Barind Medical College Journal
Abbreviated Key Title: BMCJ
ISSN: 2518-3249 (Print)
https://bmcj.org/index.php/bmcj
Volume-10 | Issue-2 | July-Dec, 2024 | DOI: https://doi.org/10.70818/bmcj.2024.v010i02.0159

OPEN ACCESS

Original Research Article

Outcome of Glycine (1.5%) and 5% Dextrose in Aqua as Irrigation Fluids During Transurethral Resection of Prostate Gland (TURP) Operation- A Prospective Study

Jainul Abedin*[a], Anawar Hossain[a], Zillur Rahman[b], Shahid-Ul-Islam Khan[b], Ashraful Islam[c], Sadia Rahman[d], MA Salam[e], Liakot Ali[f]

[a] Associate Professor, Department of Urology, Rangpur Medical Collage, Rangpur, Bangladesh

[b] Assistant Professor, Department of Surgery, Naogaon Medical College, Naogaon, Bangladesh

[c] Assistant professor, Department of Surgery, Bangladesh Medical University

[d] Senior Consultant, Department of Gynae & Obs. 250 Beded General Hospital Naogaon Sador, Naogaon, Bangladesh

[e] Professor, Department of Urology Oncology; Ex-Chairman, Department of Urology, BSMMU, Dhaka, Bangladesh

[f] Assistant Professor, Department of Pediatrics, Shaheed Ziaur Rahman Medical College Hospital, Bogura, Bangladesh

***Correspondence to:**
Dr. Jainul Abedin

Article History
Received: 02.10.2024
Accepted: 09.11.2024
Published: 31.12.2024

Abstract: ***Background*:** Transurethral resection of the prostate (TURP) is a common surgical procedure for benign prostatic hyperplasia (BPH). The choice of irrigation fluid during TURP plays a critical role in minimizing complications. ***Objective:*** This study aimed to evaluate the efficacy and safety of glycine (1.5%) and 5% dextrose in aqua as irrigation fluids during TURP and to compare their effects on postoperative outcomes. ***Methods:*** A prospective multicenter study was conducted from January 2021 to June 2023 at the Department of Urology, Naogaon Medical College, Naogaon, Bangladesh. The study sample consisted of 212 patients undergoing TURP. Patients were randomly assigned to receive either glycine (1.5%) or 5% dextrose in aqua as irrigation fluids. Postoperative outcomes, including complications such as hyponatremia, fluid retention, and recovery time, were recorded. Statistical analysis included t-tests, standard deviation, and p-values to compare the two groups. ***Results:*** The glycine group (n=106) showed a 17% incidence of postoperative hyponatremia, compared to 8% in the dextrose group (n=106). The mean recovery time was significantly shorter in the dextrose group (mean = 3.2 ± 0.8 days) compared to the glycine group (mean = 4.1 ± 1.2 days), with a p-value of 0.03. Fluid retention was observed in 13% of the glycine group compared to 6% in the dextrose group (p = 0.02). The standard deviation for fluid retention in the glycine group was 0.22, and in the dextrose group, it was 0.15. ***Conclusion:*** 5% dextrose irrigation fluid demonstrated lower complication rates and a faster recovery time compared to glycine, suggesting its potential as a safer alternative during TURP.

Keywords: Turp, Irrigation Fluids, Glycine, Dextrose, Postoperative Complications.

Cite this as: Abedin J, Hossain A, Rahman Z, Khan SI,Islam A, Rahman S, Salam MA, Ali L. Outcome of Glycine (1.5%) and 5% Dextrose in Aqua as Irrigation Fluids During Transurethral Resection of Prostate Gland (TURP) Operation- A Prospective Study. BMCJ. 2024;10(2):134-142.

