

Using Prognostic Nutritional Index and Systemic Immune-Inflammation Index to Evaluate Short-Term Survival in Hospitalized Octogenarian and Nonagenarian Patients

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Abstract

Objective: This study aimed to investigate the associations between the preoperative Prognostic Nutritional Index (PNI), Systemic Immune-Inflammation Index (SII), and short-term survival in octogenarian and nonagenarian patients who were admitted to the urology department.

Materials and Methods: We evaluated 136 octogenarian and nonagenarian patients who were admitted to the urology department. The patient-related data were collected, including demographic and comorbidities. Surgical treatment patterns and outcomes were assessed. Patients' SII and PNI scores were calculated. PNI was calculated as total lymphocyte count ($10^9/L$) \times 5 + albumin concentration (g/L). SII was calculated as neutrophil count ($10^9/L$) \times platelet count (109/L)/lymphocyte count (109/L). The cut-off values of PNI and SII were determined through receiver operating characteristic analysis. Overall survival (OS) was estimated by Kaplan-Meier analysis. The log-rank test was used to compare differences between the groups. Univariate and multivariate COX regression analyses were performed to assess the predictive values of PNI and SII for OS.

Results: The study population comprised 105 women (77.2%) and 31 men (22.8%), with a median age of 84 years (range, 80–97 years). The most common reason for hospitalization was hematuria, affecting 47 patients (34.6%). A total of 74 patients (54.4%) underwent surgical intervention. The optimal cut-off values for predicting OS were identified as 1243, 42.65, and 32.37 for SII, PNI, and SII/PNI, respectively. Kaplan-Meier analysis also revealed that low PNI was related to poorer OS in octogenarian and nonagenarian patients.

Conclusion: Preoperative PNI and SII, based on standard laboratory measurements, may be useful noninvasive, inexpensive, and simple tools for predicting short-term survival of octogenarian and nonagenarian patients admitted to the urology department.

Keywords: Octogenarian, nonagenarian, Prognostic Nutritional Index, Systemic Immune-Inflammation Index

Introduction

Currently, life expectancy is increasing and aging populations are growing remarkably. It is thought that life expectancy will increase with each passing year. It is projected that the demographic cohort of individuals aged 80 years and above will expand to exceed 150 million (1). Additionally, this ageing population needs more healthcare services, compared to the younger population. In patients aged over 80, urological diseases occur more frequently, leading to longer hospital stays and higher complication rates compared to younger patients (2). Therefore, it is necessary to adopt a specialized approach when dealing with patients over 80 years of age.

The Prognostic Nutritional Index (PNI) evaluates immune function and overall nutritional health; it is a clinical tool that measures nutritional status in several diseases, such as hepatocellular carcinoma and colorectal cancer (3). The Systemic Immune-Inflammation Index (SII) plays a pivotal role in carcinogenesis and serves as a robust prognostic indicator for various solid neoplasms, including esophageal squamous cell carcinoma, germ cell tumors, and hepatocellular carcinoma (4–6).

Octogenarian and nonagenarian nutritional status and hospitalization are important for life expectancy and overall survival (OS). To our knowledge, no studies have specifically examined the prognostic value of SII and PNI in this population.

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Our study aims to evaluate the prognostic effect of the SII and PNI in relation to short-term survival among elderly patients aged 80 and above.

Materials and Methods

A retrospective study was conducted on 136 octogenarian and nonagenarian patients who were hospitalized in the urology department of a single center between January 2021 and September 2023, after receiving approval from University of Health Sciences Türkiye Medeniyet University Göztepe Training and Research Hospital's Ethics Committee (decision number: 2023/0823, date: 29.11.2023). The patient data set comprised a range of variables, including demographics, comorbidities, diagnoses that led to the patients being hospitalized, the procedures that were performed, the American Society of Anesthesiologists scores of the patients who underwent surgery, the Dindo et al. (7) classification was employed for the assessment of complications, the length of hospital stay, the usage of antiplatelet/anticoagulant therapy, the patients' smoking status, the Katz Index of Independence in activities of daily living, and the WHOQOL-OLD score.

