 (1.12%)	0 (0.00%)	>0.999

Categorical variables are represented as count (percentage). Statistical comparisons between genders chi-square or Fisher's exact tests for categorical data. A p-value below 0.05 indicated significance. LMCA: Left main coronary artery, LAD: Left anterior descending artery, Cx: Circumflex artery, RCA: Right coronary artery, LMCA-to-RCS: Left main coronary artery originating from the right coronary sinus, LAD-to-RCS: Left anterior descending artery originating from the right coronary sinus, Cx-to-RCS: Circumflex artery originating from the right coronary sinus, RCA-to-LCS: Right coronary artery originating from the left coronary sinus

Table 4. Comparison of atherosclerosis and myocardial infarction occurrence between CAA patients and control group

	Overall (n)	Atherosclerosis			Myocardial infarction		
		Present	Absent	p	Present	Absent	p
Control group	139	36 (25.9%)	103 (74.1%)	-	18 (12.95%)	121 (87.05%)	-
Patients							
Aneurysm	30	14 (46.67%)	16 (53.33%)	**0.024**	11 (36.67%)	19 (63.33%)	**0.002**
Exit anomaly	17	8 (47.06%)	9 (52.94%)	0.067	2 (11.76%)	15 (88.24%)	0.890
Fistula	18	3 (16.67%)	15 (83.33%)	0.394	2 (11.11%)	16 (88.89%)	0.826
Myocardial bridge	62	23 (37.1%)	39 (62.9%)	0.107	9 (14.52%)	53 (85.48%)	0.764

Categorical variables are represented as count (percentage). Statistical comparisons between coronary artery anomaly patients and control group chi-square test for categorical data. P-values below 0.05 were bolded to indicate statistical significance, CAA: Coronary artery anomalie

higher prevalence of atherosclerosis was observed in the aneurysm group (46.67%) compared to the control group (p=0.024). Conversely, MI was more common in the aneurysm group (36.67%) compared to the control group (12.95%) (p=0.002). Exit anomalies showed a similar trend for atherosclerosis (47.06% vs. 25.9%) but did not reach statistical significance (p=0.067). MI occurrence in this group was rare (11.76%) and did not show a significant difference compared to the control group (p=0.890). CAFs were associated with lower rates of both atherosclerosis (16.67%) and MI (11.11%), with no significant difference from the control group (p=0.394 and p=0.826, respectively).

For myocardial bridges, 37.1% of patients exhibited atherosclerosis, while 14.52% had a history of MI. However, neither atherosclerosis (p=0.107) nor MI (p=0.764) showed statistically significant differences when compared to the control group. Statistical significance was defined as p<0.05.

DISCUSSION

CAAs represent a critical intersection between cardiovascular clinical practice and anatomical understanding. From an anatomical perspective, these anomalies highlight the importance of congenital vascular development and its implications for functional pathology. Anatomical variations, such as abnormal origins, courses, and terminations of coronary arteries, play a vital role in assessing surgical and interventional risks.[10]

Despite their low incidence, CAAs present a notable clinical concern, as they can result in myocardial dysfunction, angina, syncope, arrhythmias, MI, and even sudden death.[4] A total of 12.457 coronary angiograms were analyzed, identifying various abnormalities including outflow anomalies, atresia, CAFs, aneurysms, and MBs. CAAs were detected in 134 cases. CAAs, including CAFs, were found in 0.3% (40 cases). In a comprehensive analysis of 126.595 coronary angiograms, Yamanaka and Hobbs[11] documented the presence of coronary artery outflow anomalies, course anomalies, and CAFs in 1,686 cases, equivalent to 1.3% of the total cohort. Kardos and colleagues[12] identified CAFs, concurrent with origin and course anomalies, in 1.34% (103 cases) of 7,694 coronary angiograms. Aydınlar et al.[13] discovered that out of 12,059 cases, 100 (0.82%) exhibited CAFs with origin and course anomalies. Tuncer et al.[14] reported similar findings, identifying CAFs in 56 cases among 70,850 coronary angiograms. Findings align with existing research on the prevalence of CAAs in the Turkish population.

In this study, we compared a cohort of patients with CAAs to an age- and gender-matched control group, ensuring no significant differences in baseline characteristics. This matching facilitated a reliable comparison of cardiovascular risk factors and outcomes. The control group exhibited significantly higher rates of diabetes mellitus, hyperlipidemia, and family history of cardiovascular disease key risk factors for CAD.[15] Additionally, while the anomaly group's higher atherosclerosis rate was notable, other traditional risk factors, such as hypertension, smoking, and family history, may have a more substantial role in CAD.[16] Prior studies have highlighted these risk factors' stronger correlation with CAD compared to coronary anomalies. In summary, CAAs might modestly contribute to atherosclerosis risk, but their overall impact on major cardiovascular events remains unclear. Larger, long-term studies are needed to explore the multifactorial relationship between CAAs, atherosclerosis, and cardiovascular outcomes.