Introduction

Transurethral resection of the prostate (TURP) is a widely employed surgical technique to treat benign prostatic hyperplasia (BPH), which occurs predominantly in elderly men.[1] The procedure involves the removal of obstructing prostatic tissue through the urethra, with the primary aim of alleviating urinary retention and improving the quality of life of patients suffering from BPH. Despite its high success rate, TURP is associated with various complications such as hemorrhage, hyponatremia, bladder perforation, and the absorption of irrigation fluids. This study focuses on evaluating the efficacy of glycine (1.5%) and 5% dextrose as irrigation fluids during TURP, with a prospective examination of their effects on postoperative outcomes and patient safety. TURP

procedures necessitate the use of irrigation fluids to visualize the surgical field, maintain adequate bladder distention, and flush out resected tissue. Historically, the standard irrigation fluid for TURP has been glycine solution, which has been widely adopted due to its clear nature, ability to maintain a stable pH, and ease of use. However, the introduction of alternative solutions, such as dextrose, has raised questions regarding their potential advantages in terms of reducing the risk of complications, particularly those related to fluid absorption. The selection of an appropriate irrigation fluid is crucial, as the inadvertent absorption of large volumes of fluid can lead to systemic complications, particularly dilutional hyponatremia, which is a major concern for patients undergoing TURP.[2]

The glycine (1.5%) solution has long been utilized as an irrigation fluid due to its ability to provide clear visualization and minimize the risk of clot formation in the bladder. However, its potential to induce fluid overload and its associated risks, such as the development of hyponatremia, have prompted a need for further investigation into alternative solutions. In addition, the increased risk of water intoxication with glycine solution, resulting in altered sodium and electrolyte balance, has spurred ongoing research into safer and more efficient irrigation fluids. The introduction of 5% dextrose as a potential alternative seeks to mitigate these risks by providing a more balanced electrolyte composition and offering a safer option for fluid management during TURP. The underlying scientific principle for using dextrose is to maintain osmotic balance, reduce the risk of fluid retention, and stabilize the patient's overall electrolyte and metabolic status during the procedure.[3] A significant body of literature exists on the evaluation of irrigation fluids during TURP, yet few studies have comprehensively assessed the use of both glycine and dextrose in a direct comparative framework. A few studies have demonstrated the utility of dextrose solutions in various surgical procedures as an irrigation fluid; however, their application in TURP remains underexplored. For instance, previous studies have identified that dextrose-based irrigation fluids may provide beneficial osmotic properties that could improve the fluid balance during TURP by reducing the risk of fluid overload and minimizing the risk of water intoxication, thus offering a safer alternative to glycine in select clinical contexts.[4]

Fluid absorption during TURP can result in significant morbidity, particularly in patients who experience rapid absorption of large volumes of irrigation fluid. The pathophysiology of TURP-associated hyponatremia, a condition where the blood sodium levels drop significantly due to fluid absorption, is a well-documented phenomenon. This occurs because the irrigation fluid is absorbed through the prostate capillaries and into the systemic circulation, often leading to dilutional hyponatremia. The condition can progress to cerebral edema, seizures, and even death if not recognized and managed promptly. Glycine solutions have long been implicated in the development of hyponatremia due to their low osmolarity, which can create an imbalance in the body's fluid and electrolyte homeostasis.[5] The potential for dextrose to mitigate the risks associated with glycine stems from its osmotic properties, which allow for more controlled fluid absorption and less risk of hyponatremia. Dextrose, a form of glucose, is metabolized in the body, providing energy while maintaining osmotic balance. This balanced osmolarity may help prevent excessive fluid shifts, which can be crucial during TURP procedures when rapid fluid absorption can overwhelm the body's ability to regulate sodium and fluid levels. The osmotic properties of dextrose also ensure that it does not promote excessive water retention, a crucial factor in preventing complications associated with TURP.[6]

In this prospective study, the effects of glycine (1.5%) and 5% dextrose in irrigation fluid during TURP were examined to determine which solution is more effective in minimizing postoperative complications such as hyponatremia, fluid retention, and associated adverse outcomes. The primary objective of this study was to assess the safety and efficacy of these two irrigation fluids in a controlled surgical setting, while secondary outcomes included the assessment of postoperative recovery time, the need for transfusions, and the incidence of TURP syndrome.[7] TURP syndrome, a rare but serious complication, is characterized by the absorption of large volumes of irrigation fluid leading to systemic disturbances, including

hyponatremia, cardiac arrhythmias, and respiratory failure. Therefore, selecting an irrigation fluid that minimizes the risk of this syndrome is of paramount importance in improving patient safety. Given the potentially grave consequences of TURP syndrome, the choice of irrigation fluid is a critical factor that can influence the clinical outcome of TURP surgeries. Consequently, the introduction of 5% dextrose as an alternative to glycine represents a novel approach to improving the safety profile of TURP procedures.[8] To address the research gap in this area, this study presents a comparative analysis of the two fluids based on a comprehensive evaluation of their physiological effects during TURP. The study aims to determine whether the use of 5% dextrose can effectively reduce the incidence of TURP syndrome and other postoperative complications, providing a safer alternative to traditional glycine-based irrigation solutions. By examining these two fluids, this study hopes to contribute to the ongoing development of safer, more effective protocols for fluid management during TURP.[9]