Upon admission to the clinic, the patient's PNI and SII were calculated according to the following methodology:

- The PNI is calculated as follows: $PNI = [(10 \times \text{albumin (g/dL)}) + (0.005 \times \text{Lymphocyte count})]$
- SII is calculated as follows: $\text{platelet count} \times \text{NLR (neutrophil count/lymphocyte count)}$

Statistical Analysis

The statistical analysis were conducted using the IBM SPSS Statistics software, version 22. Normally distributed continuous variables are reported as the mean with standard deviation, and non-normally distributed continuous variables are reported as the median with range. T-tests were applied to normally distributed variables, and Mann-Whitney U tests were used for non-normally distributed variables. The optimal cut-off values of the PNI and SII were found by ROC curve analysis. We utilized the Kaplan-Meier method to estimate the probability of survival. The independent predictors of survival were determined through a multivariate COX regression model. The independent predictors of PNI and SII were determined using univariate and multivariate logistic regression. Calculations were performed to derive hazard ratios (HR) and 95% confidence intervals (CIs), where a p-value of less than 0.05 was considered statistically significant.

Results

Patient Characteristics and Clinical Outcomes

Of the 136 individuals in the study, 77.2% were women (n=105) and 22.8% were men (n=31) (Table 1). Most of these patients (56.6%) were smokers. The most common reason for hospitalization was hematuria, affecting 47 patients (34.6%). The other reasons for hospitalization are postrenal acute kidney injury (AKI) (18.4%), urolithiasis (5.9%), and malignancy (14.7%). A total of 74 patients (54.4%) underwent surgical intervention. The most frequently performed surgical procedure

Table 1. Patient characteristics and clinical outcomes

Characteristics	Patients, n (%)
Sex, n (%)	
Male	31 (22.8)
Female	105 (77.2)
Age, Median (range)	84 (80-97)
BMI, Median (range)	25 (16-38)
Smoking status, n (%)	
never smoker	59 (43.4)
current or ex-smoker	77 (56.6)
Lives with n (%)	
alone	6 (4.4)
wife	45 (33.1)
relative/other	85 (62.5)
Acute renal failure during hospitalization, n (%)	49 (36)
Presence of percutaneous nephrostomy, n (%)	14 (10.3)
Presence of double J-Stent, n (%)	12 (8.8)
Hospitalization	
elective hospitalization	54 (39.7)
emergency hospitalization	82 (60.3)

Table 1. Continued	
Characteristics	Patients, n (%)
Hospitalization reason	
hematuria	47 (34.6)
post-renal acute kidney injury	25 (18.4)
urolithiasis	8 (5.9)
malignancy	20 (14.7)
other reasons	36 (25.5)
Urinary tract infection during hospitalization, n (%)	60 (44.1)
Surgery of patients with elective hospitalization, n (%)	
n=74	
TUR-P	11 (14.9)
TUR-BT	44 (59.5)
URS	9 (12.2)
RIRS	2 (2.7)
cystolithotripsy	0 (1.4)
other surgeries	7 (9.5)
Surgical complication, n (%)	
n=74	
13 (17.6)	
Mortality at hospital, n (%)	5 (3.7)
3-month mortality, n (%)	26 (19.1)
6-month mortality, n (%)	32 (23.5)
12-month mortality, n (%)	41 (30.1)
Systemic Immune-Inflammation Index, Median (range)	1178 (172-7248)
prognostic nutritional index, median (range)	43.5 (20-59)
Mini nutritional assessment-screening, median (range)	11 (6-14)
Mini nutritional assessment-assessment, median (range)	21 (12-27)
WHOQOL-OLD score, median (range)	70 (51-76)
Length of hospitalization, median (range)	5 (1-36)
Follow-up (month), median (range)	9 (1-34)
CCI, median (range)	6 (4-10)
ECOG performance status, median (range)	2 (1-4)
Katz Index, median (range)	4 (1-6)
ASA Score, n (%)	
n=74	
ASA 2	21 (28.4)
ASA 3	53 (71.6)
Clavien dindo classification	
n=13	
Grade 1	10 (76.9)
Grade 2	3 (23.1)
BMI: Body mass index, TUR-P: Transurethral resection of prostate; TUR-BT: Tansurethral resection of bladder tumor; URS: Ureterorenoscopy, RIRS: Retrograde intrarenal surgery, CCI: Charlson Comorbidity Index, ECOG PS: Eastern cooperative oncology group performance status, ASA: American Society of Anesthesiologists	

was transurethral resection of bladder tumor, accounting for 59.5% of cases. A total of 25 patients (18.4%) were hospitalized due to post-renal AKI. Percutaneous nephrostomy was performed in 14 patients (10.3%), while Double-J stent was inserted in four patients (2.9%). The intervention was not performed on 5 patients (5.2%).

