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Renal dysfunction due to surgical stress and its effects on survival in patients aged 90 and over

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Ethics Committee Approval
The study was approved by Ethics Committee of Malatya Turgut Özal University (November 7, 2022, number 2022/191).
All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

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

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Abstract

Background/Aim: Published studies of surgical outcomes in patients aged 90 years and older have mostly focused on specific surgeries such as hip fractures. Unlike previous reports, our study includes all surgical procedures in patient groups aged 90 and over for eight years in our hospital. We aim to be able to predict the responses of an older adult's kidney due to surgical stress by using the values of plasma urea and creatine, which are preoperative and postoperative routine laboratory parameters, and to predict its effect on mortality.
Methods: Our study was conducted as a retrospective cohort study with 284 patients whose ages ranged from 90 to 119 and who had undergone a surgical operation. The patients were divided into four groups according to preoperative and postoperative creatinine values: preoperative and postoperative creatinine <1.25 mmol/L RFT-I group; preoperative creatinine <1.25 mmol/L but postoperative creatinine >1.25 mmol/L RFT-II group; preoperative creatinine >1.25 mmol/L but postoperative creatinine <1.25 mmol/L RFT-III group; and preoperative and postoperative creatinine >1.25 mmol/L RFT-IV group.
Results: Of the 284 cases, 62% required intensive care after surgery. While 95.4% of the patients were discharged, 4.6% did not survive. No renal dysfunction was observed in the RFT-I group (68.7%, n=195) (preoperative and postoperative creatinine <1.25 mmol/L). In the RFT-II group (17.6%, n=50), renal dysfunction (creatinine >1.25 mmol/L) developed due to postoperative surgical stress (creatinine <1.25 mmol/L). In patients in the RFT-III group (6%, n=17), preoperative renal dysfunction (creatinine >1.25 mmol/L) improved with postoperative care (creatinine <1.25 mmol/L). In the RFT-IV group (7.7%, n=22), preoperative renal dysfunction (creatinine >1.25 mmol/L) did not improve postoperative renal dysfunction despite appropriate perioperative fluid replacement.
Conclusion: Our study observed an increase in postoperative urea and creatinine values due to surgical stress in our patient group aged 90 and over, who had limited physiological reserves. However, it has been shown that improvement in renal function tests can be achieved with appropriate fluid replacement and postoperative intensive care treatment in patients with postoperative or preoperative renal dysfunction. Our rates of postoperative renal dysfunction due to surgical stress were lower and did not change mortality.

Keywords: geriatrics, acute kidney injury, mortality

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Introduction

Aging encompasses all the functional and structural changes that occur over time at the level of cells, tissues, and systems in the organism. It is an irreversible physiological process [1]. The World Health Organization considers the age of 65 to be the old age limit. However, the transition of people to dependent lives is around the age of 75 [2].

With the decrease in death rates in recent years, life expectancy in our country has increased to 70 years. It is estimated that the number of older people will increase twice in the next 20 years and reach 12 million in 2050 [3]. Diseases and organ dysfunctions increase in the elderly population with age and prolonged life span [4]. Renal blood flow and mass decrease with age, which increases the risk of developing renal failure in elderly patients, especially in the perioperative and postoperative periods, when exposed to nephrotoxic drugs and applications. The reduced capacity to hold water and electrolyte loads makes liquid treatment more critical [5].

With the advancement of anesthesia and surgical techniques, major elective and emergency surgery services are being provided to a larger number of elderly patients; therefore, the life expectancy of the elderly is increasing even more [6]. In the elderly, a limited physiological reserve is sufficient to maintain hemostasis in a normal state, while surgery may result in stress-related insufficiency. However, decreased body mass index and total water and fat ratios change the distribution and elimination of anesthetic drugs [7].

Published studies on surgical outcomes in patients 90 years of age and older have mostly focused on specific surgeries, and most are based on hip fracture cases [8,9]. Plasma creatinine and urea values are the most commonly used preoperative laboratory tests to evaluate kidney function [10].

Patients aged 90 years and older who had been admitted to our hospital with various symptoms over eight years and underwent surgical treatment were included in our study. Our aim is to predict the responses of an elderly person's kidney due to surgical stress by using the values of plasma urea and creatine, which are preoperative and postoperative routine laboratory parameters, and to predict their effects on mortality.