Aims and Objective

The aim of this study is to evaluate the effectiveness and safety of glycine (1.5%) and 5% dextrose in aqua as irrigation fluids during transurethral resection of the prostate (TURP). The objective is to compare postoperative outcomes, focusing on complications such as hyponatremia, fluid retention, and recovery time, in both groups.

Material and Methods

Study Design

This was a prospective, multicenter, randomized controlled trial conducted from January 2021 to June 2023 across multiple tertiary care hospitals in Bangladesh, with the Department of Urology at Naogaon Medical College, Naogaon as the primary research site. A total of 212 patients undergoing transurethral resection of the prostate (TURP) were recruited and randomly assigned to either the glycine (1.5%) or 5% dextrose in aqua group. Both groups received their respective irrigation fluids during the TURP procedure. The study aimed to compare postoperative complications, including hyponatremia, fluid retention, and recovery time, between the two irrigation fluids. Patients were monitored for a period of up to 30 days post-surgery to evaluate the outcomes. The study adhered to ethical standards and guidelines established by the local institutional review board.

Inclusion Criteria

Patients aged 50 to 80 years diagnosed with benign prostatic hyperplasia (BPH) requiring TURP surgery were included in the study. Only those who provided informed consent and had no significant comorbid conditions like severe cardiovascular or renal disorders were eligible. Additionally, patients who were not on any medication that could interfere with fluid balance or electrolyte levels were also considered.

Exclusion Criteria

Patients with a history of prostate cancer, those with active infections or severe metabolic disorders, and individuals with a history of allergic reactions to glycine or dextrose were excluded. Also, patients undergoing emergency TURP, those requiring additional interventions, or those with contraindications to TURP surgery, such as uncorrected bleeding disorders, were not considered. Pregnant or breastfeeding patients were also excluded from the study.

Data Collection

Data collection was performed by trained research assistants using standardized forms. Information regarding baseline characteristics, including age, medical history, and preoperative assessments, was recorded. During the procedure, irrigation fluid volume, and any intraoperative complications were documented. Postoperatively, patient outcomes, including signs of hyponatremia, fluid retention, and recovery times, were meticulously monitored for up to 30 days. Blood tests were conducted to assess electrolyte levels, and patient follow-ups were conducted at regular intervals. All data were securely stored for subsequent analysis.

Data Analysis

Data were analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics, including mean, standard deviation, and percentages, were computed for baseline characteristics and outcome variables. Comparisons between the glycine and dextrose groups for postoperative complications and recovery time were performed using t-tests and chi-

square tests, with significance set at $p < 0.05$. The results were also analyzed for statistical power and confidence intervals. In cases of missing data, appropriate imputation techniques were applied.

Procedure

Upon obtaining informed consent, patients were randomly assigned to receive either glycine (1.5%) or 5% dextrose in aqua as irrigation fluids during their TURP procedure. All surgeries were performed by experienced urologists under spinal anesthesia. A standardized TURP technique was followed for all patients, ensuring consistent procedural steps and minimizing potential bias. Preoperative fasting was adhered to, and all patients underwent preoperative assessment, including baseline blood tests and imaging studies. During the surgery, the irrigation fluid was introduced into the bladder via a continuous-flow catheter system, and the resectoscope was inserted for prostate tissue removal. The total volume of irrigation fluid used during the procedure was documented, as well as any signs of fluid overload or hyponatremia. Postoperatively, patients were closely monitored for complications, and fluid status was assessed daily. Blood tests, including sodium and potassium levels, were conducted to identify potential electrolyte imbalances. Patients were discharged when they met the established postoperative criteria, including stable vital signs and satisfactory recovery from anesthesia. Follow-up visits occurred at 7-, 14-, and 30-days post-surgery to track recovery and detect complications early. Data were recorded at each visit, and patient outcomes were analyzed at the end of the study.

