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Transurethral Resection of Prostate: A Continuing Battle of Irrigating Fluids

Original Research

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Abstract

Background: Transurethral resection (TUR) syndrome is a complication arising from the excessive absorption of irrigating fluid during endoscopic transurethral resection of the prostate (TURP), leading to central nervous system changes, and circulatory and electrolyte imbalances. This study compares the effects of using glycine 1.5%, glucose 5%, and normal saline 0.9% as irrigating solutions in TURP.

Objective: To determine the efficacy and safety of glycine 1.5%, glucose 5%, and normal saline 0.9% as irrigating solutions in reducing perioperative morbidity and TUR syndrome incidence in patients undergoing TURP.

Methods: In this prospective, randomized controlled trial, 360 patients with moderate to severe bladder outlet obstruction from benign prostatic hyperplasia were divided into three groups: glycine (120), glucose (120), and saline (120), using respective irrigating solutions. Parameters such as operation time, hospital stay, and perioperative complications were recorded.

Results: The glycine group exhibited a higher incidence of TUR syndrome, with three cases noted. No cases were observed in the saline group, while two occurred in the glucose group. Postoperative hyperglycemia was recorded in the glucose group (170 ± 35.9 mg/dl), along with hypokalemia (3.67 ± 0.92 mmol/l). A slight increase in serum sodium (142.6 ± 12.6 mmol/l) was observed in the saline group.

Conclusion: TURP using glucose 5% or saline 0.9% as irrigating solutions is associated with lower perioperative morbidity, reduced catheterization duration, shorter hospital stays, and an absence of cardiac toxicity compared to the use of glycine 1.5%.

Keywords: Benign prostatic hyperplasia, Glucose 5%, Glycine 1.5%, Normal saline 0.9%, Transurethral resection of the prostate, Transurethral resection syndrome, TURP.

INTRODUCTION

Endoscopic surgical procedures often necessitate the use of irrigating fluids to expand the operating field and remove debris and blood. One of the challenges in transurethral resection of the prostate (TURP), a common surgical method for treating benign prostatic hyperplasia, is the potential systemic absorption of these fluids, which can lead to significant complications, commonly referred to as TUR syndrome. Symptoms such as nausea, vomiting, confusion, and arterial hypotension are notably increased when large volumes of certain solutions, like glycine 1.5%, are absorbed. Severe cases may necessitate intensive care, and there have been reports of fatalities associated with the procedure (1-6).

The choice of irrigating fluid is critical but often influenced by tradition and the specific properties of the fluid, such as cost, transparency, and viscosity. Glycine, while transparent and inexpensive, is unphysiological due to its lack of electrolytes, potentially leading to adverse effects when absorbed in large quantities. Laboratory studies on animals have suggested both direct and indirect cardiotoxic effects of glycine (7, 8). Conversely, glucose solutions are physiological and generally well-tolerated when absorbed, making them a potentially safer alternative (9).

Given the varying properties and potential risks associated with different irrigating solutions, this study aims to rigorously compare the perioperative morbidity, operation time, and length of hospital stay among patients treated with glycine 1.5%, glucose 5%, and saline 0.9%. The objective is to determine which solution offers the best balance of safety, effectiveness, and cost-efficiency for patients undergoing TURP due to moderate to severe bladder outlet obstruction from benign prostatic hyperplasia. This comparison seeks not only to guide clinical practice but also to optimize patient outcomes and safety in a procedure where the choice of fluid can significantly impact the surgical and postoperative experience.

METHODS

In this randomized controlled trial, 360 patients scheduled for transurethral resection of the prostate (TURP) due to benign prostatic hyperplasia were enrolled and systematically assigned to three different study groups. Each group was differentiated by the type of irrigating fluid used: 1.5% glycine solution, 5% glucose solution, and 0.9% normal saline, with each group comprising 120 patients. The assignment of patients to their respective groups was managed through a computer-generated randomization sequence, ensuring the random nature of group allocation.

