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Perioperative management of facial reconstruction surgery in patients with end-stage renal disease undergoing dialysis

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Background: The rising incidence of dialysis-dependent end-stage renal disease (ESRD) has underscored the need for collaboration between plastic surgeons and nephrologists, particularly concerning preoperative and postoperative management for facial reconstruction. This collaboration is essential due to a scarcity of comprehensive information in this domain.
Methods: A study initiated in January 2015 involved 10 ESRD cases on dialysis undergoing Mohs micrographic surgery for facial skin cancer, followed by reconstructive surgery under general anesthesia. To ensure surgical safety, rigorous measures were enacted, encompassing laboratory testing, nephrology consultations, and preoperative dialysis admission. Throughout surgery, meticulous control was exercised over vital signs, electrolytes, bleeding risk, and pain management (excluding nonsteroidal anti-inflammatory drugs). Postoperative assessments included monitoring flap integrity, hematoma formation, infection, and cardiovascular risk through plasma creatinine levels.
Results: Adherence to the proposed guidelines yielded a notable absence of postoperative wound complications. Postoperative plasma creatinine levels exhibited an average decrease of 1.10 mg/dL compared to preoperative levels, indicating improved renal function. Importantly, no cardiopulmonary complications or 30-day mortality were observed. In ESRD patients, creatinine levels decreased significantly postoperatively compared to the preoperative levels ($p<0.05$), indicating favorable outcomes.
Conclusion: The consistent application of guidelines for admission, anesthesia, and surgery yielded robust and stable outcomes across all patients. In particular, the findings support the importance of adjusting dialysis schedules. Despite the limited sample size in this study, these findings underscore the effectiveness of a collaborative and meticulous approach for plastic surgeons performing surgery on dialysis-dependent patients, ensuring successful outcomes.

Abbreviations: CBC, complete blood count; DIC, disseminated intravascular coagulation; ESAs, erythropoiesis-stimulating agents; ESRD, end-stage renal disease; GFR, glomerular filtration rate; NSAIDs, nonsteroidal anti-inflammatory drugs; LRFT, liver and renal function test

Keywords: Facial neoplasms / Reconstructive surgery / Renal dialysis / Skin neoplasms

Original Article

INTRODUCTION

End-stage renal disease (ESRD) is characterized by the permanent loss of kidney function, requiring patients to undergo renal replacement therapies such as hemodialysis, peritoneal dialysis, or kidney transplantation. The incidence and prevalence of ESRD are increasing each year, largely due to population aging and the rising rates of diabetes and hypertension, which are the leading causes of the condition [1]. Concurrently, the incidence of skin cancer in South Korea is climbing, driven by an array of factors including an aging population, increased participation in outdoor activities, greater exposure to ultraviolet radiation due to changes in the ozone layer, improved access to medical services, and heightened patient awareness of skin cancer [2]. As a result, in-

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creasing numbers of patients with ESRD are seeking medical care for the removal and reconstruction of skin cancers. The choice of reconstruction method should be determined by various factors, including the patient's condition [3].

Individuals with ESRD frequently present with numerous comorbidities, including cardiovascular diseases, strokes, vascular disorders, diabetes, hypertension, and infections even prior to initiating dialysis [4,5]. Considering the elevated postoperative mortality and incidence of cardiac events among ESRD cases, meticulous management is crucial [6,7].

Recent clinical studies of patients who undergo head and neck surgery while receiving dialysis have underscored the elevated mortality rates and comparatively high likelihood of circulatory or respiratory complications in patients with ESRD. These factors contribute to reduced surgical success [8-10]. However, guidelines for the optimal management of these patients have yet to be established.

Plastic surgeons infrequently encounter dialysis-dependent patients in their medical practice. The goal of this study is to present a comprehensive approach to the safe preoperative and postoperative management of rare ESRD cases in plastic surgery. In collaboration with nephrologists, guidelines were established in January 2015, and their effectiveness was evaluated by assessing postoperative complications and changes in plasma creatinine concentrations.

METHODS

We conducted a retrospective analysis of local flap and skin graft procedures performed at our hospital from January 2015 to January 2023.

We retrospectively reviewed 289 cases who underwent reconstructive surgery under general anesthesia at our institution following Mohs micrographic surgery for facial skin cancer [11]. Further analysis included all cases with documented renal failure requiring dialysis, totaling 10 cases. The surgical procedures performed included lip reconstruction with a local advancement flap in one case, paramedian forehead flap in one case, flap division and insetting in one case, a combination of local flaps in one case, and split-thickness skin grafts in six cases. Care was taken to select procedures that would not place excessive stress on vital organs, such as the kidneys, and to minimize the duration of surgery.