This study found no statistically significant gender differences in CAAs, consistent with evidence suggesting these anomalies are largely independent of gender-specific factors. Anatomical and functional variations, such as myocardial bridges, aneurysms, and exit anomalies, are more influenced by individual hemodynamic conditions and genetic predispositions than by sex.[9] A study concluded that both genders similarly influence the prevalence, clinical presentation, and atherosclerotic burden of CAAs, with RCA originating from LCX being more common in males than females. These findings emphasize the need for personalized evaluation and management of CAAs, regardless of gender. Future research with larger cohorts and advanced imaging methods is necessary to explore any subtle gender-related variations in outcomes.[17]

The circumflex artery originating from the right coronary sinus is the most common CAAs, with an incidence of 0.32-0.67% in coronary angiograms. Located behind the aorta, this anomaly is a significant concern for cardiovascular surgeons, as it increases the risk of damaging the circumflex artery during valve replacement procedures.[4,7,18] In our study, cases with this anomaly exhibited a retroaortic course and a short, sharp angle of origin. This anatomical variation can lead to complications during surgical procedures such as aortic valve replacement and mitral valve repair due to potential vascular injury and improper positioning of the artery.[9,19] These findings underscore the importance of preoperative imaging and careful intraoperative monitoring.

Rare anomalies, such as the LMCA originating from the right coronary sinus, can result in an abnormal course of the coronary artery in cases with interarterial outlet anomalies. This deviation may lead to structural changes that could disrupt blood flow or obstruct coronary perfusion, predisposing individuals to myocardial ischemia and sudden cardiac death. Rooted in embryological errors, these anomalies, including abnormal aorta-pulmonary pathways, disrupt normal blood flow and increase the risk of CAD. In our study, two cases were observed in which the coronary arteries passed behind the aorta without the risk of interarterial compression, both of which did not exhibit myocardial ischemia (**Figure 1**).[20-22]

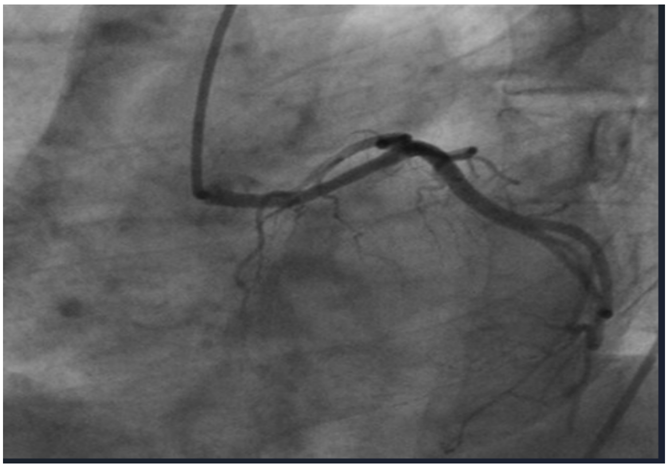

Figure 1. Left main coronary artery originating from the right coronary sinüs (type IV)

The origin of the right coronary artery (RCA) from the left coronary sinus is a rare anatomical variant, observed in 0.03-0.17% of coronary angiographic examinations. Arterial compression near the aorta can lead to various cardiac complications, including myocardial ischemia, rapid heart rate, fainting, and sudden death. Specifically, the interarterial course, where the RCA arises from the left coronary sinus and passes between the aorta and pulmonary artery, may worsen myocardial ischemia and infarction. Although less common, retroaortic coronary artery origin can also increase the risk of MI.[16,23,24] In our study, MI was detected in three cases, one with an interarterial and two with retroaortic coronary artery origin anomalies.

The LAD originating from the right coronary sinus is an extremely rare anatomical variant, with a prevalence of less than 0.01%. Normally, the LAD arises from the left coronary sinus, supplying the anterior wall of the left ventricle and the interventricular septum. In our series, two cases exhibited LAD originating from the right aortic sinus, a rarer variant than the RCA-originating LAD, with no hemodynamic changes or complications observed. However, LAD origin from the right coronary sinus may increase the risk of myocardial ischemia, infarction, and other CAD due to artery compression or altered blood flow.[3,11,25]

Single coronary artery anomaly, occurring in 0.024% of individuals, presents with a single ostium originating from the aortic arch. The presence of this anomaly has been reported in 0.2–1.6% of coronary angiographic examinations. This study identified a single-ostium coronary artery anomaly in one case. Although this anomaly typically has no impact on blood flow, it might raise the risk of sudden death in a few instances (**Figure 2**).[8,26,27]