The surgical procedures were standardized across all groups. A 26 French continuous irrigating resectoscope was utilized, with the Saline group using a bipolar loop for the bipolar current, while the Glycine and Glucose groups employed a monopolar current setup. All procedures were carried out by surgeons of equal qualifications and experience to maintain consistency. The operating room nurse prepared the designated fluids and managed patient assignments, ensuring that the medical and nursing staff responsible for patient care and postoperative assessments were blinded to the group allocations.

Prior to the surgical intervention, each patient underwent a comprehensive evaluation, which included a detailed medical history and routine laboratory investigations—complete blood count, serum electrolytes, kidney function tests, and prostate-specific antigen levels, among others. Special attention was given to exclude patients with significant comorbidities such as cardiac disease, renal insufficiency, or coagulation disorders, as well as those who had received specific treatments like diuretics or blood transfusions within 10 hours prior to surgery.

During surgery, patients were monitored for vital parameters, including heart rate and mean arterial blood pressure. The management of intraoperative hypotension was standardized with the administration of ephedrine if needed. The volume of irrigation fluid used was meticulously recorded using gravimetric methods, and the height of the fluid reservoir was consistently maintained at 60 cm above the level of the patient's bed.

The primary outcome of interest, the incidence of TUR syndrome, was meticulously defined and monitored. TUR syndrome was identified based on a postoperative serum sodium level below 125 mmol/L along with symptoms like nausea, mental confusion, or visual

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

disturbances. Additional operative data, such as the duration of surgery, amount of prostatic tissue resected, and length of hospital stay, were also systematically recorded.

This study adhered strictly to the ethical standards of the Declaration of Helsinki and received approval from the local ethics committee. Informed consent was duly obtained from all participants, ensuring that they were aware of the study's nature and the potential risks involved. This methodological rigor not only enhances the validity of the study results but also reinforces the ethical commitment to patient safety and scientific integrity.

RESULTS

In this study, the patient demographics revealed a mean age ranging from 53 to 70 years in the glycine group, 55 to 71 years in the glucose group, and 50 to 67 years in the saline group. The mean ages were 60.7, 60.9, and 62 years, respectively, indicating a comparable baseline across the groups.

Table 1. Patient characteristics of studied groups.

Parameter	Glycine Group	Glucose Group	Saline Group
Age (years)	53-70 (60.7 ± 5.1)	55-71 (60.9 ± 4.9)	50-67 (62 ± 6.5)
Operation Time (min)	45-70 (57.1 ± 8.2)	40-75 (58.3 ± 10.8)	55-80 (62.5 ± 11.2)
Amount of Prostatic Tissue Resected (gm)	70-125 (89.16 ± 18.3)	75-120 (91.9 ± 16)	70-110 (82.5 ± 15.5)
Resections ≥120 gm	12 resections	Eight resections	0 resections
Indwelling Catheter Removal (days)	2-4 (2.4 ± 0.71)	1-2 (1.67 ± 0.45)	1-2 (1.54 ± 0.34)
Hospital Stay (days)	3-5 (3.31 ± 0.63)	2-3 (2.29 ± 0.46)	2-3 (2.19 ± 0.38)

Operative times varied slightly between groups, with the glycine group averaging 57.1 minutes, the glucose group 58.3 minutes, and the saline group the longest at 62.5 minutes. The amount of prostatic tissue resected also showed variations; the glycine group had an average of 89.16 grams, the glucose group 91.9 grams, and the saline group slightly less at 82.5 grams. Notably, only a few cases in the glycine (12 patients) and glucose (8 patients) groups involved resection of tissue weighing 120 grams or more.

Postoperative recovery metrics such as catheterization duration and hospital stay further highlighted differences. The catheter was removed on average within 2.4 days in the glycine group, 1.67 days in the glucose group, and 1.54 days in the saline group. Correspondingly, the average hospital stay was longest for the glycine group at 3.31 days, followed by 2.29 days for the glucose group, and 2.19 days for the saline group.

