The Relationship between Mortality and the Modified Nutrition Risk in Critically Ill (mNUTRIC) and Nutritional Risk Screening 2002 (NRS-2002) Scores in the Intensive Care Unit

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ABSTRACT

Objective: To measure the effects on mortality of the Modified Nutrition Risk in Critically Ill (mNUTRIC) and Nutritional Risk Screening 2002 (NRS-2002) scores in critical patients in the Intensive Care Unit (ICU) and to investigate the relationship between macronutrient deficiency and the mNUTRIC and NRS-2002 scores.

Study Design: A descriptive study.

Place and Duration of Study: The Department of Intensive Care, Burdur Public Hospital, Turkey, between 01st October 2019 and 01st November 2021.

Methodology: The study included 311 patients aged >18 years, treated in the ICU for more than 7 days, and who received more than 48 hours of mechanical ventilation when required. The patients were divided into two groups according to calorie sufficiency as those who received <70% or >70% of the energy calculated for the first 5 days in ICU.

Results: Of the 311 patients included in the study, the high nutritional risk was determined in 20.9% according to the NRS-2002, and 62.7% according to the mNUTRIC. In patients classified as having high nutritional risk in nNUTRIC (score ≥5), the in-hospital mortality risk was 3-fold higher (p<0.001), and in patients classified as having high nutritional risk in NRS-2002 (score ≥5), it was 2-fold higher (p=0.002). There was a strong relationship found between a high mNUTRIC score and insufficient calorie intake and there was no relationship between the mNUTRIC score and protein intake (p=0.058).

Conclusion: While the mNUTRIC score was a significant scoring system to show 28-day in-hospital survival, the efficacy of NRS-2002 in showing mortality could not be demonstrated.

Key Words: *Intensive care unit, Mortality, mNUTRIC, Nutritional status, NRS-2002.*

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INTRODUCTION

Malnutrition is common in patients in the Intensive Care Unit (ICU) and has been associated with various negative outcomes such as remaining on mechanical ventilation for a long period, a lengthy stay in ICU, and higher mortality rates.[1]

There are several scoring systems and tools for the determination of nutrition risk.[2,3] The vast majority of these scoring systems are for outpatients or inpatients, and there are very few nutrition risk tools that can be used for ICU patients.[4]

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According to the American Society for Parenteral and Enteral Nutrition/Society of Critical Care Medicine (ASPEN /SCCM) 2016 guidelines, the use of the Nutrition Risk in Critically Ill (NUTRIC) and Nutritional Risk Screening 2002 (NRS-2002) is recommended since they are related to the severity of the disease.[5]

The NRS-2002 has primarily been applied for hospitalised patients and uses parameters such as weight loss, changes in nutritional intake, body mass index (BMI), and APACHE-II score for disease severity.[6] Although it was not developed for ICU, a score of ≥5 indicates a high risk in ICU, considered a marker of mortality, and is associated with poor clinical results.[7] The NUTRIC score was recently developed by Heylan *et al.*, and without IL-6, includes 5 criteria of age, comorbidities, SOFA, APACHE, and stay of >24 hours in ICU. The scoring is from 0-9 with a score of ≥5 accepted as high risk. It has been reported to be useful in determining patients who will obtain less or more benefit from the aggressive protein and energy requirement for intensive care. This score has been stated to be a specific score in the determination of first nutrition of ICU patients.[8]

The weakness acquired by critical patients in ICU is related to muscle loss (up to 1 Kg per day) and significant protein destruction. The European Society for Clinical Nutrition and Metabolism (ESPEN) recommends daily protein uptake of 1.2-1.5 g/Kg.[9]

Several observational studies have reported that administering around 80% of the predicted energy requirement is the calorie amount with the best effect on survival.[10] Administration of calorie much lower or much higher than this value has been associated with an increase in mortality.[11]

The aim of this study was to measure the effects of the mNUTRIC and NRS-2002 scores on 28-day mortality in critical patients in the ICU and to compare distinguishing characteristics. It was also aimed to investigate the relationship between macronutrient deficiency and the mNUTRIC and NRS-2002 scores.

METHODOLOGY

This study was conducted in the Department of Intensive Care, Burdur Public Hospital, Burdur, Turkey, between October 2019 and November 2021. Approval for the study was obtained from the Clinical Research Ethics Committee of AFSU Medical Faculty (Decision No. 8, dated:2022).