Patient Demographics, Characteristics and Their Associations with PNI

The association between pre-admission PNI levels and patient demographics and clinical factors is shown in Table 2. Patients

with lower PNI (<42.65) were significantly more likely to be older, have lower body mass index (BMI), ($p=0.002$), higher Electrocardiography Performance Status ($p=0.002$), AKI during hospitalization ($p=0.001$), elective admission ($p=0.001$), and longer hospital stays ($p=0.001$). A significant association was found between pre-hospitalization age ($p=0.009$) and reason for hospitalization ($p=0.033$), but not between pre-hospitalization age ($p=0.009$) and gender ($p=0.793$).

Table 2. Correlation of clinical and demographic characteristics Prognostic Nutritional Index (PNI) levels in patients			
	Low PNI (n=63)	High PNI (n=73)	p
Age (years), mean+SD	86.1 ± 4.5	84.3 ± 3.2	0.009T
Gender, n (%)			
Female	15 (23.8)	16 (21.9)	0.793
Male	48 (76.2)	57 (78.1)	
BMI, mean+SD	24 ± 4.1	26.2 ± 4.0	0.002T
Lives with n (%)			
Alone	2 (3.2)	4 (5.5)	0.416F
Wife	18 (28.6)	27 (37)	
Other-related	43 (68.3)	42 (57.5)	
CCI, median (minimum-maximum)	6 (4-9)	5 (4-10)	0.364M
ECOG PS, median (minimum-maximum)	3 (1-4)	2 (1-4)	0.002M
Acute kidney injury during hospitalization	33 (52.4)	16 (21.9)	0.001
Percutaneous nephrostomy	8 (12.7)	6 (8.2)	0.391
Double J-stent	3 (4.8)	9 (12.3)	0.121
Hospitalization			
emergency	50 (79.4)	32 (43.8)	0.001
elective	13 (20.6)	41 (56.2)	
Reason for hospitalization			
hematuria	26 (41.3)	21 (28.8)	0.033F
postrenal AKI	16 (25.4)	9 (12.3)	
urolithiasis	4 (6.3)	4 (5.5)	
malignancy	66 (9.5)	14 (19.2)	
other	11 (17.5)	25 (34.2)	
Urinary tract infection	33 (52.4)	27 (37)	0.071
Hospitalization days	6 (1-36)	3 (1-35)	0.001M
T: T-test, M: Mann-Whitney-U Test, F: Fisher exact test. BMI: Body mass index, CCI: Charlson Comorbidity Index, ECOG PS: Eastern cooperative oncology group performance status, SD: Standard deviation			

Table 3. Correlation of clinical and demographic characteristics and Systemic Immune-Inflammation Index (SII) levels in patients			
	Low SII (n=63)	High SII (n=73)	p
Age (years), mean+SD	85.1±4.2	85.2±3.8	0.871T
Gender, n (%)			
Female	16 (21.9)	15 (23.8)	0.793
Male	57 (78.1)	48 (76.2)	
BMI, mean + SD	25.9±3.73	24.3±4.5	0.025T
Lives with n (%)			
alone	5 (6.8)	1 (1.6)	0.194F
wife	26 (35.6)	19 (30.2)	
other-related	42 (57.5)	43 (68.3)	
CCI, median (minimum-maximum)	6 (4-9)	5 (4-10)	0.699M
ECOG PS (minimum-maximum)	2 (1-4)	2 (1-4)	0.279M
Acute kidney injury during hospitalization	21 (28.8)	28 (44.4)	0.058
Percutaneous nephrostomy	4 (5.5)	10 (15.9)	0.047
Double J-stent	10 (13.7)	2 (3.2)	0.031
Hospitalization			
emergency	37 (50.7)	45 (71.4)	0.014
elective	36 (49.3)	18 (28.6)	
PNI, mean±SD	47.2±7.2	39±7.4	0.001T

Table 3. Continued

	Low SII (n=63)	High SII (n=73)	p
Reason for hospitalization			
hematuria	22 (30.1)	25 (39.7)	0.144F
postrenal AKI	10 (13.7)	15 (23.8)	
urolithiasis	4 (5.5)	4 (6.3)	
malignancy	12 (16.4)	8 (12.7)	
other	25 (34.2)	11 (17.5)	
Urinary tract infection	30 (41.1)	30 (47.6)	0.445
Hospitalization days	2 (0-13)	1 (0-7)	0.030M

T: T-test, M: Mann-Whitney-U Test, F: Fisher exact test.

