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ROLE OF TRACE ELEMENTS (ZN, CU, MG) IN THE POSTOPERATIVE HEALING PROCESS AFTER UROLOGICAL SURGERIES

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Abstract:
The healing process after urological surgeries is based on complex biological mechanisms and is closely dependent on the adequate supply of trace elements. In particular, zinc (Zn), copper (Cu), and magnesium (Mg) play a key role in regeneration by stimulating collagen synthesis, enhancing immune responses, and supporting the antioxidant defense system. This article analyzes the effects of these elements on postoperative wound healing, based on clinical and experimental studies. The findings suggest that monitoring trace element levels and using them as adjunctive therapy could improve recovery outcomes and reduce postoperative complications in urological practice.

Keywords: Urological surgery, healing process, trace elements, zinc, copper, magnesium, regeneration.

INTRODUCTION

Urological surgeries are among the most important directions of modern medicine, providing effective treatment for diseases of the urinary system. Currently, various open, laparoscopic, and laser-assisted surgical procedures are widely performed on the kidneys, bladder, prostate, and urinary tract. After such procedures, a wound healing (regeneration) process begins at the surgical site. This process is based on numerous cellular and biochemical mechanisms and is influenced by a variety of internal and external factors.

Effective healing determines not only the success of surgery but also faster patient recovery, fewer complications, and improved long-term prognosis. Therefore, a detailed study of the mechanisms of postoperative healing remains a relevant field in medical research.

PHASES OF WOUND HEALING

The wound healing process is typically divided into three main stages:

Inflammatory phase – occurs within the first 24–72 hours after surgery. Platelets and leukocytes are activated, cytokine release increases, and the risk of infection is reduced.

Proliferative phase – characterized by fibroblast activation, collagen production, and neovascularization. This phase lasts from one to four weeks.

Remodeling (maturation) phase– involves reorganization of collagen fibers and strengthening of tissue mechanical resistance.

The successful completion of these phases is directly influenced by the balance of trace elements in the body.

General Role of Trace Elements

Zinc (Zn), copper (Cu), and magnesium (Mg) act as cofactors of many enzymes, participating in metabolism and tissue regeneration:

- Zinc (Zn): Essential for DNA replication, cell division, and immune system activation. Zinc-dependent metalloenzymes are directly involved in wound healing.
- Copper (Cu):Plays a role in angiogenesis, collagen formation, and is part of antioxidant

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enzymes (superoxide dismutase). Copper deficiency may delay tissue repair.
- Magnesium (Mg): Regulates ATP-dependent energy metabolism, muscle and nerve function, and intercellular signaling during regeneration.

CLINICAL SIGNIFICANCE AFTER UROLOGICAL SURGERIES

Recent clinical observations show that trace element levels often change after urological surgeries. Several factors contribute to this:

- Intraoperative blood loss
- Fluid therapy-induced electrolyte shifts
- Increased metabolic demand caused by surgical stress
- Pre-existing comorbidities (e.g., diabetes, chronic kidney disease)

Deficiency of these elements may result in delayed wound healing, excessive scarring, and a higher risk of infectious complications.

RELEVANCE OF THE STUDY

Exploring the role of trace elements in the postoperative healing process after urological surgeries is a pressing issue. While many clinical and experimental studies worldwide have analyzed zinc, copper, and magnesium, their significance in urological surgery remains insufficiently studied, especially in local settings.

There is still a need to:

- Implement systematic monitoring of trace elements
- Develop protocols for early detection and correction of deficiencies
- Optimize dosage and duration of trace element supplementation in urological patients

This study aims to fill this gap by reviewing the literature, presenting clinical data, and offering practical recommendations.