Materials and methods

Our retrospective cross-sectional study was carried out in accordance with the Declaration of Helsinki after the approval of the Ethics Committee of X University dated November 7, 2022, and numbered 2022/191. The study included 284 patients between the ages of 90 and 119 who presented to our hospital with various symptoms between June 30, 2014, and October 7, 2022, and underwent surgical treatment. The data of the patients included in the study were obtained from the patient files and the hospital's automation system. Patients with chronic renal failure and at risk of severe blood loss were excluded from the study. The age of the patients, comorbidities, and American Society of Anesthesiologists (ASA) scores were recorded. The patients' urea and creatinine values were recorded on the first and second postoperative days. Also, the type of operation and type of anesthesia; the status and duration of hospitalization in the intensive care unit (ICU); whether there was intubation, inotropic, dialysis, and blood transfusion treatment; discharge; and non-survival status were recorded.

In our study, the serum creatinine limit value was accepted as 1.25 mmol/L according to the laboratory parameters in our clinic. The patients included in our study were divided into four groups according to preoperative and postoperative creatinine values: preoperative and postoperative creatinine <1.25 mmol/L RFT-I group; preoperative creatinine <1.25 mmol/L but postoperative creatinine >1.25 mmol/L RFT-II group; preoperative creatinine >1.25 mmol/L but postoperative creatinine <1.25 mmol/L RFT-III group; and preoperative and postoperative creatinine >1.25 mmol/L RFT-IV group.

Statistical analysis

While evaluating the findings obtained in the study, IBM SPSS Statistics 22 program was used for statistical analyses. The Kolmogorov-Smirnov test evaluated the conformity of the parameters to the normal distribution, and it was found that the parameters did not show a normal distribution. While evaluating the study data, in addition to descriptive statistical methods (mean [standard deviation], median, frequency), the Kruskal Wallis test was used to compare the quantitative data between the groups, and Dunn's test was used to determine the group that caused the difference. The Chi-Square, Fisher's Exact Chi-Square, and Fisher Freeman Halton Exact Chi-Square tests were used to compare the qualitative data. The significance was evaluated at the level of $P<0.05$.

Results

The study was conducted with 284 patients ranging in age from 90 to 119. The average age was 93.08 (3.71) years. While only 4.2% of the cases were ASA 2, 95.8% were ASA 3. Hypertension was observed in 63.4% of the patients, neurological diseases in 29.2%, chronic obstructive pulmonary disease (COPD) in 21.8%, congestive heart failure (CHF) in 13.4%, coronary artery disease (CAD) in 12.7%, diabetes in 11.3%, and other comorbidities in 3.5%. Of the cases, 83.1% underwent orthopedic surgery. Of the patients, 85.2% underwent regional anesthesia (Table 1).

A total of 62% of the cases required postoperative intensive care. The most common cause of intensive care hospitalization was respiratory failure (73.9%), followed by delirium (21.6%), hemodynamic follow-up (2.8%), and hypotension (1.7%). Of the cases, 3.9% were intubated, 9.2 received inotropic treatment, 0.7% received dialysis, and 56.7% received blood transfusion treatment. While 95.4% of the patients were discharged, 4.6% did not survive (Table 2).

We accessed the urea and creatinine values of the patients participating in the study on the preoperative and postoperative first and second days but we could not access the urine follow-ups. However, we divided our patients into four groups based on ≥0.3 mg/dl increases in serum creatinine levels within 48 hours according to the KDIGO classification. No renal dysfunction was observed in 68.7% (n=195) of the patients (preoperative and postoperative creatinine <1.25 mmol/L) in the RFT-I group. There was no preoperative renal dysfunction (creatinine <1.25 mmol/L) in the RFT-II group (17.6%, n=50), but renal dysfunction (creatinine >1.25 mmol/L) developed due to postoperative surgical stress. Patients in the RFT-III group

(6%, n=17) had preoperative renal dysfunction (creatinine >1.25 mmol/L), and with postoperative care, these patients saw improved renal dysfunction (creatinine <1.25 mmol/L).