BMI, body mass index; CCI, Charlson comorbidity index; ECOG PS, eastern cooperative oncology group performance status, PNI, prognostic nutritional index, SD: Standard deviation, min.-max.: Minimum, maximum

Patient Demographics, Characteristics and Their Associations with SII

The demographic and clinical attributes of the patients, as they relate to their pre-hospital SII, are shown in Table 3. Patients with higher SII exhibited higher PNI ($p=0.001$). SII was significantly associated with length of hospital stay ($p=0.030$) but not with age ($p=0.871$) or gender ($p=0.793$).

Optimal Cut-off Points for SII, PNI, and the SII/PNI Ratio

Using ROC curve analysis, we defined the optimal cut-off values for the SII, PNI, and the combined SII/PNI index. The optimal cut-off values for predicting OS were identified as 1243 for SII, 42.65 for PNI, and 32.37 for SII/PNI, respectively. The area under the curve for OS was 0.699, 0.723, and 0.728 for SII, PNI, and SII/PNI, respectively (Figure 1). Percutaneous nephrostomy tubes were placed in patients who had dilated upper systems. Although this improves the short-term survival of these patients, who have a percutaneous nephrostomy tube associated with poorer OS ($p<0.001$) (Figures 2A), it does not affect long-term outcomes. On the other hand, no statistically significant difference in OS was observed between male and female patients ($p=0.684$) (Figure 2B).

Factors Affecting Patient Survival: A Univariate and Multivariate Analysis

The univariate analysis showed that OS was significantly influenced by ECOG-PS, percutaneous nephrostomy procedures, reasons for hospitalization, SII, PNI, Katz Index scores, and hospital stay length.

Multivariate COX regression analysis revealed that percutaneous nephrostomy (HR 5.013, 95% CI 2.485-10.114, $p<0.001$), PNI (HR 0.926, 95% CI 0.890-0.964, $p<0.001$), and length of hospital stay (HR 1.040, 95% CI 1.002-1.079, $p=0.038$) were independent predictors of OS, as shown in Table 4.

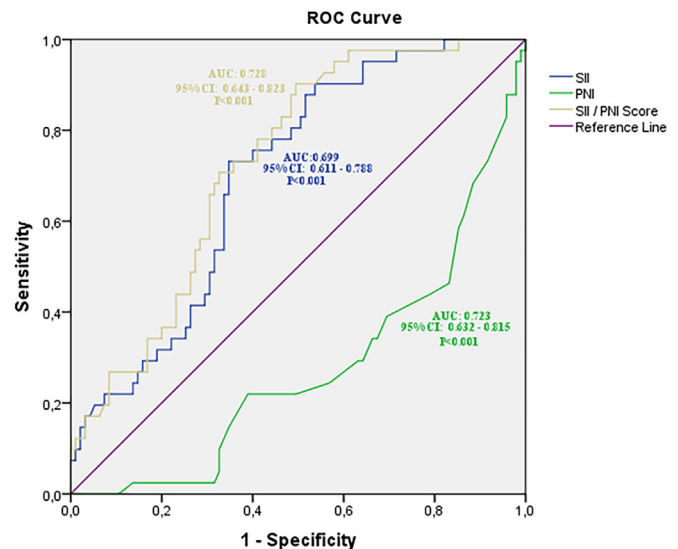


Figure 1. Details of the receiver operating characteristics (ROC) analysis of the effect of the SII, PNI and SII/PNI score. The area under the curve (AUC) for (OS) was 0.699, 0.723, and 0.728 for SII, PNI, and SII/PNI, respectively.