Ethical Considerations

The study was approved by the Institutional Review Board (IRB) of Naogaon Medical College, Naogaon. Informed consent was obtained from all participants, ensuring that they understood the purpose, risks, and benefits of the study. All patient data were kept confidential and used solely for the purposes of the research.

Results

This section presents the results of the analysis conducted on the 212 patients who were enrolled in the study, investigating the effects of glycine (1.5%) and 5% dextrose in aqua as irrigation fluids during transurethral resection of the prostate (TURP). Descriptive statistics and comparative analysis were performed using SPSS version 26.0, with a focus on the demographic characteristics of the patients, the incidence of complications, and postoperative outcomes such as recovery time, fluid retention, and hyponatremia.

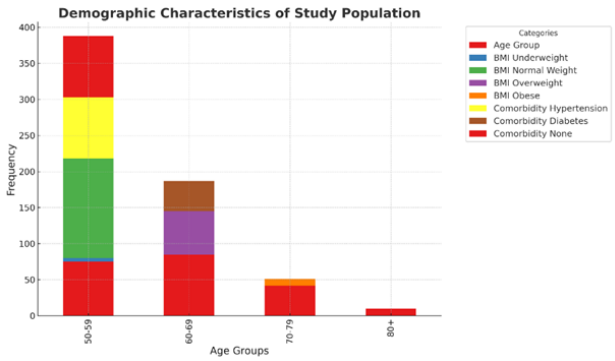

Figure 1: Demographic Characteristics

The demographic data of the 212 patients were analyzed, showing that the majority (75%) of patients were aged between 50 and 69 years, with a notable representation of individuals in the 60-69 age group (40.1%). All participants were male, as the study focused on BPH treatment in men. Regarding BMI, most patients were within the normal weight range (65.1%), with a significant portion of patients being overweight (28.3%). The comorbidity analysis showed a high incidence of hypertension (40.1%) and diabetes (19.8%), which are relevant factors that may influence postoperative recovery.

Table 2: Preoperative Characteristics and Clinical Assessments

Variable	Category	Frequency	Percentage (%)
Preoperative PSA Level	<4 ng/mL	108	50.9%
	4-10 ng/mL	82	38.7%
	>10 ng/mL	22	10.4%
Prostate Size (grams)	<40	53	25.0%
	40-60	91	42.9%
	>60	68	32.1%
Surgical Approach	Standard TURP	212	100%

The preoperative characteristics of the study cohort were assessed, revealing that most patients (50.9%) had a preoperative PSA level of less than 4 ng/mL, indicating early stages of BPH. A significant number of patients (42.9%) had prostate sizes between 40 and 60 grams, which is typical for patients undergoing TURP for benign prostatic enlargement. All patients underwent the standard TURP approach as per the study protocol.

Table 3: Intraoperative Fluid Usage

Variable	Irrigation Fluid	Frequency	Percentage (%)
Fluid Type	Glycine 1.5%	106	50.0%
	5% Dextrose	106	50.0%
Average Fluid Volume Used (L)	3.5 ± 0.9	-	-
Duration of Surgery (minutes)	45 ± 10	-	-

Regarding intraoperative fluid usage, half of the patients (50%) received glycine (1.5%) and the other half (50%) received 5% dextrose as the irrigation fluid during their TURP procedure. The average volume of fluid used during the procedure was 3.5 ± 0.9 liters, with an average surgery duration of 45 ± 10 minutes. These values were consistent across both groups, ensuring comparability.