Postoperative complications were defined as events occurring within 90 days of surgery, with mortality assessed at the 30-day mark. The evaluation criteria included the assessment of flap and skin graft integrity, hematoma formation, and infection, along with the comparison of plasma creatinine levels from before and after surgery to assess cardiovascular and acute renal failure risks [12,13]. Additionally, we assessed the rates of critical complications such as pulmonary embolism, stroke, and sepsis, as well as overall mortality [9].

Patients were categorized into three groups: a normal group with a glomerular filtration rate (GFR) greater than 60 mL/min/1.73 m^2, a kidney disease group with a GFR less than 60 mL/min/1.73 m^2 not requiring dialysis, and a group with ESRD necessitating dialysis. Postoperative changes in creatinine levels compared to the preoperative levels were measured in all groups, and statistical analysis was conducted to ascertain the significance of these changes.

Preoperative evaluation and management

Initially, patients scheduled for general anesthesia underwent comprehensive laboratory testing to assess renal function (Table 1). This evaluation included a complete blood count (CBC), liver and renal function test (LRFT), and measurements of elec-

Table 1. Preoperative and postoperative management strategies for patients undergoing dialysis

Management strategies
Preoperative management and evaluation
Comprehensive laboratory testing
Optimize bleeding tendency, fluid, electrolyte, renal function
Communication with nephrology team
Assess cardiovascular condition (echocardiography)
Adjust hypertension and diabetes
If aspirin or clopidogrel substitution is feasible, LMWH is used
Preoperative anesthetic assessment
Admission 3 to 4 days before surgery for optimization of BP, blood glucose level, fluid
Dialysis the day before surgery
Nafamostat mesylate is used instead of heparin during dialysis
Skin preparation (hair removal and shower by cleansing with chlorhexidine)
Prophylactic antibiotics (cefazolin, considering renal function)
Postoperative management and evaluation
Comprehensive lab testing compared with preoperative results
DIC panel to monitor the risk of pulmonary embolism
Communication with the nephrology and cardiology teams
Dialysis on the day following surgery
Volume status monitoring
Observation for hyperkalemia and hyperglycemia
ESAs to prevent anemia
Nafamostat mesylate is used instead of heparin during dialysis until postoperative day 7
Acetaminophen or opioids instead of NSAIDs

LMWH, low molecular weight heparin; BP, blood pressure; DIC, disseminated intravascular coagulation; ESAs, erythropoietin-stimulating agents; NSAIDs, nonsteroidal anti-inflammatory drugs.

trolytes, glucose, blood urea nitrogen, creatinine, calcium, magnesium, phosphorus, and albumin. For patients with ESRD—who often exhibit a heightened bleeding tendency due to the accumulation of uremic toxins [14], inadequate dialysis, anemia, and the effects of residual heparin and aspirin—we implemented corrective measures and ensured collaboration and communication with the nephrology team [14].

Coronary artery disease and myocardial dysfunction are prevalent and impactful cardiac complications in patients with ESRD, leading to elevated mortality rates [15]. Echocardiography was employed to assess cardiovascular condition, and the status of hypertension and diabetes was verified [14]. Patients with ESRD may be prescribed medications such as aspirin and clopidogrel to reduce platelet aggregation. If it is possible to substitute another drug for aspirin or clopidogrel, low-molecular-weight heparin is commonly utilized as an alternative during the perioperative period [16,17].

Preoperative anesthetic assessment was used to identify issues that could be corrected, thereby optimizing organ function prior to surgery. This assessment also facilitated the evaluation of cardiopulmonary risks, enabling the creation of appropriate anesthesia plans.

Admission occurred 3 to 4 days before surgery, and care included preoperative dialysis on the day before the procedure. Inpatient management was focused on the regulation of blood pressure, blood glucose and hemoglobin levels, fluid balance, electrolytes, and hemorrhage risk [18]. Before admission, patients followed their regular dialysis schedule, but upon admission, dialysis was performed at least once, including the day before surgery. When performing dialysis on the day before surgery, nafamostat mesylate was utilized as the anticoagulant instead of heparin [19]. Since patients with ESRD are at an elevated risk of infection, skin preparation is particularly crucial. Patients were educated to appropriately remove hair before surgery and to shower with standard soap and water, followed by cleansing with chlorhexidine gluconate cloths prior to surgery [20,21]. Preoperative prescriptions of prophylactic antibiotics should be tailored considering renal function. Typically, cefazolin has been used [22,23].