The study included a total of 311 patients, who were treated in ICU for more than 7 days and 221 patients were followed up on mechanical ventilators for at least 48 hours.[12]

Exclusion criteria were as follows: Patients with incomplete data on m-NUTRIC and NRS-2002 variables and patients who were discharged or died were used within 7 days after ICU admission.

Oral or enteral nutrition methods were used within 24-48 hours of the patients being taken to the intensive care unit. Parenteral nutrition methods were used for patients who could not be fed orally. In cases where patients could not reach 25 Kcal/Kg/day, combined oral/enteral and parenteral feeding were used. Patients were fed with formulated products. We have included the calories in the calorie calculation of the liquids and medicines that we add to their treatment when necessary (propofol (1.1 Kcal/ml), citrate (3.0 Kcal/g), lactate (3.62 Kcal/g), and glucose (3.4 Kcal/g). Calorie intake was calculated as 5 days. The patients were divided into two groups as survivors and non-survivors.

Calorie calculations were made using the Harris-Benedict equation (HBE), or a simplistic weight-based value (25–30 Kcal/Kg/-day) formula because an indirect calorimeter could not be used.[13]

Patients were divided into those receiving <70% or >70% of the calories calculated as adequate for the first 5 days. Calorie sufficiency (%) was calculated as such: 5 days of calorie intake/5 days of calorie requirement x 100. Body weight was determined by this formula: For male: (0.98 x CC) + (1.16 x KH) + (1.73 x MUAC) + (0.37 x SS)- 81.69 and for female: (1 .27 x CC) + (0.87 x KH) + (0.98 x MUAC)+ (0.4 x SS) – 62.35 (CC: Calf circumference, KH: knee height, MUAC: mid upper arm circumference, SS: subscapular skinfold).[14] The protein requirement was evaluated as 1.2-1.5 g/Kg/day according to actual body weight.[5] Low protein intake was accepted as <1.2g/Kg/day in this study.

The nutrition risk status of patients was evaluated with the NRS-2002 and the NUTRIC scores. The 9-point mNUTRIC score was used. A score of 0-4 was defined as a low risk of malnutrition, and a score of 5-9 as a high risk of malnutrition associated with worse clinical results.[15]

If a positive response was obtained from one of the four questions in the first stage, evaluation of the patient with the test was continued. Disease severity and nutrition status were evaluated and scored. An additional point was given to patients aged >70 years. Patients with a score of ≥3 were considered as high risk and those <3 as low risk.[6]

Data obtained in the study were analysed statistically using SPSS version 26.0 software and p<0.05 was considered statistically significant. The conformity of continuous variables to normal distribution was assessed with the Shapiro-Wilk test and Kolmogorov-Smirnov test. Variables showing normal distribution were presented as mean ± standard deviation values and data not showing normal distribution as median and interquartile range (IQR) values. Categorical variables were stated as number (n) and percentage (%). In the comparisons between groups of categorical variables, the Chi-squared test was used.

In the comparisons of continuous variables, the Independent Samples t-test was used for the data with normal distribution and the Mann-Whitney U-test for those not showing normal distribution. Multiple logistic regression analysis was used to calculate 95% confidence intervals related to relative risk (RR) and Hospital mortality. Sensitivity and specificity for mortality were calculated with a receiver operating characteristic (ROC) curve used to evaluate the performance of the tested points. The Youden Index was used to determine the best cutoff values according to the ROC analysis results. Survival analysis was applied with the Kaplan-Meier method. Factors affecting survival were investigated with the Log Rank test.

RESULTS

A total of 311 patients with a median age of 78 (IQR:66-85) years and a median BMI of 25(IQR:22-28) Kg/m^2 were evaluated in the study. High nutrition risk was determined in 65(20.9%) of the patients according to the NRS-2002, and in 195 (62.7%) according to the mNUTRIC. A total of 182 patients died from the 311 participants. Hemodialysis was used in 40 (12.9%) patients and mechanical ventilation in 221 (71.1%), and these 221 patients were followed up on a mechanical ventilator for at least 48 hours. The mortality rate of patients on mechanical ventilation was determined to be statistically significantly high (p<0.001). The median length of stay in ICU was 12 days (IQR:8-19 days).

Table I: Comparisons of the characteristics of the critical patients admitted to ICU according to survival and non-survival.