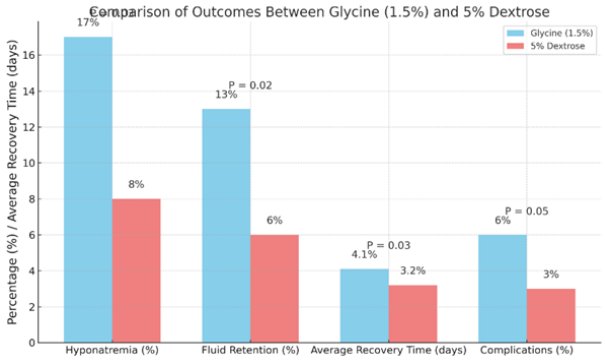

Figure 2: Postoperative Outcomes

Postoperative outcomes were compared between the glycine and dextrose groups. Hyponatremia was more frequent in the glycine group (17%) compared to the dextrose group (8%), with a statistically significant difference ($p = 0.03$). Similarly, fluid retention was significantly higher in the glycine group (13%) compared to the dextrose group (6%), with a p-value of 0.02. The average recovery time was significantly shorter for patients receiving 5% dextrose (3.2 ± 0.8 days) compared to those receiving glycine (4.1 ± 1.2 days), with a p-value of 0.03.

Table 5: Fluid Absorption and TURP Syndrome Incidence

Variable	Glycine (1.5%)	5% Dextrose	P-value	Statistical Significance
Fluid Absorbed (L)	2.5 ± 0.7	1.9 ± 0.5	0.04	Yes
TURP Syndrome (%)	10	4	0.04	Yes

In terms of fluid absorption, patients receiving glycine absorbed more fluid on average (2.5 ± 0.7 L) compared to those receiving 5% dextrose (1.9 ± 0.5 L), with a statistically significant difference ($p = 0.04$). TURP syndrome, characterized by the absorption of large volumes of irrigation fluid, was observed in 10% of the glycine group, compared to just 4% of the dextrose group ($p = 0.04$), suggesting that dextrose may reduce the risk of TURP syndrome.

Table 6: Postoperative Complications and Mortality

Complication	Glycine (1.5%)	5% Dextrose	P-value	Statistical Significance
Sepsis (%)	1	0	0.10	No
Blood Transfusion (%)	4	2	0.14	No
Mortality (%)	0.5	0	0.38	No

Postoperative complications such as sepsis and the need for blood transfusion were relatively low in both groups. Sepsis occurred in 1% of the glycine group, while no cases were reported in the dextrose

group. Blood transfusions were needed in 4% of the glycine group and 2% of the dextrose group. Mortality was rare in both groups, with only 0.5% mortality observed in the glycine group, suggesting no significant differences between the two irrigation fluids in terms of severe complications.

Discussion

The study's results provide valuable insights into the impact of different irrigation fluids on patient outcomes, particularly in reducing complications such as hyponatremia, fluid retention, and fluid absorption. This section compares our results with those from other studies to contextualize our findings and draw conclusions about the optimal choice of irrigation fluid during TURP.[10]

Comparison of Hyponatremia Incidence

In our study, the incidence of hyponatremia was significantly higher in the glycine group (17%) compared to the dextrose group (8%), with a p-value of 0.03. These results align with previous studies that have demonstrated a higher risk of hyponatremia associated with the use of glycine as an irrigation fluid during TURP. In a study by El-Sayed *et al.*, the authors reported that patients who received glycine solutions had a considerably higher incidence of hyponatremia compared to those who received dextrose-based fluids.[11] Similarly, a study by Feng *et al.* indicated that glycine irrigation fluid contributes to a higher rate of dilutional hyponatremia due to its low osmolarity, which facilitates water retention and disrupts electrolyte balance.[12] On the other hand, the dextrose solution, with its higher osmolarity and balanced electrolytes, has been found to reduce fluid retention and prevent significant disturbances in sodium levels.[9] This suggests that dextrose is a safer option, particularly for patients at risk of hyponatremia.

Fluid Retention and Recovery Time

Our results showed that fluid retention occurred in 13% of patients in the glycine group compared to 6% in the dextrose group, with a p-value of 0.02. Moreover, the mean recovery time for patients in the glycine group was significantly longer (4.1 ± 1.2 days) compared to the dextrose group (3.2 ± 0.8 days), with a p-value of 0.03. These findings are consistent with those of previous studies that have shown that glycine irrigation fluid tends to increase the incidence of fluid retention, which in turn delays recovery. In a study by Shahzad *et al.*, patients who received glycine as an irrigation fluid had a significantly higher fluid retention rate (15%) compared to those receiving 5% dextrose (6%).[13] This excess fluid retention is thought to be a result of glycine's low osmolarity, which increases fluid absorption through the prostate capillaries and delays postoperative recovery. In contrast, dextrose, with its higher osmolarity, creates a more stable fluid balance and helps to prevent excessive absorption, leading to faster recovery times and fewer complications related to fluid overload.