ROC: Receiver operating characteristic, PNI: Prognostic nutritional index, SII: Systemic Immune-Inflammation Index, AUC: Area under the curve, OS: Overall survival

Discussion

The aging population and extended life expectancy have contributed to considerable growth in the number of geriatric patients requiring urological treatment. In the absence of evidence-based guidelines specific to the management of frail elderly patients, case studies can offer valuable insights into the complex diagnostic and therapeutic dilemmas encountered in this population (8). In recent times, there has been a notable increase in interest surrounding the prognostic value of SII and PNI. Additionally, emerging research highlights the role of inflammation in disease initiation, progression, and metastasis, as well as its impact on immune regulation (9-12). The study's

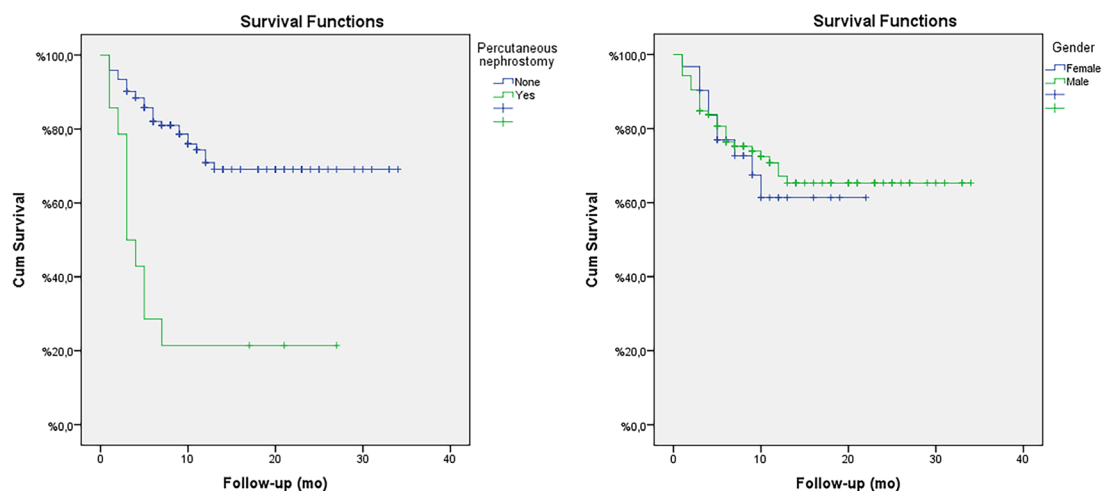


Figure 2. (a) Percutaneous nephrostomy tubes improve the short-term survival of these patients, who have a percutaneous nephrostomy tube associated with poorer OS ($p < 0.001$). b) Kaplan-Meier analyses for OS over 80 years old according to percutaneous nephrostomy (2A) and gender (2B). No statistically significant difference in OS was observed between male and female patients ($p = 0.684$).

OS: Overall survival

Variable	Univariate model	p	Multivariate model	p
	HR (95% CI)		HR (95% CI)	
Age (years)	1.071 (1.000–1.148)	0.051		
Gender (Ref: Female)	0.864 (0.432–1.766)	0.689		
BMI	0.926 (0.855–1.002)	0.056		
Marriage Status	1.276 (0.651–2.503)	0.478		
Lives with (Ref: Alone)	1.924 (1.021–3.626)	0.043		
CCI	1.062 (0.841–1.340)	0.613		
Additional malignancy	1.410 (0.553–3.594)	0.472		
ECOG PS	1.777 (1.199–2.633)	0.004		
Antiaggregant status	1.309 (0.708–2.419)	0.390		
Anticoagulant status	0.966 (0.461–2.025)	0.927		
Smoking status	0.633 (0.332–1.210)	0.167		
Percutaneous nephrostomy	4.795 (2.385–9.641)	<0.001	5.013 (2.485–10.114)	<0.001
Double J-stent	0.228 (0.031–1.656)	0.144		
Number of previous hospitalizations	1.012 (0.880–1.165)	0.865		
Number of hospitalizations in the last year	1.266 (0.991–1.616)	0.059		
Reason for hospitalization	0.730 (0.591–0.902)	0.004		
SII	1000	<0.001		
PNI	0.929 (0.896–0.964)	<0.001	0.926 (0.890–0.964)	<0.001
Katz Index	0.724 (0.586–0.894)	0.003		
Mini nutritional assessment-screening	0.798 (0.665–0.956)	0.015		
Mini nutritional assessment-assessment	0.906 (0.819–1.002)	0.055		
WHOQOL-OLD score	0.921 (0.853–0.995)	0.036		
Urinary tract infection	1.256 (0.678–2.326)	0.468		
Hospitalization days	1.063 (1.031–1.096)	<0.001	1.040(1.002–1.079)	<0.038

BMI: Body mass index, CCI: Charlson Comorbidity Index, ECOG PS: Eastern cooperative oncology group performance status, SII: Systemic Immune-Inflammation Index; PNI: Prognostic Nutritional Index, HR: Hazard ratio, CI: Confidence interval

aim is to examine the clinical utility and predictive power of SII and PNI in hospitalized individuals aged 80 and above, and to analyze their comparative predictive accuracy. Our study results indicates that a high SII and low PNI prior to surgery are independent predictors of short-term survival in patients over the age of 80.