Patients characteristics	All patients (n:311)	Non-survivors (n:129)	Survivors (n:182)	p-value
Age median (IQR)	78(66-85)	73(63-82)	81(71-87)	<0.001
Weight kg median (IQR)	69(58-80)	70(60-80)	68(55-79)	0.033
Length cm median (IQR)	165(158-172)	165(160-172)	165(157-172)	0.249
BMI, kg/m^2 median (IQR)	25(22-28)	25(22-29)	25(21-28)	0.075
mNUTRIC median (IQR)	5(4-6)	4(3-5)	6(5-7)	<0.001
NRS2002 median (IQR)	4(3-4)	4(3-4)	4(4-5)	<0.001
ICU lenght of stay day median (IQR)	12(8-19)	12(8-18.5)	13(9-20)	0.162
Mechanical ventilation(%)	221(71.1)	158(86.8)	63(48.8)	<0.001
APACHEII	20(15-24)	16(14-20)	22(18-25)	<0.001
SOFA	5(4-6)	4(3-5)	6(5-7)	<0.001
mNUTRİC				
Low(%)	116(37.3)	96(74.4)	20(11)	<0.001
High(%)	195(62.7)	33(25.6)	162(89)	
NRS2002				
Low(%)	246(79.1)	113(87.6)	133(73.1)	0.002
High(%)	65(20.9)	16(12.4)	49(26.9)	
Renal replacement therapy(%)	40(12.9)	9(7)	31(17)	0.009

In the comparisons between groups of categorical variables, the chi-squared test was used. In the comparisons of continuous variables the Mann Whitney U-test to those not showing normal distribution. BMI: Body mass index; NRS: Nutritional risk screening; NUTRIC: Nutrition risk in critically Ill; APACHE: Acute physiology and chronic health evaluation; SOFA: Sequential organ failure assessment; ICU: Intensive care unit; MV: Mechanical ventilator; OR: odds ratio.

Table II: Relationship between energy target and clinical outcomes.

	Total (n:311)	Energy >70% (n:201)	Energy <70% (n:110)	p-value
ICU lenght of stay day Median(IQR)	12(8-19)	13(8-20)	12(8-17)	0.377
28-day mortality	182(58.5)	100(54.9)	82(45.1)	<0.001
MV gün Median (IQR)	10(5-13)	5(0-12)	7(1-12)	0.106
mNUTRİC skor	5(4-6)	5(4-6)	6(4-7)	0.001
NRS2002 skor	4(3-4)	4(3-4)	4(3-5)	0.099

In the comparisons between groups of categorical variables, the Chi-squared test was used. In the comparisons of continuous variables the Mann Whitney U-test to those not showing normal distribution. ICU: Intensive care unit; MV: Mechanical ventilator; NRS: Nutritional risk screening; mNUTRIC: Modified nutrition risk in critically Ill; OR: Odds ratio.

Table III: Correlations of the protein target and clinical results.

	Total (n:311)	Protein >70% (n:220)	Protein <70% (n:91)	p-value
ICU lenght of stay day Median(IQR)	12(8-19)	12(8-20)	13(8-18)	0.803
28-day mortality	182(58.5)	121(66.5)	61(33.5)	0.058
MV gün Median (IQR)	10(5-13)	6(0-12)	7(0-12)	0.901
mNUTRİC skor	5(4-6)	5(4-6)	5(4-7)	0.058
NRS2002 skor	4(3-4)	4(3-4)	4(3-4)	0.055

In the comparisons between groups of categorical variables, the Chi-squared test was used. In the comparisons of continuous variables the Mann Whitney U-test to those not showing normal distribution. ICU: Intensive care unit; MV: Mechanical ventilator; NRS: Nutritional risk screening; mNUTRIC: Modified nutrition risk in critically Ill; OR: Odds ratio.

The comparisons of the characteristics of the surviving patients (n:129, 41.4%) and the non-surviving patients (n: 182, 58.5%) are shown in Table I. The non-survivors were found to have statistically significant higher scores from the mNUTRIC and NRS-2002 compared to the survivors (p<0.001, and p=0.002 respectively). The rates of vasopressor use and renal replacement therapy (RRT) were statistically significantly higher in the non-surviving patients than in the survivors (p=0.009). In patients classified as high nutritional risk in mNUTRIC (score ≥5), the in-hospital mortality risk was 3-fold higher (RR:3.48; 95%CI: 2.58-4.69; p<0.001), and in patients classified as high nutritional risk in NRS-2002 (score ≥5) 2-fold higher (RR:2.17; 95%CI: 1.29-3.64; p=0.002).