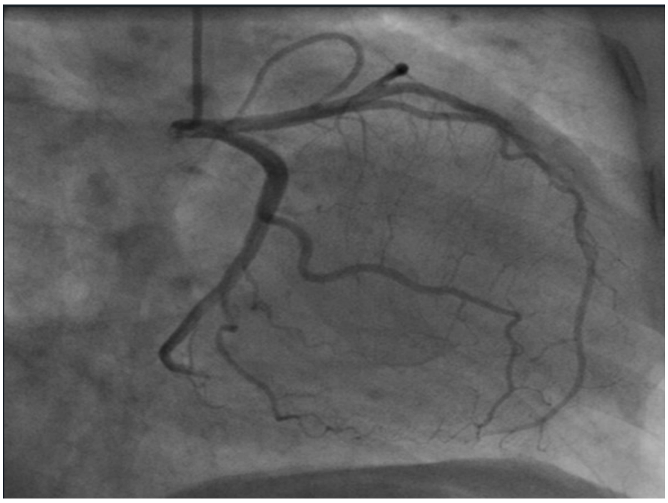

Figure 2. Single coronary artery

Among 1,495 patients examined through 64-slice multidetector computed tomography coronary angiography, only one case of circumflex artery atresia was observed, highlighting the low prevalence of this anomaly.[28] Conversely, our series identified only one instance of RCA atresia. Despite the examination of this cohort, coronary artery atresia remains a rare anomaly, as confirmed by angiographic scans.

In addition, the prevalence of atherosclerosis and MI in the control group was consistent with general population rates, supporting previous data. This provides a relevant baseline for comparing cardiovascular risks in patients with CAAs.[29] CAAs are characterized by abnormal vessel dilation, posing risks due to potential hemodynamic stress, which may lead to further dilation or rupture. CAA aneurysms have a prevalence of 0.3%-5% in coronary angiography patients.[30,31] Our study's frequent LAD artery aneurysms align with previous findings emphasizing the LAD's functional dominance in coronary circulation (**Figure 3**). While CAAs are not directly caused by atherosclerosis, they can promote it, especially in individuals with cardiovascular risk factors.[28,32] Our findings suggest CAA aneurysms increase the risk of atherosclerosis and MI, likely due to hemodynamic stress, structural weakness, and

Figure 3. Left anterior descending arter aneurysms

morphological changes in the arterial wall.[32] MB, found in 0.5-16% of coronary angiograms, are characterized by an epicardial coronary artery segment running through the myocardium. While usually benign, MB can occasionally lead to significant cardiac issues.[33-35] In our study, the LAD artery was most commonly affected, consistent with the literature. However, MB showed no significant association with atherosclerosis or MI compared to the control group. This is in line with studies suggesting that while MB may alter blood flow and cause vascular damage, its role in atherosclerosis and MI remains debated, with some studies showing no increased risk, while others propose mechanical stress on the vessel wall as a potential risk factor.[36]

The prevalence of coronary artery fistulas (CAF) in this study aligns with previous reports, which document an incidence of 0.1% and 0.08% in adult patients undergoing coronary angiography.[37] CAFs are a rare CAAs with pathophysiological significance, as they can lead to myocardial ischemia by diverting blood to heart chambers or large vessels, a phenomenon known as "coronary steal." This bypass impairs myocardial perfusion, particularly during periods of increased oxygen demand.[38] In our study, lower rates of atherosclerosis and MI were observed in patients with CAF compared to previous reports linking these anomalies to higher coronary event rates. This discrepancy may be attributed to the limited sample size, and further research is needed to clarify the role of fistulas in the development of atherosclerosis and MI.

The exit anomaly group showed a potential association with increased atherosclerosis risk, though not statistically significant. Previous studies suggest that exit anomalies may affect coronary flow, but their direct impact on atherosclerosis and MI remains unclear. The low MI frequency in this group indicates the complexity of these anomalies and suggests other unmeasured factors may contribute to cardiovascular risk. Further research is needed to clarify the mechanisms linking exit anomalies to coronary artery disease.[39,40]

CONCLUSION

Through a comprehensive analysis of CAAs in a large population, this study confirms the consistency of its findings with previously established prevalence and types of anomalies. Although the study did not reveal substantial variations in anomaly distribution or associated clinical features based on gender, the results underscore the critical need for early identification and precise classification to inform clinical decision-making. It is essential to recognize these anomalies to optimize treatment strategies, minimize complications, and improve outcomes, especially within the context of percutaneous or surgical interventions. These findings highlight the importance of coronary angiography in the identification and treatment of CAAs. Given these findings, it is crucial to emphasize the role of coronary angiography not only in identifying but also in determining the best treatment strategies for CAAs.

In addition to highlighting the significance of early detection, our study also examines the relationship between CAAs and key cardiovascular risk factors, such as atherosclerosis and MI. The findings suggest that aneurysms and certain coronary anomalies, such as exit anomalies, may be associated with an increased risk of atherosclerosis and MI, while other anomalies like myocardial bridges and CAFs show more varied associations. These results highlight the need for further research into the mechanisms through which coronary anomalies contribute to cardiovascular disease and suggest that clinicians should consider these anomalies in the broader context of patient cardiovascular risk management.