Regarding hemodynamic stability, there was no significant preoperative difference in heart rates or mean arterial blood pressures across the groups. Following anesthesia induction, all groups experienced a notable decrease in mean arterial blood pressure and heart rate, although these changes did not persist intraoperatively or postoperatively, indicating effective management of hemodynamic responses during surgery.

Table 2. Hemodynamic changes in the studied groups.

Parameter	Time Point	Glycine Group	Glucose Group	Saline Group	p-value
	Preoperative	72.5 ± 10.3	73.2 ± 9.8	71.9 ± 10.1	$p > 0.05$
	10 minutes after induction	57.5 ± 12.6	56.4 ± 13.5	54.6 ± 11.9	$p < 0.05$
	Intra-operative	59.2 ± 11.4	58.3 ± 12.1	57.6 ± 11.7	$p > 0.05$
	Immediate Postoperative	61.3 ± 10.8	60.5 ± 11.2	59.7 ± 10.9	$p > 0.05$
Mean Arterial Blood Pressure (MABP) (mmHg)	Preoperative	82.4 ± 15.2	81.7 ± 14.8	83.1 ± 15.5	$p > 0.05$
	10 minutes after induction	71.6 ± 19.6	73.4 ± 18.5	72.5 ± 18.8	$p < 0.05$
	Throughout the Intra-operative	73.8 ± 17.9	74.1 ± 18.3	73.6 ± 18.1	$p > 0.05$
	Immediate Postoperative	75.2 ± 16.7	74.9 ± 17.2	74.5 ± 16.9	$p > 0.05$

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Laboratory values, including hemoglobin, serum sodium, potassium, and glucose levels, were initially similar across groups. However, postoperatively, the glycine and glucose groups exhibited a minor decrease in serum sodium levels, which was not observed in the saline group. The glucose group specifically showed a significant temporary increase in blood sugar levels immediately post-surgery, which normalized within six hours.

Complications were minimal but present; two patients each in the glycine and glucose groups required blood transfusions due to significant drops in hemoglobin levels. Additionally, TUR syndrome was observed in two patients in the glycine group and one in the glucose group. Notably, six patients in the glycine group developed ischemic ECG changes, and three of these showed elevated troponin I levels, necessitating extended postoperative monitoring in the care unit.

Table 3. Chemical and hematological values of studied groups in the immediate postoperative period

Parameter	Group	Preoperative Value	Postoperative Value	p-value
Haemoglobin **(g/dL)**	Glycine Group	13.8 ± 1.2	13.6 ± 1.3	p > 0.05
	Glucose Group	14.0 ± 1.3	13.8 ± 1.4	p > 0.05
	Saline Group	13.7 ± 1.1	13.6 ± 1.2	p > 0.05
Serum Sodium (mmol/L)	Glycine Group	140.5 ± 4.1	137.8 ± 3.8	p > 0.05
	Glucose Group	141.2 ± 3.9	138.2 ± 4.0	p > 0.05
	Saline Group	140.8 ± 4.0	142.6 ± 12.6	p > 0.05
Serum Potassium (mmol/L)	Glycine Group	4.1 ± 0.5	3.9 ± 0.6	p > 0.05
	Glucose Group	4.2 ± 0.6	3.67 ± 0.92	p > 0.05
	Saline Group	4.0 ± 0.5	3.8 ± 0.5	p > 0.05
Random Blood Sugar (mg/dL)	Glycine Group	98.5 ± 10.3	102.5 ± 15.1	p > 0.05
	Glucose Group	97.2 ± 11.1	170.2 ± 35.9	p < 0.05
	Saline Group	99.0 ± 10.7	100.2 ± 12.4	p > 0.05

These findings, summarized in several tables for clarity, provide a comprehensive overview of the clinical outcomes associated with the type of irrigating fluid used during TURP, highlighting both the efficacy and safety profiles of each fluid in the surgical management of benign prostatic hyperplasia.