The in-hospital mortality risk for those at high nutritional risk in both the mNUTRIC and NRS-2002 scores increased by 7-fold (RR:7.08, 95% CI:2.60-19.32; p<0.001).

No significant difference was found between the group receiving <70% of the daily calorie requirement and the group receiving >70% of the daily calorie requirement in the length of stay in ICU, length of time on mechanical ventilation, and NRS-2002 score (p=0.099). The 28-day mortality rate and the mNUTRIC score of the group receiving <70% of the energy requirement showed statistically significant high values (p=0.001). The comparisons of length of stay in ICU, 28-day mortality, and time on mechanical ventilation according to the energy intake groups are shown in Table II.

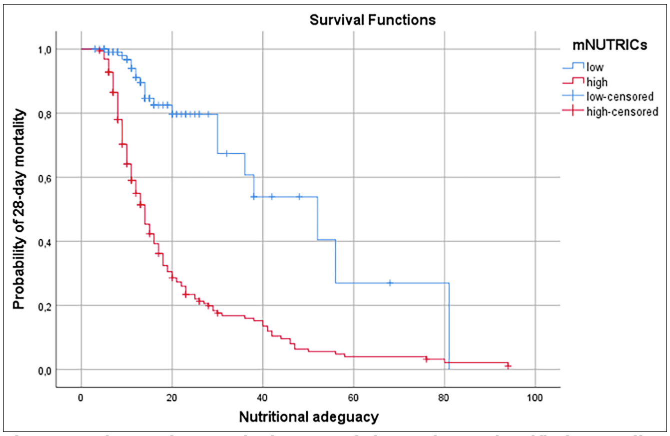

Figure 1: The 28-day survival curve of the patients classified according to the mNUTRIC score.

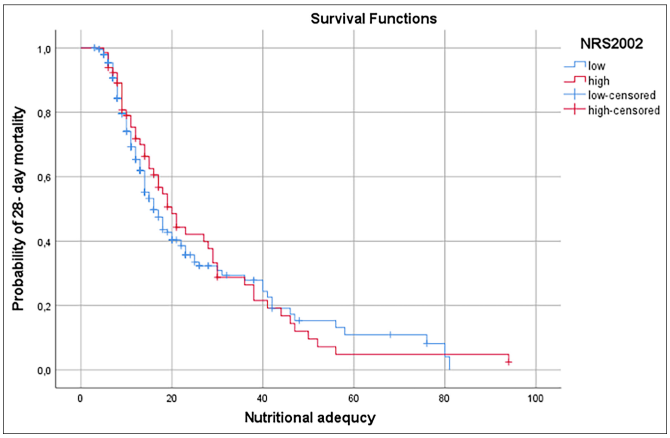

Figure 2: The 28-day survival curve of the patients classified according to the NRS-2002 score.

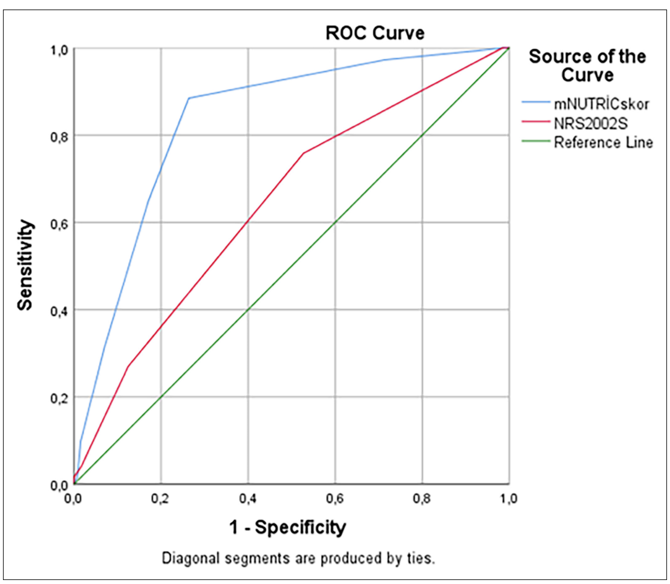

Figure 3: The ROC curves to predict in-hospital mortality of critical patients in ICU.