ETHICAL DECLARATIONS

Ethics Committee Approval

Ethical approval for this retrospective study has been obtained from the Kırıkkale University Non-interventional Clinical Researches Ethics Committee (Date: 02/25/2021, Decision No: 2021.01.24).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Review

MEDICINE PALLIATIVE CARE

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The impact of non-pharmacological interventions on quality of life in dementia: a review of evidence and outcomes

Ömer Özişli, Enes Kara

Department of Medical Services and Techniques, Vocational School of Health Services, Sakarya University, Sakarya, Turkiye

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ABSTRACT

Dementia is a neurodegenerative disease that causes a progressive decline in cognitive function in older people, seriously affecting their quality of life. Different types of dementia, such as Alzheimer's disease, vascular dementia and dementia with Lewy bodies, cause a significant decline in patients' daily living skills, social interactions and general health status. In this context, the impact of dementia on individuals' quality of life has been extensively studied. Non-pharmacological interventions have an important place in the management of dementia. Approaches such as physical activity, cognitive exercises, social interaction, healthy diet and music therapy support patients' cognitive functions and offer potential benefits in improving quality of life. Research indicates that these interventions not only delay the cognitive decline associated with dementia but also reduce psychological symptoms like depression and anxiety, thereby enhancing emotional well-being. In particular, given the progressive nature of dementia, it is emphasised that the implementation of such interventions plays an important role in mitigating the negative effects of the disease. Evidence from recent studies underscores that the integration of these approaches into dementia care improves daily functioning and lessens caregiver burden, emphasizing the need for a comprehensive care model. Furthermore, given the economic and societal impact of dementia, it is essential to develop strategies to improve patients' quality of life. Studies show that holistic and sustainable interventions are needed to mitigate the far-reaching effects of dementia on individuals and society.

Keywords: Dementia, quality of life, neurodegenerative diseases, cognitive impairment, social interaction

DEMENTIA

Dementia is recognised as one of the most serious health problems of our time. The number of people with dementia is increasing rapidly worldwide and, according to data from 2019, approximately 50 million people will be affected by this disease.[1] This number is predicted to reach 152 million by 2050, demonstrating that dementia is a serious public health problem at both individual and societal levels. Dementia leads to a progressive deterioration in a person's cognitive functions, reducing their ability to function independently in activities of daily living and, over time, leading to their total loss.[2]

Dementia is a condition that profoundly affects the quality of life of both the person with dementia and their carers. Particularly as the disease progresses, the physical, emotional and mental strain on carers increases as the person's level of dependency increases.[3] Carers of people with dementia are mostly family members or close friends, and this situation defines them as 'informal carers'. Informal carers usually take on this responsibility without professional support, which increases their risk of experiencing stress and burnout.[4]

Given the high burden of dementia on individuals and society, the development of effective intervention strategies has become a necessity. Non-pharmacological interventions play an important role in the management of this disease. These interventions have been developed to alleviate psychological symptoms such as depression and anxiety, improve quality of life and reduce the burden on carers.[5] However, there is insufficient consensus in the literature as to which intervention is more effective. In this context, systematic reviews and meta-analyses that evaluate the effectiveness of different interventions for people with dementia and their carers help to identify the most effective strategies by looking at the available information from a broader perspective.

Trials comparing the effectiveness of non-pharmacological interventions developed to alleviate the effects of dementia provide important information for health professionals and policy makers with regard to people with dementia and their carers. These interventions attempt to alleviate the cognitive and physical difficulties experienced by people with dementia and the psychological and physical distress experienced by their carers. Various non-pharmacological approaches are being evaluated to improve the quality of life of people with dementia and to reduce the burden of care on carers. These approaches will be used to minimise the impact of dementia on individuals and society.

QUALITY OF LIFE

The World Health Organisation has defined health as 'a state of complete physical, mental and social well-being and not

Corresponding Author: Ömer Özişli, omerozisli@sakarya.edu.tr

merely the absence of disease'. According to this definition of health, it is not enough to have no health problems to be a healthy individual. This person is also expected to have a state of complete well-being. Complete well-being cannot be achieved for most people. Therefore, most people in society cannot be described as healthy and only a few people can be described as healthy.[6] The World Health Organisation defines quality of life as 'how individuals view their goals, expectations, standard of living, values, culture and belief structures in the society in which they live as a whole'.[7] The concept of quality of life was first defined by Thorndike (1939). According to this definition, quality of life is 'the reaction of the social environment in which the individual lives and is the result of a good quality perception of the individual'. Andrew and Withey defined quality of life as 'the intersection of individual satisfaction and social relationships'.[8]

Quality of life is a universal goal. This can be explained by Maslow's (1970) theory of the hierarchy of needs. There are five titles in the hierarchy of needs:

✓ Physical needs (food, water, shelter...)

✓Safety needs (security, health, protection...)

✓Social needs (belonging to a group...)

✓ Respect needs (social status, recognition...)

✓Self-actualisation (enrichment of individual life, achievement of goals...)