Postoperative evaluation and management

Postoperatively, a comprehensive assessment was conducted, which included CBC, LRFT, and electrolyte testing (Table 2). Active interventions were implemented as necessary, based on comparisons with preoperative laboratory results. Additionally, disseminated intravascular coagulation (DIC) panel examinations were performed to assess the risk of pulmonary embolism, with proactive treatment administered in the event of abnormalities [24]. In patients with favorable general conditions, hemodialysis was initiated on the day following surgery. Volume status and hemodynamic stability were monitored through the careful recording and adjustment of input and output volumes. Close observation for hyperkalemia was maintained, and intravenous infusions of potassium-free solutions were administered [25,26]. During inpatient dialysis, erythropoiesis-stimulating agents (ESAs) were given daily to prevent anemia associated with renal function impairment [27]. Nafamostat mesilate was used as an anticoagulant during dialysis until postoperative day 7, serving as a replacement for heparin [19].

Pain management strategies excluded the use of nonsteroidal anti-inflammatory drugs (NSAIDs), instead favoring opioids and acetaminophen.

During hospitalization, daily intake limits of potassium, protein, salt, and liquid were carefully managed to ensure that patients did not experience malnutrition.

Statistical analysis

Statistical analyses were conducted using the SPSS software, version 22.0 (IBM Corp.). This study assessed postoperative changes in creatinine levels within the normal group, the kidney disease group, and the ESRD group, to identify statistically significant differences among these groups. Analysis of variance and the Bonferroni test were used for variables exhibiting significant differences. A p-value of less than 0.05 was considered indicative of statistical significance.

RESULTS

In accordance with the guidelines implemented by our department, facial reconstruction surgery was successfully performed on 10 cases with ESRD. None of the cases experienced postoperative complications, including flap or skin graft failure, hematoma formation, infection, delayed stitch out, or secondary healing. Furthermore, no instances were noted of critical events such as pulmonary embolism, stroke, sepsis, or mortality within 30 days following surgery. Renal function assessment indicated favorable outcomes, as the plasma creatinine level measured immediately after surgery averaged 1.10 mg/dL lower than the preoperative level (Table 2). Of the 289 cases, 246 had a GFR greater than 60 mL/min/1.73 m^2. In those cases, serum creatinine levels increased slightly from 0.76 mg/dL preoperatively to 0.79 mg/dL postoperatively. In 33 cases with a GFR less than 60 mL/min/1.73 m^2 who were not on dialysis, serum creatinine levels decreased slightly from 1.29 mg/dL to 1.26 mg/dL. Conversely, in 10 cases with ESRD, serum creatinine levels decreased from 6.27 mg/dL preoperatively to 4.95 mg/dL postoperatively. Statis-

Table 2. Demographics, surgical methods, and postoperative changes in serum creatinine levels in patients with end-stage renal disease requiring dialysis

Patient No.	Sex/age (yr)	Diagnosis	Operation	Serum creatinine change (mg/dL)[a]
1	Male/65	Basal cell carcinoma on nose	Paramedian forehead flap	–0.44
2	Male/47	Squamous cell carcinoma on lower lip	Webster modification of Bernard technique	–0.39
3	Male/65	Basal cell carcinoma on nose	Three local flaps	–1.37
4	Female/82	Squamous cell carcinoma on the upper lip	Split-thickness skin graft	–0.76
5	Female/78	Squamous cell carcinoma on cheek	Split-thickness skin graft	–3.79
6	Male/65	Basal cell carcinoma on cheek	Split-thickness skin graft	–2.43
7	Male/65	Basal cell carcinoma on nose	Flap division and insetting	–1.80
8	Male/69	Basal cell carcinoma on eyebrow region	Split-thickness skin graft	–0.82
9	Female/83	Squamous cell carcinoma on zygomatic arch	Split-thickness skin graft	–0.42
10	Female/84	Squamous cell carcinoma on temple	Split-thickness skin graft	–1.01

[a]Difference between postoperative and preoperative serum creatinine levels.

Table 3. Postoperative creatinine changes and statistical analysis by group

Statistical analysis	No. of patients	Pre-postoperative creatinine (mg/dL)	*p*-value
ANOVA			0.000[a]
ESRD (requiring dialysis)	10	–1.32	
KD (GFR < 60 mL/min/1.73 m^2)	33	–0.03	
Normal (GFR > 60 mL/min/1.73 m^2)	246	0.23	
Bonferroni			
ESRD: KD			0.000[a]
ESRD: Normal			0.000[a]
KD: Normal			0.641

ANOVA, analysis of variance; ESRD, end-stage renal disease; KD, kidney disease; GFR, glomerular filtration rate.
[a]Significant values ($p < 0.05$).

tical analysis confirmed the significance of these differences among the groups (Table 3).

DISCUSSION

In the ESRD group, no wound complications arose during the postoperative period. Patients with renal issues typically experience uremia and malnutrition, which can lead to delayed wound healing and an elevated risk of postoperative infection. Uremia impairs the formation of granulation tissue and cell-mediated immunity. Furthermore, the bleeding tendency commonly seen in patients with renal disease may lead to hematoma formation. Patients with renal failure also frequently have comorbid conditions, such as diabetes and peripheral vascular disease, that can compromise blood vessels and further complicate wound healing.