No significant difference was found between the group receiving <70% of the daily protein requirement and the group receiving >70% of the daily protein requirement in the length of stay in ICU, length of time on mechanical ventilation, 28-day mortality, mNUTRIC score, and NRS-2002 score (p>0.05). The comparisons of length of stay in ICU, 28-day mortality, and time on mechanical ventilation according to the protein intake groups are shown in Table III.

The 28-day survival graph of the patients classified according to the mNUTRIC score is shown in Figure 1. The group with a high mNUTRIC score was found statistically significantly lower on 28-day survival graph of the patient (p< 0.001).

The 28-day survival graph of the patients classified according to the NRS-2002 score is shown in Figure 2. No statistically significant difference was determined between the groups with high and low NRS-2002 scores in 28-day survival (p=0.62).

The ROC curve to predict in-hospital mortality is shown in Figure 3. In the ROC curve to predict mortality, the Area under the Curve (AUC) was 0.832 (95% CI: 0.783-0.881) for the mNUTRIC score alone, and 0.642 (95% CI: 0.580-0.704) for the NRS-2002 score alone. A cutoff value of 4.5 for the mNUTRIC score had a sensitivity of 0.88 and specificity of 0.736 for the prediction of survival. A cutoff value of 3.5 for the NRS-2002 score was determined to predict survival with a sensitivity of 0.758 and specificity of 0.473.

DISCUSSION

The aim of this study was to measure the of the mNUTRIC and NRS-2002 scores effects on 28-day mortality in critical patients in the ICU and to compare distinguishing characteristics. The relationship between macronutrient deficiency and the mNUTRIC and NRS-2002 scores was also investigated.

Malnutrition is one of the most important problems in ICUs. In the clinical guidelines of the European Society for Clinical Nutrition and Metabolism (ESPEN), the NRS-2002 and the NUTRIC scoring are reported to be the two most used tools in the determination of nutrition status in ICUs.[9] In different studies evaluating the risk of malnutrition in critical patients in ICU, the risk of malnutrition in patients with high mNUTRIC and NRS-2002 scores has been reported to be 47.6% according to the NUTRIC score and 35.6% according to NRS-2002,[16] 28.2% according to the NUTRIC score,[17] 36.5% according to the NUTRIC score and 55% according to NRS-2002,[18] and 54.4% according to mNUTRIC and 48.4% according to NRS-2002.[19] In the current study, 62.7% of the patients according to the mNUTRIC score and 20.9% according to the NRS-2002 score were determined to have a high nutritional risk.

In their study in which 28-day mortality was evaluated, Mukhopadhyay *et al*. reported a strong correlation between mortality and mechanical ventilation use, renal replacement therapy, inotrope use, and the mNUTRIC score.[20] In the current study, a relationship was shown between mortality and mechanical ventilation, renal replacement therapy (p =0.009), the mNUTRIC score (p <0.001), and the NRS-2002 score (p =0.002).

Zusman *et al*. revealed that increasing the calorie administration/resting energy expenditure (REE) to 70% was associated with decreased mortality, while an increase above 70% was associated with increased mortality. Therefore, they concluded that both overfeeding and underfeeding might be harmful to critically ill patients.[21] In their study, Weijs *et al*. showed that the 28-day mortality of intensive care patients who were given 1.2-1.5 g/Kg/day protein was decreased.[22]

A previous study showed a relationship between mortality and a high NUTRIC score and reported that mortality was higher in patients with insufficient (<70%) calorie support.[23] Canales *et al*. stated that a high NUTRIC score was a strong marker of insufficient calorie and protein intake, and this relationship was not observed with the NRS-2002 score.[24] Jeong *et al*. reported that 28-day mortality was reduced when high energy and protein were given to patients with a high NUTRIC score.[25]

In the current study, while a strong relationship was found between a high mNUTRIC score and insufficient calorie intake, there was no relationship between a high mNUTRIC score and insufficient protein intake (p=0.058). Moreover, no relationship was found between NRS-2002 scores and insufficient calorie or protein intake (p=0.055).