Maslow's hierarchy of needs shows that the satisfaction of the most basic human needs is important in terms of both quality and quantity. Quality of life is related to the way in which one becomes aware and reaches the level of excellence throughout life.[9]

Quality of life is shaped by an individual's ability to have a job he or she wants, to develop hobbies related to his or her field of interest, to be accepted in a social environment, and to achieve individual satisfaction. An individual's quality of life is also shaped by his or her outlook on life. The perception of quality of life can vary from person to person. Quality of life reflects the individual's sphere of life. An individual who is satisfied in one area of life may not be able to achieve quality of life in another area of life. In the perception of quality of life, one person may keep his perception of quality of life high by enjoying his job, while for another person the positive perception of quality of life is the relationship with his relatives. People's quality of life can also vary for different reasons. For example, the development of situations such as interest in the opposite sex and falling in love, sudden illness, mistreatment at work or in the family can rapidly change an individual's well-being and quality of life.[10]

There are two types of quality of life indicators. There are objective indicators and subjective indicators. Objective indicators of quality of life include the basic needs of individuals in society. These physical needs are the same for all people. These indicators, also known as objective indicators, include the physical and mental health of the individual, the material lifestyle, the quality of the living environment, the level of nutrition, and job opportunities. Indicators of physical well-being are those that are more visible to the public. In this sense, they are indicators that can be measured and observed by individuals.[11] Objective indicators of quality of life include characteristics such as gender, age, marital status, level of education, income, health, social support, housing characteristics and leisure activities.[12]

Subjective measures of quality of life include individuals' satisfaction or dissatisfaction with life. The subjective indicator also includes an individual's dissatisfaction with the situation in which they find themselves.[13] Subjective quality of life indicators reflect the psychological well-being of individuals. Emotional well-being and issues related to its effects are the subject of these phenomena.[14]

Quality of life has a dynamic structure. It also shows variability. In this sense, quality of life is not the value and measurement of something that has happened and is fixed for the individual. It is a situation that is perceived and experienced according to changing experiences and conditions.

Quality of Life in Old Age

Ageing is a normal process. It involves anatomical, physiological, social and mental changes in older people. In the current century, rapid changes and transformations are taking place in the fields of health and technology. As a result, the decline in the birth rate, the importance of public health services, the awareness of nutritional habits, the early diagnosis of many diseases and the rapid steps taken to treat them have also increased the life expectancy predicted from birth. The World Health Organisation has defined old age as a decline in the individual's ability to adapt to his or her environment. According to the World Health Organisation, the world's population is ageing and it is predicted that the elderly population will reach 2.1 billion by 2050.[15] In parallel with the increase in the world's elderly population, the elderly population in Turkey is also increasing. Ageing is one of the most important issues of the last century.[16]

Biological, physiological, psychological and social changes associated with ageing also differentiate the life processes of older people.[17] Quality of life in old age varies according to different parameters. Marital status, sociality, economic status, age, satisfaction with life with family members, cognitive status and isolation influence these changes. These issues that develop in old age should be taken into account when interpreting quality of life. These considerations are important for protecting the health of older people and for understanding the factors that influence their quality of life and happiness. It is well known that quality of life and well-being in old age are more important than length of life. While the main goal for health problems in young people is treatment, the main goal for the older population is to maintain quality of life.[18]

Biological, psychological, physical and social changes that occur at all stages of development are considered to be regression in old age.[19] With advancing age, older people become less active and adopt a more sedentary lifestyle. Chronic diseases also increase with age. As the incidence of disease increases, older people become more fragile. In this case, older people need more help from others in their daily lives, and their quality of life is negatively affected. In order to reduce the effects of this negative picture, it is necessary to support active living opportunities for older people, together with exercise as far as possible.[20] This support should be provided through a holistic approach and will have even more significant results in maintaining the quality of life of older people.[21]

Although older people often do not want to, they find it difficult to carry out active life activities as a result of the limitation of their life activities in the process and the limitation itself. As a result of these difficulties, they may be excluded from most areas such as education, the economy, health and politics. As a result of this exclusion, older people may also leave their place of residence and become even more isolated in their new place of residence. The absence of neighbours and friends whom they trusted in their previous environment increases the severity of this feeling of loneliness. Lonely older people feel more excluded than other older people. The more crowded the environment of older people, the less they feel excluded.[22]

The occurrence of chronic diseases in old age is a common situation. In this context, knowing which diseases they suffer from most and managing the process in a healthy way gives good results. Human life expectancy varies according to the wear and tear on the life reserves of individuals, especially the elderly. Although attempts are made to treat most of the chronic diseases of the elderly, the main aim is to control the life functions of the elderly through treatment and to take steps to maintain their quality of life. For example, when treating anaemia in an elderly person with anaemia, the aim is also to maintain the elderly person's condition by reducing the severity of the disease. The aim is to prevent the rapid development of diseases by starting drug treatment early in order to create a healthy life for the elderly, to minimise loss of movement and balance, and to ensure early diagnosis of predictable and unpredictable diseases. As a result of early intervention, diseases can be suppressed and the quality of life of the elderly can be improved. Today, quality services for the elderly will contribute to successful ageing and facilitate the most appropriate approach to the elderly. In order to protect the health of the elderly, it should not be forgotten that respecting and developing the rights of the elderly in the modern sense is the premise of quality of life in geriatrics.[23]