MATERIALS AND METHODS

Study Design: Prospective observational study
Study Base: Department of Urology, Tashkent Medical Academy (2023–2024)
Sample Size: 60 patients
Groups:
Main group (n=30): Zinc, copper, and magnesium levels were regularly monitored postoperatively, and deficiencies were corrected with targeted mineral therapy.
Control group (n=30): Received standard postoperative management without additional mineral supplementation.
Inclusion Criteria:
Patients aged 40–70 years undergoing surgery for prostate adenoma or renal cyst.
Exclusion Criteria:
Severe cardiovascular failure, liver diseases, endocrine disorders.
Laboratory Analysis:
Serum Zn, Cu, Mg measured by atomic absorption spectrophotometry.
Clinical wound healing assessed by epithelialization time, scar formation, and inflammatory markers (CRP, IL-6).
Follow-up:
Day 14 and Day 30 post-surgery.
Statistical Analysis:
- Data processed with SPSS 26.0
- Student's t-test and χ^2 test used
- $p < 0.05$ considered statistically significant

Clinical Cases
Case 1 (Main group):
56-year-old male, prostate adenoma surgery. On postoperative day 5, Zn = 7.5 µmol/L (below normal). Oral zinc sulfate supplementation led to faster epithelialization by day 14 and decreased CRP levels.
Case 2 (Control group):
62-year-old male, renal cyst excision. On postoperative day 10, Mg = 0.57 mmol/L (low). No supplementation was given, resulting in muscle spasms and delayed wound healing (epithelialization completed by day 18).

Table 1. Trace Element Levels and Wound Healing Parameters

Parameters	Main Group (n=30)	Control Group (n=30)	p-value
Zn (µmol/L)	12.1 ± 1.8	8.3 ± 2.0	<0.01
Cu (µmol/L)	16.4 ± 2.1	13.7 ± 2.5	<0.05
Mg (mmol/L)	| 0.83 ± 0.09	0.61 ± 0.12	<0.01
CRP (mg/L)	8.2 ± 3.4	15.7 ± 4.2	<0.01
Epithelialization time (days)	11.2 ± 2.1	16.8 ± 2.9	<0.001
Complete scar formation (days)	25.6 ± 3.0	33.4 ± 3.8	<0.001

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Infectious complications (%)	10%	30%	<0.05

Table 2. Average Changes in Trace Element Levels.

Trace Element	Normal Range	| Pre-op	Post-op (Day 7) / Change (%)
Zinc (Zn)	12–16 µmol/L	12.1	10.2 (–15%)
Copper (Cu)	11–24 µmol/L	14.5	13.1 (–10%)
Magnesium (Mg)	0.70–1.05 mmol/L	0.85	0.72 (–15%)

DISCUSSION

Our findings confirm that postoperative serum levels of zinc, copper, and magnesium significantly decrease after urological surgeries. This is consistent with the literature reporting increased oxidative stress and inflammatory responses following surgical interventions, leading to greater utilization of antioxidant trace elements (Johnston et al., 2018; Schneider et al., 2020).

Magnesium depletion appears to be associated with metabolic stress and electrolyte imbalance, causing muscle spasms and delayed recovery (Ivanov et al., 2021). Correcting trace element deficiencies can accelerate collagen synthesis, promote angiogenesis, and reduce infectious complications.
The study highlights the need for perioperative monitoring and timely correction of trace elements as part of enhanced recovery after surgery (ERAS) protocols in urology.

PRACTICAL RECOMMENDATIONS

1.Preoperative screening: Measure Zn, Cu, and Mg levels before surgery to identify deficiencies early.
2.Postoperative monitoring: Reassess trace element levels within 3–5 days after surgery and correct as needed.
3.Supplementation: Administer parenteral trace elements in severe deficiency and oral supplements in mild cases.
4.Dietary optimization: Encourage zinc-, copper-, and magnesium-rich foods (nuts, legumes, grains, seafood) to support recovery.
5.High-risk patients: Pay special attention to elderly and patients with chronic kidney disease or metabolic syndrome.
6.National guidelines: Develop local clinical protocols for perioperative trace element management in Uzbekistan.

CONCLUSION

Trace elements — especially Zn, Cu, and Mg — play a crucial biological role in wound healing after urological surgeries. Deficiencies may impair fibroblast activity, collagen production, and angiogenesis, leading to delayed healing and higher risk of complications.
Routine monitoring and timely supplementation of trace elements can accelerate recovery, reduce infection risk, and improve postoperative outcomes. Incorporating this approach into clinical protocols is recommended to enhance patient care in urological surgery.

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