Table 4. Perioperative complications in the studied groups.

Parameter	Glycine Group	Glucose Group	Saline Group
Number of Patients Needing Blood Transfusion	2	2	0
Decrease in Hemoglobin to <9 g/dL	2	2	0
TUR Syndrome	2	1	0
Ischemic ECG Changes	6	0	0
Elevated Troponin I	3	0	0
Patients Admitted to Post-Anesthesia Care Unit (PACU)	3 (due to elevated Troponin I)	0	0

Abbreviations: TURP: Transurethral resection of the prostate; TUR Syndrome: Transurethral resection syndrome; HR: Heart rate; BPH: Benign prostatic hyperplasia; PSA: Prostatic specific antigen; C Tn I: Calcium troponin I; ECG: Electrocardiogram; MABP: Mean arterial blood pressure.

DISCUSSION

In this randomized, masked trial, patients with prostatic hyperplasia undergoing endoscopic resection of the prostate were assigned to three groups, each using different types of irrigating fluids. The findings revealed a similar incidence of TUR syndrome in the glycine and glucose groups, whereas none of the patients in the saline group developed this complication. Notably, TUR syndrome in the glycine group was associated with ischemic ECG changes and elevated troponin I levels, underscoring potential cardiovascular risks linked to glycine use.

The use of irrigating fluids is essential in endoscopic surgical procedures to enhance visibility and manage surgical debris. However, the systemic absorption of these fluids can lead to severe complications, including TUR syndrome, characterized by dilutional hyponatraemia and subsequent brain edema. Glycine, commonly used in TURP, has been implicated in various adverse effects, including

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

cardiovascular and cerebral risks due to its pharmacological properties and low osmolality (10, 11). Clinical observations and experimental studies have consistently shown that glycine absorption can lead to significant echocardiogram changes and elevated troponin I levels, indicating cardiotoxic effects (12, 13). Furthermore, high levels of glycine may cause cerebral edema, visual disturbances, and even transient blindness (14-16).

The study also explored the metabolic implications of glycine, with hyperammonaemic encephalopathy and episodes of ketosis and metabolic acidosis being notable complications due to its metabolism (17-19). In contrast, normal saline and glucose 5%, used with bipolar diathermy, emerged as safer alternatives due to their more favorable physiological profiles. Normal saline, ideal for its non-conductive properties with bipolar systems, avoids the risk of hyponatraemia, though it can lead to hyperchloremic metabolic acidosis if infused rapidly (20). Glucose 5% is metabolized systemically and is less likely to cause significant fluid overload or electrolyte imbalances, requiring substantial volumes to significantly expand the intravascular compartment (20, 21).

This study supports the growing body of literature advocating for the use of bipolar saline and glucose solutions as safer alternatives for TURP. Uddin MH et al. and Yassein et al. have highlighted the safety of bipolar saline in reducing the risk of TUR syndrome, particularly in patients with larger prostates or those at higher risk (21, 22). Similarly, Collins et al. reported that while glycine usage was linked to postoperative hyperglycemia and potential toxicity, the alternative use of glucose did not result in detrimental ECG changes or troponin elevations, indicating a safer profile for cardiovascular stability during TURP (23).

Despite these findings, the study has limitations. The blinding of medical staff may not completely eliminate bias in postoperative care and assessment. Additionally, the external validity of the results might be constrained by the specific surgical techniques and patient demographics involved.

Overall, the evidence suggests a compelling case for the careful selection of irrigating fluids in TURP, considering both the efficacy in surgical management and the minimization of postoperative complications. Future research should focus on further validating these results in broader patient populations and refining surgical techniques to enhance patient safety and outcomes.

CONCLUSION

Endoscopic transurethral resection of the prostate using bipolar normal saline or monopolar glucose 5% as irrigating solutions demonstrated lower perioperative morbidity, shorter catheterization periods, and reduced hospital stays compared to monopolar glycine 1.5%, with the primary complication being transient hyperglycemia in the glucose group.

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