Dementia and Quality of Life

Dementia is a syndrome that is often difficult to reverse due to neuronal degeneration. The main symptoms are cognitive impairment and behavioural restriction. These symptoms are one of the targets of interventions to improve patients' quality of life. Poor depressive and behavioural states negatively affect the quality of life of people with dementia in various activities. The quality of life of people with dementia who engage in various social activities and occupations is better than that of those who do not engage in these activities. The quality of life of people with dementia who have a hobby is also higher. People with dementia who spend most of their time sleeping and doing passive activities during the day have a fairly low quality of life. The quality of life of people with dementia improves when the families or care centres caring for people with dementia show interest in the patient with different activities.[24]

People who assess the quality of life of people with dementia act within the framework of the information provided by the patient's relatives. As carers' responses, such as attention deficit, memory status, judgement style and way of responding to questions, are predominant in measuring the quality of life of people with dementia, methodological assessments may sometimes differ. In a holistic view of dementia, it is important to consider the patient's general well-being, social status, mobility and, most importantly, basic human needs.[25] When assessing this issue, it is very valuable for the patient to assess the quality of life of the person with dementia and to take action to improve it.

The type of communication used to contribute to the quality of life of the person with dementia is also important. In the conclusions of the study of communication in people with dementia, conducted by Ruth Tappen and colleagues at Florida Atlantic University, it was stated that such patients should not be asked open-ended questions and that answers should be in the form of yes and no. Communication with people with dementia should focus on a single topic, and emotions should not be discussed. The following points should be observed when communicating with people with dementia:[26]

- Treat the person with dementia as an adult
- Assume that the patient understands you
- Observing and following emotions that cannot be expressed verbally
- Allowing the person with dementia time to respond
- Trying to recognise the patient without forgetting that the person with dementia is an individual
- Changing the communication strategy according to the specific situation of the person with dementia.

In dementia, techniques such as simplifying communication (related to daily life), facilitating (feelings and thoughts), understanding style (maintaining conversation and dialogue), supportive (supporting the patient's personality) according to the purpose of the patient's care are effective on the patient's quality of life.

Dementia has early, intermediate and advanced stages. In the early stage, the person begins to forget names. Newly learned information is quickly forgotten. There is difficulty finding things and a need to keep a list. In the early stage, there is a deterioration in near memory. During normal work, they have difficulty with complex calculations. In the middle stages, distant memory deteriorates. Patients may get lost in unfamiliar places. They also have difficulty speaking with disorientation and difficulty using and finding words. At this stage, patients' quality of life deteriorates considerably. In the final stage of the disease, the patient is unable to recognise even family members. They have no sense of time or space. They can confuse the rooms even in the house they live in. They get lost in places they used to know. In this case, the patient becomes agitated, shows repetitive behaviour and is now completely dependent.[27]

Some of the things that family members and patients can do to improve the quality of life of people with dementia are:[28]

- Physical activity: Encouraging physical activity in people with dementia has been shown to positively impact overall health by promoting physical and mental well-being. Regular exercise, such as walking or light stretching, can slow the rapid progression of dementia by enhancing blood flow to the brain and supporting cardiovascular health. Studies suggest that even short daily walks help improve mood and cognitive performance in individuals with dementia.[50,51]

- Mental exercise: Engaging dementia patients in mental exercises, such as solving puzzles, playing memory card games, or using word association activities, has been found to strengthen neural connections and promote cognitive flexibility. Regular mental exercises help delay cognitive decline by stimulating memory and problem-solving skills. Research highlights the benefits of structured cognitive activities in sustaining attention and slowing memory loss in dementia patients.[52,53]

- Social interaction: Social interaction plays a critical role in supporting the emotional well-being of individuals with dementia. Positive engagement with family members, friends, or group activities can reduce feelings of isolation and foster a sense of belonging. Studies show that social interaction lowers levels of depression and anxiety in dementia patients, which in turn enhances their overall quality of life.[54,55] By encouraging participation in social gatherings or family events, caregivers help dementia patients maintain emotional resilience and feel valued.

- Healthy nutrition: Providing a balanced diet rich in antioxidants, omega-3 fatty acids, vitamins, and minerals has proven effective in promoting brain health and overall well-being. Foods like leafy green vegetables, berries, nuts, and fish rich in omega-3 fatty acids are known to help reduce inflammation and oxidative stress in the brain, supporting cognitive function. Nutritional studies indicate that diets incorporating these elements are associated with improved mental clarity and a reduced risk of dementia progression.[56,57] Additionally, maintaining a regular eating schedule with small, nutrient-dense meals can help stabilize energy levels and support mood in dementia patients.