Table 1: ASA scores, comorbidities, operation type and anesthesia type in patients

		n	%
ASA	2	12	4.2
	3	272	95.8
Comorbidities	Hypertension	180	63.4
	Diabetes Mellitus	32	11.3
	CHF	38	13.4
	COPD	62	21.8
	CAD	36	12.7
	Neurological diseases	83	29.2
	Other diseases	10	3.5
Operation type	**Neurosurgery**	6	2.2
	Subdural hemorrhage	3	1.1
	Epidural hematoma	1	0.4
	Kyphoplasty	2	0.7
	General Surgery	17	6
	Inguinal hernia	8	2.8
	Malignancy	3	1.1
	Acute cholecystectomy	2	0.7
	Ileus	2	0.7
	Appendectomy	2	0.7
	Otolaryngology surgery	1	0.4
	FES	1	0.4
	Cardiovascular surgery	5	1.8
	Embolectomy	4	1.4
	Pericardial tamponade	1	0.4
	Orthopedics surgery	236	83.1
	Hip fracture	224	78.9
	Radius fracture	5	1.6
	Tibia fracture	3	1.1
	Knee arthroplasty	2	0.7
	Proximal humeral fracture	1	0.4
	Foot amputation	1	0.4
	Plastic surgery	2	0.7
	Tissue injury	2	0.7
	Urology surgery	17	6
	Prostate hyperplasia	12	4.2
	Ureteroscopy	3	1.1
	Hydrocele	2	0.7
Anesthesia type	General anesthesia	25	8.8
	Peripheral nerve block	12	4.2
	Sedation	5	1.8
	Rejyonel anesthesia	242	85.2

ASA: The American Society of Anesthesiologists physical status classification, FES: Functional endoscopic sinus surgery, HF: Heart failure, COPD: chronic obstructive pulmonary disease, CAD: Coronary Artery Disease

Table 2: Perioperative treatments, intensive care stay and duration

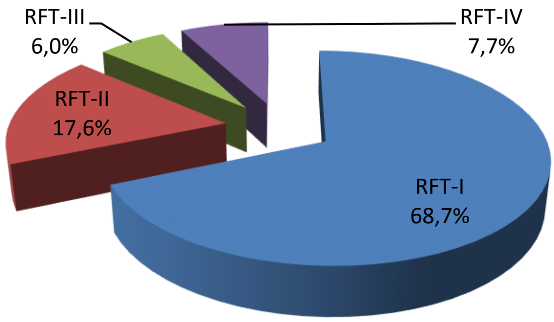
		Min-Max	Median
Length of stay in intensive care		0-91	2.18 (6.49) (1)
Duration of hospital stay		2-95	11.05 (9.13) (9)
		n	%
Status of hospitalization in the ICU	No	108	38
	Yes	176	62
Reason for hospitalization in ICU (n=176)	Hemodynamic monitoring	5	2.8
	Delirium	38	21.6
	Hypotension	3	1.7
	Respiratory failure	130	73.9
Intubation	No	273	96.1
	Yes	11	3.9
Inotropic therapy	No	258	90.8
	Yes	26	9.2
Leaving the hospital	Discharge	271	95.4
	Non survivors	13	4.6
Dialysis therapy	No	282	99.3
	Yes	2	0.7
Blood transfusion therapy	No	123	43.3
	Yes	161	56.7

ICU: Intensive care units

In the RFT-IV group (7.7%, n=22), preoperative renal dysfunction (creatinine >1.25 mmol/L) (Figure 1) did not improve postoperative renal dysfunction despite appropriate perioperative fluid replacement.

ASA was similar among groups (*P*=0.685). The number of inpatients admitted to the ICU was higher in the RFT-IV group. The number of patients intubated and given inotropic drugs was higher in the RFT-II group, and dialysis was applied to two patients in the RFT-II group. The number of patients who were given blood and did not survive was higher in the RFT-III group. Hospital and intensive care hospitalization periods were longer in the RFT-III group, but these results were not statistically significant (*P*=0.285) (Table 3).

Figure 1: Distribution of groups



There was a statistically significant difference between the groups in terms of preoperative urea levels (*P*=0.001). Preoperative urea levels in the RFT-I group were lower than in the RFT-II, RFT-III, and RFT-IV groups (*P*=0.001). Preoperative urea levels in the RFT-II group were lower than in the RFT-III and RFT-IV groups (*P*=0.001). Preoperative urea levels were similar between RFT-III and RFT-IV groups. There was a statistically significant difference among the groups in terms of postoperative day 1 and day 2 urea levels (*P*=0.001). The postoperative day 1 and day 2 urea levels in the RFT-I group were lower than in the RFT-II, RFT-III, and RFT-IV groups (*P*=0.001). Postoperative day 1 and day 2 urea levels were similar among RFT II, RFT-III, and RFT IV groups (Table 4).