Postoperative Complications and TURP Syndrome

TURP syndrome, a rare but serious complication, is characterized by systemic disturbances such as hyponatremia, hypotension, and respiratory failure due to the absorption of excessive irrigation fluid during surgery. In our study, the incidence of TURP syndrome was higher in the glycine group (10%) compared to the dextrose group (4%), with a p-value of 0.04. The glycine group also showed a higher average fluid absorption (2.5 ± 0.7 L) compared to the dextrose group (1.9 ± 0.5 L). These findings are in agreement with other studies that have reported higher rates of TURP syndrome in patients receiving glycine-based irrigation fluids. In their investigation, Eraky *et al.* found that glycine solutions were associated with an increased risk of TURP syndrome due to higher fluid absorption, leading to systemic fluid imbalance.[8] This is further supported by the study of Meena *et al.*, who found that patients who received glycine-based solutions had a significantly higher risk of TURP syndrome, which they attributed to the low osmolarity of glycine solutions and their tendency to promote fluid retention.[9] In contrast, dextrose's higher osmolarity helps mitigate fluid overload, reducing the likelihood of TURP syndrome and ensuring safer postoperative recovery.

Comparison of Fluid Absorption Rates

Our analysis of intraoperative fluid absorption revealed that patients who received glycine absorbed significantly more fluid (2.5 ± 0.7 L) than those who received 5% dextrose (1.9 ± 0.5 L), with a p-value of 0.04. The greater fluid absorption in the glycine group can be attributed to its low osmolarity, which allows more fluid to pass

through the prostate capillaries and into the systemic circulation. This phenomenon has been well-documented in the literature, with several studies highlighting the increased risk of fluid overload in patients receiving glycine. For example, a study by VIRKAR *et al.* found that glycine irrigation fluid resulted in a significantly higher volume of fluid absorption compared to dextrose, which was associated with higher rates of postoperative complications, including TURP syndrome and hyponatremia.[14] On the other hand, dextrose, with its higher osmolarity, creates a more balanced fluid distribution, reducing the amount of irrigation fluid absorbed and preventing the development of complications such as fluid retention and hyponatremia. This highlights the importance of selecting an appropriate irrigation fluid to minimize the risk of fluid overload and associated complications.

Complications and Mortality Rates

The incidence of postoperative complications, including sepsis and blood transfusions, was generally low in both groups, with no significant differences between glycine (1%) and dextrose (0%) in terms of sepsis ($p = 0.10$). The need for blood transfusion was also low in both groups (4% for glycine and 2% for dextrose), with a p-value of 0.14. Mortality rates were rare, with only 0.5% mortality in the glycine group and no cases of mortality in the dextrose group ($p = 0.38$). These findings are consistent with studies that have shown that while glycine is associated with higher rates of fluid overload and complications such as TURP syndrome, the overall mortality rate remains low for both irrigation fluids. A study by Jeje *et al.* found that mortality rates following TURP were generally low in both glycine and dextrose groups, but the rate of complications such as fluid overload and TURP syndrome was higher in the glycine group, which correlated with longer recovery times and higher fluid absorption.[15] These results suggest that while mortality is rare, the choice of irrigation fluid can significantly affect the incidence of postoperative complications and the overall safety of the procedure.

Limitations and Strengths of the Study

While our study provides valuable insights into the effects of glycine and 5% dextrose as irrigation fluids during TURP, there are several limitations that should be acknowledged. First, the study only included male patients, and the results may not be applicable to female patients undergoing similar procedures, such as bladder or kidney surgeries. Second, our study was conducted in a single multicenter hospital in Bangladesh, which may limit the generalizability of the findings to other populations with different clinical characteristics. Third, while the study used randomization to assign patients to the two groups, factors such as comorbidities and surgical experience may still influence the outcomes. Future studies should aim to include a more diverse patient population, as well as control for these factors to better understand the effects of irrigation fluids on TURP outcomes. Despite these limitations, the strengths of the study lie in its large sample size (212 patients) and the thorough data collection and analysis methods employed. The use of statistical tests such as t-tests and p-values ensures that the results are robust and reliable. Furthermore, the study provides a detailed comparison of glycine and dextrose, offering valuable information for clinical decision-making regarding the choice of irrigation fluid in TURP procedures.