- Music and art therapy: Music and art have therapeutic effects that are especially beneficial for dementia patients. Listening to familiar music or engaging in simple artistic activities like painting can evoke positive memories, stimulate emotions, and improve cognitive functioning. Music therapy has been shown to reduce agitation and improve emotional expression, which can enhance the quality of life for individuals with dementia. Recent studies show that music and art therapy sessions, even as short as 20–30 minutes, can help dementia patients feel more connected and engaged.[58,59]

Living with dementia is a challenging process for both the person with dementia and the family. The family should be supported in all efforts to improve the quality of life of the person with dementia. When approaching the person with dementia, it is important to remember that each patient is an individual. With this in mind, it is important to adopt approaches that are appropriate to the characteristics of the person with dementia.

Epidemiology of dementia and its impact on quality of life: Dementia is an increasingly common health problem worldwide, especially with the growth of the elderly population. The ageing process is one of the main factors directly influencing the prevalence of dementia. While the prevalence of dementia increases significantly in the population aged 65 years and older, this rate reaches dramatic proportions in people aged 85 years and older.[29] Dementia leads to a range of social, economic and health problems that affect not only the lives of older people but also the overall quality of life of society.

The increase in the number of people with dementia is exacerbating the impact of the disease on health services. The increased need for care places a significant burden on health systems, while reducing the quality of life for families and communities. Carers often face emotional, physical and financial difficulties, and this situation negatively affects their quality of life.[30] In addition, the long-term care needs of people with dementia lead to increased costs for health care systems and difficulties in the sustainability of these services.[31]

In economic terms, the cost of caring for people with dementia is a major burden for families and governments. These costs are one of the factors that directly affect the quality of life of people with dementia. Increased financial burden associated with dementia usually requires more resources to be allocated to health systems, which may affect the provision of other health services and reduce the overall level of welfare in society.[32]

In conclusion, the prevalence of dementia is a multidimensional problem that negatively affects the quality of life of individuals and societies. In this context, the development of strategies to mitigate the effects of dementia is of great importance in terms of protecting and improving quality of life at both individual and societal levels (**Figure 1**).

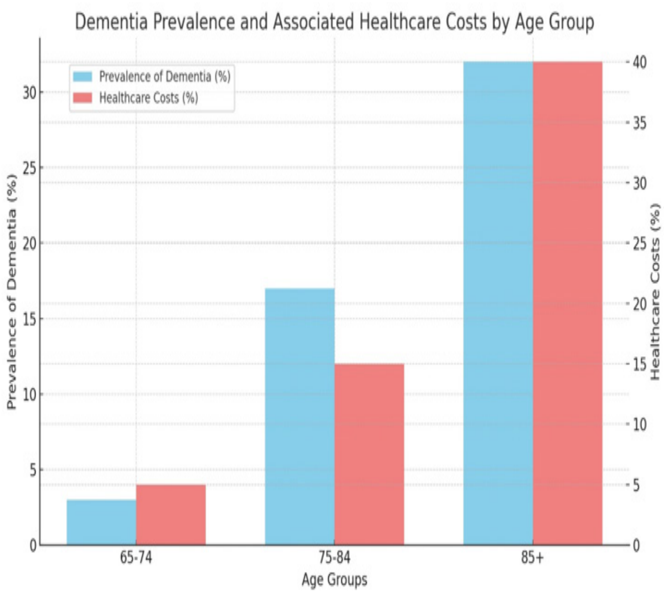

Figure 1. Dementia prevalence and health care costs by age
This figure shows how the prevalence of dementia increases with age and the associated health expenditure rises significantly. The data highlight the social and economic impact of dementia and the contribution of an ageing population to rising healthcare costs.

The impact of dementia types and clinical symptoms on quality of life: Dementias are a group of disorders that affect people's quality of life in different ways, with different types and clinical symptoms. Alzheimer's disease, one of the most common types of dementia, accounts for about 60-70% of all dementia cases and is generally characterised by memory loss, language difficulties and disorientation.[33] These symptoms of Alzheimer's disease severely limit patients' ability to live independently, leading to a significant reduction in their quality of life.

Vascular dementia is the second most common type of dementia and is caused by reduced blood flow to the brain. This type of dementia usually occurs after a stroke and manifests itself with symptoms such as impaired motor function, distraction and difficulty walking.[34] These motor and cognitive impairments caused by vascular dementia have a negative impact on quality of life by reducing the person's ability to carry out activities of daily living.

Dementia with Lewy bodies, another important type of dementia, is characterised by symptoms such as movement disorders, visual hallucinations and attention problems. This type of dementia can have symptoms similar to those of Parkinson's disease and can cause severe limitations in both the physical and cognitive abilities of patients.[35] These multiple symptoms of dementia with Lewy bodies have a direct impact on patients' quality of life, with hallucinations and motor disturbances in particular limiting daily activities and social interactions.