Table 4: Evaluation of groups in terms of laboratory findings

	RFT-I	RFT-II	RFT-III	RFT-IV	
	Mean (SD) (Median)	Mean (SD) (Median)	Mean (SD) (Median)	Mean (SD) (Median)	*P-values*
Preoperative urea mmol/L	48.13 (17.54) (45.2)	57.35 (22.83) (53)	101.83 (41.36) (98)	87.41 (29.96) (76)	0.001 *
Urea on postoperative day 1 mmol/L	53.7 (31.1) (50)	78.49 (36.66) (71)	70.5 (21.76) (72)	95.49 (39.06) (94.8)	0.001 *
Urea on postoperative day 2 mmol/L	54.01 (20.4) (51)	88.84 (33.07) (88.1)	71.2 (24.97) (71)	97.21 (29.75) (87)	0.001 *

Kruskal Wallis Test, *$P<0.05$

Table 3: Evaluation of perioperative treatments, intensive care stays and durations between groups

		RFT-I n (%)	RFT -II n (%)	RFT-III n (%)	RFT-IV n (%)	*P-values*
ASA	2	9 (4.6)	1 (2)	1 (5.9)	1 (4.5)	[1]0.685
	3	186 (95.4)	49 (98)	16 (94.1)	21 (95.5)	
Status of hospitalization in the ICU	No	76 (39)	21 (42)	6 (35.3)	5 (22.7)	[2]0.449
	Yes	119 (61)	29 (58)	11 (%64.7)	17 (77.3)	
Intubation	No	190 (97.4)	45 (90)	16 (94.1)	22 (100)	[1]0.075
	Yes	5 (2.6)	5 (10)	1 (5.9)	0 (0)	
Inotropic therapy	No	179 (91.8)	44 (88)	13 (76.5)	22 (100)	[1]0.066
	Yes	16 (8.2)	6 (12)	4 (23.5)	0 (0)	
Leaving the hospital	Discharge	188 (96.4)	47 (94)	15 (88.2)	21 (95.5)	[1]0.285
	Non survivors	7 (3.6)	3 (6)	2 (11.8)	1 (4.5)	
Comorbidities	Hypertension	120 (61.5)	34 (68)	12 (70.6)	14 (63.6)	[2]0.771
	Diabetes	26 (13.3)	2 (4)	2 (11.8)	2 (9.1)	[1]0.279
	CHF	25 (12.8)	5 (10)	3 (17.6)	5 (22.7)	[1]0.429
	COPD	41 (21)	15 (30)	2 (%11.8)	4 (18.2)	[1]0.400
	CAD	22 (11,3)	9 (18)	1 (5,9)	4 (18.2)	[1]0.405
	Neurological diseases	58 (29.7)	17 (34)	5 (29.4)	3 (13.6)	[2]0.367
Dialysis therapy	No	195 (100)	48 (96)	17 (100)	22 (100)	[1]0.097
	Yes	0 (0)	2 (4)	0 (0)	0 (0)	
Blood transfusion therapy	No	90 (46.2)	17 (34)	5 (29.4)	11 (50)	[2]0.246
	Yes	105 (53.8)	33 (66)	12 (70.6)	11 (50)	
Anesthesia type	General anesthesia	18 (9.2)	4 (8.0)	0 (0)	3 (13.6)	[3]0.350
	Peripheral nerve block	9 (4.6)	2 (4.0)	0 (0)	1 (4.5)	
	Sedation	2 (1.0)	1 (2.0)	0 (0)	2 (9.1)	
	Regional anesthesia	1666 (85.1)	43 (86.0)	17 (100)	16 (72.7)	
Duration of hospitalization in the ICU (median)		1.94 (6.99) (1)	2.66 (5.14) (1)	4.35 (7.84) (1)	1.45 (1.18) (1.5)	[4]0.609
Duration of hospital stay (median)		10.87 (9.16) (9)	11.98 (10.02) (9)	12.35 (7.42) (11)	9.5 (8.2) (8)	[4]0.306

[1] Fisher Freeman Halton Exact Test, [2] Ki-square test, [3] Fisher's Exact Test, [4] Kruskal Wallis Test

Discussion

During illness or surgical stress, the kidneys' ability to adapt to changing conditions decreases in older individuals. While young people can easily tolerate such changes, they can cause fluid–electrolyte disorders and kidney failure in the elderly [11].

Our study was conducted retrospectively with 284 patients whose ages ranged from 90 to 119 years and who underwent surgical operations. The patients were divided into four groups according to their preoperative and postoperative creatinine values. With appropriate perioperative fluid replacement and postoperative intensive care treatment, more than half of our patient group's preoperatively existing kidney dysfunction improved. Our rates of postoperative kidney dysfunction were lower and did not affect mortality.