While Maciel *et al.* reported a 2-fold increase in the relative risk ratio in predicting mortality in ICU with the NRS-2002 score, Reis *et al*. reported a 1.41-fold increase with the NRS-2002 score, a 3.01-fold with the NUTRIC score, and a 2.29-fold with combined score evaluation (NRS-2002 and mNUTRIC).[7,19] In the current study, for patients classified as the high nutritional risk in mNUTRIC (score ≥5), the in-hospital mortality risk was 3-fold higher (RR:3.48; 95%CI: 2.58-4.69; p<0.0001), and 2-fold higher (RR:2.17; 95%CI: 1.29-3.64; p=0.002) in patients classified as the high nutritional risk in NRS-2002 (score ≥5). The in-hospital mortality risk for those at high nutritional risk in both the mNUTRIC and NRS-2002 scores increased by 7-fold (RR:7.08, 95% CI:2.60-19.32; p<0.001).

Mendes *et al*. showed that mortality increased significantly in critical patients in ICU with a NUTRIC score of ≥5 (p<0.001).[12] Other studies with critical patients in ICU have also shown a significant increase in 28-day mortality with mNUTRIC score >4.[8,15,17,20] In line with the findings of the other studies, the results of the current study revealed that the group with a high mNUTRIC score had statistically significant lower 28-day survival (p<0.001).

In their study with ICU patients, Maciel *et al*. reported that although the NRS-2002 was not developed for ICU, a score of ≥5 indicated a high risk, and it was a marker of mortality and was associated with poor clinical outcomes.[7] Other studies conducted in ICUs have reported no statistically significant difference between high NRS-2002 scores and low NRS-2002 scores in regards to mortality, the development of infection, and the time spent on mechanical ventilation.[18] In the current study, there was no statistically significant difference in 28-day survival according to high and low NRS-2002 scores (p>0.62).

In their study in which the in-hospital mortality was evaluated according to the ROC curve, Reis *et al*. reported a positive relationship with high mortality when AUC was 0.695 in the mNUTRIC score and 0.645 in the NRS-2002 score.[19] Na-Wang *et al*. reported the AUC of the NUTRIC score ROC curve as 0.763 (CI:0.740-0.786) and stated that it was related to mortality.[17] Mendes *et al*. reported that when NUTRIC score was ≥ 5, the AUC for the ROC curve for 28-day mortality was 0.658 (95% CI: 0.620-0.696).[12] In the current study, in the ROC curve to predict mortality, the AUC was 0.832 (95% CI: 0.783-0.881) for the mNUTRIC score alone, and 0.642 (95% CI: 0.580-0.704) for the NRS-2002 score alone. A cutoff value of 4.5 for the mNUTRIC score had a sensitivity of 0.88 and specificity of 0.736 for the prediction of survival. A cutoff value of 3.5 for the NRS-2002 score was determined to predict survival with a sensitivity of 0.758 and specificity of 0.473.

In another study that compared the NRS-2002 and NUTRIC scores in ICU, both scoring systems were found to be effective in the determination of nutrition status, but different results were found in many cases and no correlation could be shown between them.[16] The NUTRIC score was found to be superior to the NRS-2002 score in the evaluation of malnutrition in ICU in another study.[24] The current study results showed that the mNUTRIC score was statistically more significant than the NRS-2002 in the evaluation of malnutrition and mortality.

This study had several limitations. This was a single-centred study and retrospectively designed. Indirect calorimetry is the gold standard measurement for calculating the energy needs of individuals. But indirect calorimetry was not available during the study. Alternatively, a formula was used to calculate the energy required using each patient's ideal body weight.

CONCLUSION

NRS-2002 and mNUTRIC scores are useful tools for the prediction of mortality. While the mNUTRIC score was a significant scoring system to show 28-day in-hospital survival, the efficacy of NRS-2002 in showing mortality could not be demonstrated. While ICU mortality was higher in patients with a high mNUTRIC score receiving insufficient calories, no relationship was found between a high mNUTRIC score and insufficient protein intake.

ETHICAL APPROVAL:
Ethical approvals were obtained prior to initiation of the research work. Approval for the study was granted by the Clinical Research Ethics Committee of Afyonkarahisar University of Health Sciences (Decision No. 8, dated:2022).

PATIENTS' CONSENT:

The study was conducted following the Declaration of Helsinki, and patients gave their written consent.

COMPETING INTEREST:

The authors declared no competing interests.

AUTHORS' CONTRIBUTION:

KYG, SO: Designed, conceptualised, and drafted the work, reviewed and edited the work, and substantively revised the manuscript and supervised the work,

KYG: Collected data and revised the figures.

All authors approved the final version of the manuscript to be published.

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