Frontotemporal dementia, on the other hand, tends to occur at a younger age and is characterised by personality changes, impairment in social behaviour and decline in language skills. This type of dementia causes a significant reduction in quality of life by negatively affecting people's social lives and family relationships.[36]

Each type of dementia affects people's quality of life in different ways. Impairments in patients' cognitive, motor and social skills lead to a loss of independence and a reduction in their quality of life. This situation has a negative impact not only on patients but also on family members and carers (**Figure 2**).

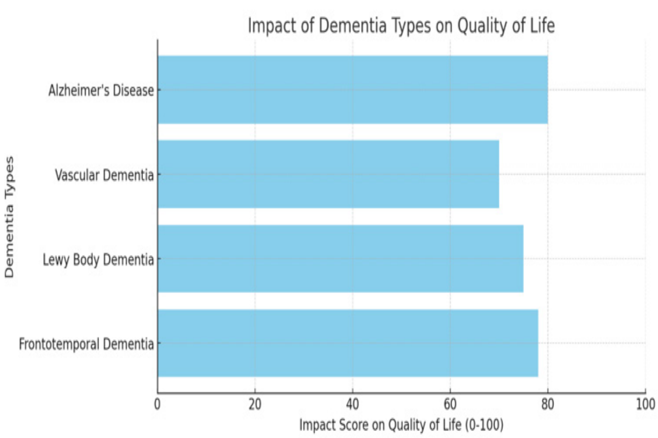

Figure 2. Impact of dementia types on quality of life
This figure shows the impact of different types of dementia on quality of life. As the figure shows, each type of dementia has a different impact on quality of life. This figure provides a comparative visualisation of the changes in patients' quality of life according to the type of dementia.

Dementia and Carers' Quality of Life

Dementia not only affects the quality of life of people with dementia, but also the quality of life of their carers. Most care for people with dementia is provided by family members or close friends. These carers are usually under great physical, emotional and mental strain without professional support.[37]

This situation has a serious impact on the carer's quality of life and can lead to negative outcomes such as stress, depression and burnout.

These difficulties experienced by carers tend to increase as dementia progresses. As people with dementia lose their independence and their ability to carry out activities of daily living declines, the burden on carers increases. This can lead to carers neglecting their own health and experiencing social isolation.[38] In addition, the economic burden on carers increases as the costs of caring for people with dementia can be quite high, especially in the long term.[39]

Another factor that negatively affects carers' quality of life is the emotional difficulties they face during the caring process. Dementia causes carers to watch their loved one gradually lose cognitive and physical abilities. This process can lead to carers becoming emotionally exhausted and experiencing grief reactions.[40] In addition, carers often feel lonely and lack adequate social support.[41]

From this perspective, protecting and improving the quality of life of carers of people with dementia should be considered an important issue in dementia management. Support services and interventions for carers can play an important role in reducing their burden and improving their quality of life. In particular, psychological support, educational programmes and practical help with care processes can help caregivers cope with stress and maintain their quality of life.[42]

Social and Economic Impact of Dementia and Quality of Life

Dementia is not only a medical condition that directly affects the quality of life of individuals, but also has profound and far-reaching social and economic effects. The social impact of dementia is a serious reduction in the quality of life of people with dementia and their families. As people with dementia lose cognitive and physical function, their risk of social isolation increases; this situation negatively affects the quality of life not only of the individual but also of the family members and communities who care for them.[43] Social isolation worsens the mental health of people with dementia and their carers, and this process is more pronounced in cases where social support is inadequate.[44]

From an economic perspective, dementia imposes a heavy financial burden on both individuals and societies. The global cost of dementia will exceed USD 1 trillion in 2018 and is expected to exceed USD 2 trillion by 2030.[45] These costs include direct health care expenditures as well as indirect costs such as care services, lost productivity and social security payments.[46] Long-term care needs due to dementia can reduce living standards by challenging the economic sustainability of families and societies.

The care needs of people with dementia are usually met by family members, leading to economic hardship for families. Carers often have to give up their full-time jobs or reduce their working hours, resulting in a reduction in household income.[47] In addition, the cost of medical and social services related to dementia care is a major burden for many families, and this burden negatively affects their quality of life.[48]

At the community level, dementia places great pressure on health and social care systems. The increasing demand for long-term care services requires a significant proportion of health budgets to be allocated to dementia-related services. This can lead to a reduction in resources for other health services and a decline in the quality of general health services.[49]

CONCLUSION

Dementia leads to irreversible loss of cognitive and physical abilities in older people and severely reduces their quality of life. Given the social and economic burden of this disease, multidisciplinary approaches and non-pharmacological interventions are becoming increasingly important. In particular, the development of effective strategies for the management of dementia is crucial both to improve quality of life at the individual level and to reduce the financial burden on society. Health policies must therefore be designed to provide more effective and sustainable solutions in this area.

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