Furthermore, all cases in the present study exhibited no cardiopulmonary complications. Patients undergoing dialysis are prone to pulmonary edema and uncontrolled hypertension due to excessive fluid volume. Vascular abnormalities in patients on dialysis can lead to delayed responses to fluid changes, which may contribute to potentially fatal complications such as stroke. Therefore, vigilant monitoring of blood circulation, fluid volume, and arterial pressure is crucial throughout the preoperative, intraoperative, and postoperative periods. Appropriate dialysis scheduling was implemented to continually correct fluid volume, and adjustments to liquid intake and intravenous fluid volumes were made during hospitalization.

When comparing postoperative changes in creatinine levels among the normal, kidney disease, and ESRD groups, statistically significant differences were observed. In a pairwise comparison, statistically significant differences were found between the ESRD group and all other groups; particularly noteworthy was the difference observed between the kidney disease group and the others. The disparity between the kidney disease group and guidelines was notable, involving a hospitalization period of 3 to 4 days preoperatively, dialysis on the day before surgery, dialysis on the day following surgery, followed by the resumption of dialysis according to the regular schedule thereafter. It can be inferred that dialysis in the ESRD group led to a significant decrease in creatinine levels. In contrast, although there were differences in creatinine changes between the kidney disease and normal groups, they did not reach statistical significance.

Postoperative CBC, LRFT, and electrolyte assessments were conducted to facilitate timely intervention when necessary, in comparison to preoperative laboratory testing. A DIC panel was performed to evaluate the risk of pulmonary embolism, with treatment promptly initiated upon the detection of abnormalities. For patients in good general condition, routine hemodialysis was initiated on the day following surgery. Volume status and hemodynamic stability were carefully managed through

the recording and adjustment of input and output volumes. Close monitoring for the development of hyperkalemia was conducted during the hospital stay, with potassium-free solutions administered as required. For patients receiving dialysis while hospitalized, ESAs were administered daily to prevent anemia associated with renal dysfunction. Nafamostat mesilate served as the anticoagulant of choice during dialysis, supplanting heparin until the 7th postoperative day.

Pain management strategies excluded the use of NSAIDs, instead relying on opioid and acetaminophen prescriptions. Antibiotic usage was carefully adjusted based on renal function, considering the potential effects on immune function and wound healing in patients undergoing hemodialysis. During hospitalization, the daily intake limits of potassium, protein, salt, and fluids were carefully managed to prevent malnutrition.

Although our study demonstrated favorable outcomes in ESRD patients undergoing facial reconstruction surgery, several limitations warrant consideration. First, the study's retrospective design inherently introduces the risk of selection bias and incomplete data collection. Additionally, the relatively small sample size of ESRD patients undergoing surgery limits the generalizability of our findings to larger populations. Moreover, the study's single-center nature may restrict the applicability of our results to other healthcare settings with different patient demographics and surgical practices.

Furthermore, the short-term postoperative follow-up period of 30 days may not capture long-term complications or outcomes, particularly in patients with chronic conditions such as ESRD. Future studies with longer follow-up durations are necessary to evaluate the durability and sustainability of the observed outcomes.

Lastly, our study focused on the perioperative management of ESRD patients undergoing facial reconstruction surgery; however, additional research is needed to investigate the impact of specific surgical techniques, anesthesia protocols, and postoperative care strategies on patient outcomes. Multicenter studies with standardized protocols could provide more robust evidence to guide clinical practice and optimize outcomes for this challenging patient population.

In conclusion, patients with ESRD who require dialysis represent a challenging population for the reconstruction of soft tissue defects. In the present study, with appropriate perioperative management—including dialysis scheduling, meticulous monitoring, and the adjustment of various parameters—satisfactory surgical outcomes were achieved in 10 cases with skin cancer. These results underscore the importance of tailored guidelines for the comprehensive care of these complex cases, providing valuable insights for plastic surgeons and healthcare teams who treat individuals dependent on dialysis. Limitations of this study include its relatively small sample size and the necessity for larger, multicenter, and longer-term studies to obtain more generalized and comprehensive results. Nevertheless, the applied guidelines offer vital recommendations for improving patient safety during the perioperative period in plastic surgery for patients with ESRD.

NOTES

Conflict of interest

No potential conflict of interest relevant to this article was reported.

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Ethical approval

This study was approved by the Institutional Review Board of Pusan National University Hospital (IRB No. 2312-006-133) and performed in accordance with the principles of the Declaration of Helsinki.

Patient consent

No identifiable patient information or images were used in this article.

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