On the other hand, patient-related factors, including systemic inflammatory response (SIR) markers, can also influence cancer progression and prognosis. Malnutrition, indicated by low albumin levels, is linked to increased morbidity, mortality, and impaired response to cancer treatment. It also weakens the immune system, promoting tumor recurrence (13–17). In our study, we found that the low PNI group patients' survival was less than the other group. The mechanisms of SIR are complex and remain controversial. Neutrophils have been linked to the presence of chemokines, growth factors and proteases that regulate angiogenesis. This could potentially influence the tumor's blood supply and growth rate (18–21). It was observed that cancer patients with a SII greater than 330×10^9 cells/L exhibited a poorer prognosis compared to those with lower SII scores (22). Elevated SII levels, characterized by increased granulocyte and platelet counts and decreased lymphocyte counts, suggest a weakened immune response and heightened inflammatory state, leading to adverse outcomes. Neutrophils are integral components of innate immunity, playing a crucial role in host defense mechanisms such as antibody-dependent cellular cytotoxicity and phagocytosis (23). The present study revealed that elevated SII was associated with lower BMI, fewer double-J stents, more percutaneous nephrostomy tubes, longer hospital stays, and increased emergency hospitalizations.

A reduction in the number of lymphocytes in the bloodstream may be indicative of an impaired anti-tumor immune response. Additionally, it is established that the inflammatory response associated with the tumor and the cytokines released because of this inflammation can lead to a reduction in blood albumin levels, which may, in turn, contribute to tumor progression (24–25).

The PNI was initially proposed as a means of assessing the immunological and nutritional status of patients who have undergone gastrointestinal surgery (26). It is also known that the lymphocyte count and the blood albumin level have prognostic importance (27). Lymphocytes, another essential component of the PNI, play a pivotal role in cell-mediated immune responses, which can significantly impact tumor recurrence and progression. Additionally, a compromised nutritional status can further contribute to tumor progression by hindering tumor immunity. This immunosuppressed state can lead to suboptimal outcomes in cancer patients. PNI has been shown to be a valuable prognostic marker in various cancers. Systemic inflammation has been linked to tumor progression,

recurrence, metastasis, and poor oncological outcomes (28–29). In our study, lower PNI was associated with increasing age, lower BMI, higher ECOG-PS, emergency hospitalization, UTI, and a longer hospital stay.

While optimal cutoff values for PNI and SII to predict OS remain elusive, previous research has explored their potential. Mori et al. utilized ROC curve analysis to find PNI cutoffs, reporting 51 for renal carcinoma and 50 for NSCLC, respectively (30). We found that PNI and SII cutoff values of 42.65 and 1243, respectively, are useful to predict short-term survival.

Our study shows that SII and PNI are important markers for older adults. Patients with low SII and high PNI had better outcomes, while those with low PNI and high SII had worse outcomes. Using both SII and PNI improves prediction.

Study Limitations

It should be noted that this study is subject to several limitations, including its retrospective design, single-center nature, and lack of additional analysis of inflammatory markers, which could have provided further insights into the pathophysiology of the disease.

Conclusions

This study highlights the prognostic value of the PNI, SII, and SII/PNI ratio in predicting short-term survival among older adults. Multivariate COX regression analysis identified percutaneous nephrostomy, lower PNI, and a longer length of hospital stay as independent predictors of poor OS.

Ethics

Ethics Committee Approval: University of Health Sciences Türkiye Medeniyet University Göztepe Training and Research Hospital's Ethics Committee (decision number: 2023/0823, date: 29.11.2023).

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: İ.H.Z., M.Ç.Ç., Ö.A., Concept: İ.H.Z., M.Ç.Ç., Ö.A., A.K., A.Y., Design: İ.H.Z., M.Ç.Ç., Data Collection or Processing: İ.H.Z., Ö.A., A.K., A.Y., Analysis or Interpretation: İ.H.Z., Ö.A., A.Y., Literature Search: İ.H.Z., M.Ç.Ç., A.K., A.Y., Writing: İ.H.Z., M.Ç.Ç., A.K.

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