In our study, hypertension and neurological diseases were the most common comorbidities among the groups, and the incidence rates of comorbidities were similar. In a study conducted by Karaman et al. [12] on 255 patients, hypertension and diabetes were the most common comorbidities. In our study, we attribute the more frequent occurrence of neurological diseases to the fact that our age group is more advanced. Hip fractures are an important health problem among the elderly [13]. Most of our patients had hip fractures. The most common type of anesthesia used in our study was regional anesthesia, and it was similar among the groups. Bakı et al. [14] defended the superiority of regional anesthesia over general anesthesia in terms of complications in their study conducted in 2014.

In a study conducted by Stahl et al. [15] on 115 patients over 90 years of age who underwent orthopedic surgery, delirium and respiratory failure were the most common complications. In our study, respiratory failure was the most common complication. The number of inpatients admitted to the ICU was higher in the RFT-IV group. The hospital and intensive care hospitalization periods were longer in the RFT-III group. Our patients' hospital and intensive care hospitalization times were like those of a study conducted by Kassahun et al. [16] in 2017. However, our intensive care hospitalization rates were lower.

Most of the time, it is difficult to clinically evaluate liver function correctly. Two classification systems are helpful in detecting and staging renal function: risk, injury, failure, loss, end-stage renal disease (RIFLE), and acute kidney injury network (AKIN) staging systems. In both systems, creatinine increases, and urine flow measurements are at the forefront [5].

In our study, we determined the urea and creatinine values of the patients on the preoperative and postoperative first and second days. However, we could not access the urine follow-ups, which was one of the restrictive factors of our study. Our patient rates in the RFT-II group were similar to the study conducted by Ghanem et al. [17] in an orthopedic patient group over 90 years of age. In a multicenter comprehensive study conducted by Bell et al. [18], postoperative renal dysfunction rates were lower than the rates in our study. In a study conducted by Bakı et al. [9] on orthopedic patients in 2021, the rates of renal dysfunction were lower than in our RFT-II patient group. This situation depended on the advanced age of our patient group. In the studies conducted by Hobson et al. [19] on patients undergoing surgery, the rates of renal dysfunction were higher than in the RFT-II group in our study. Again, Leistner et al. [20] reported higher rates of renal dysfunction in patients aged 80 years and older who underwent cardiac interventions than in the RFT-II group. We attribute this condition to appropriate perioperative fluid replacement and postoperative intensive care follow-up.

In this age group, the risk of dehydration and preoperative renal dysfunction due to nonsteroidal anti-inflammatory drugs increased. Perregaard et al. [21] found that 11.1% of patients had preoperative renal dysfunction in a study conducted on 3416 patients in 2016. Our preoperative renal dysfunction rates were higher in our patient group. However, renal dysfunction recovered postoperatively in more than half of our patients with appropriate perioperative fluid replacement therapy.

Recent studies conducted on elderly patient groups have shown the relationship between postoperative renal dysfunction and mortality. In extensive studies conducted by Chiang et al. [22], kidney dysfunction was associated with increased mortality. Again, in their 2022 study, Kaşıkara et al. [23] showed that postoperative dysfunction had a higher mortality rate. Similarly, in our study, mortality rates were higher in the group of patients with preoperative and postoperative renal dysfunction than in the group without renal dysfunction. However, the rate was not statistically significant. We attribute this situation to the comprehensive treatments applied in perioperative and postoperative intensive care units in our elderly patient group.

Limitations

The fact that our study was conducted in a single center, the relatively small number of patients, and the inability to access patients' urine follow-ups were restrictive factors. We think that future studies need to be done more comprehensively and prospectively. As a result, the rates of postoperative kidney dysfunction due to surgical stress were lower in our group of patients aged 90 and older with limited physiological reserve, who were divided into four groups according to preoperative and postoperative creatinine values, and had no effect on postoperative mortality.

Conclusions

Our study observed an increase in postoperative urea and creatinine values due to surgical stress in our patient group aged 90 and over, who had limited physiological reserves. However, it has been shown that improvement in renal function tests can be achieved with appropriate fluid replacement and postoperative intensive care treatment in patients with postoperative or preoperative renal dysfunction. Our rates of postoperative renal dysfunction due to surgical stress were lower and did not change mortality. However, more comprehensive and prospective studies are needed on this subject.

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