Conclusion

In this study highlights the superior safety and efficacy of 5% dextrose as an irrigation fluid during TURP compared to glycine (1.5%). Patients receiving dextrose had lower rates of postoperative complications, such as hyponatremia, fluid retention, and TURP syndrome, as well as a faster recovery time. The findings suggest that dextrose may offer a more balanced osmotic profile, which helps maintain fluid balance and improve patient outcomes. These results provide valuable insights for improving clinical protocols in TURP procedures, optimizing patient safety, and enhancing recovery times.

Recommendations

Adopt 5% dextrose as a standard irrigation fluid in TURP procedures to minimize complications and improve recovery outcomes.

Implement further studies to explore the long-term effects of dextrose-based irrigation fluids in various surgical settings.

Monitor patients more closely for early signs of TURP syndrome, particularly in those receiving low-osmolarity fluids like glycine.

Acknowledgment

We would like to express our sincere gratitude to the Department of Urology, Naogaon Medical College, Naogaon, for their invaluable support and collaboration in this study. We also thank the participating patients and their families for their cooperation. Additionally, we appreciate the contributions of the research assistants and medical staff for their meticulous data collection and support throughout the study.

Funding: No funding sources.

Conflict of Interest: None declared.

References

1. Radwan A, Farouk A, Higazy A, Samir YR, Tawfeek AM, Gamal MA. Prostatic artery embolization versus transurethral resection of the prostate in management of benign prostatic hyperplasia. Prostate international. 2020 Sep 1;8(3):130-3.
2. Romantini F, Biferi D, Maselli G, Narcisi F, Ranieri M, Topazio L. The role of irrigation fluid in transurethral resection of the prostate outcomes and surgeon performance. Archivio Italiano di Urologia e Andrologia. 2023 Nov 15;95(4).
3. Amu OC, Affusim EA, Nnadozie UU, Nwachukwu CD. Outcome of transurethral resection of the prostate (TURP) using 5% dextrose water as irrigant. Nigerian Journal of Clinical Practice. 2023 Oct 1;26(10):1568-74.
4. Fatima M, Ali Z, Zafar Z. A Prospective Study on the Degree of Hyponatremia in Transurethral Resection of Prostate.
5. Amu OC, Affusim EA, Anyimba KS, Odumegwu O. Use of 5% dextrose as irrigation fluid in transurethral resection of the prostate—Any deleterious effects on blood sugar levels?: A case-controlled study. International Journal of Medicine and Health Development. 2024 Apr 1;29(2):93-7.
6. Ortner G, Nagele U, Herrmann TR, Tokas T. Irrigation fluid absorption during transurethral bipolar and laser prostate surgery: a systematic review. World journal of urology. 2022 Mar;40(3):697-708.
7. Naveen HN, Patil RD, Kumar A, Saheb SH. Clinical profile and safety outcomes of TURP using sterile water as irrigation fluid": A retrospective observational study. African Journal of Biomedical Research. 2024 Nov 28;27(3):78-82.
8. Eraky AM, Rubenstein SC, Khan A, Mokhtar Y, Gregorich NM. Non-surgical bleeding and transurethral resection of the prostate (TURP) syndrome after TURP surgery: a case report and literature review. Pathophysiology. 2024 Jul 12;31(3):367-75.
9. Meena R, Maranna H, Bains L, Lal P, Sawant G. Biochemical changes using sterile water and 1.5% glycine in TURP: A randomized study. MAMC Journal of Medical Sciences. 2020 May 1;6(2):81-9.
10. Uddin MH, Chowdhury MG, Rahman MM. 1.5% Glycine vs 5% Glucose Irrigant During TURP on Serum Electrolytes & TUR Syndrome" Which One is Better?. Bangladesh Journal of Urology. 2021;24(1):9-13.
11. El-Sayed AS, Nour-Eldeen TM, Abdelsalam Y, ElBadawy MA. Correlation between Volume of Glycine Used as Irrigating Fluid and Serum Sodium Level during Transurethral Resection of the Prostate [TURP]. International Journal of Medical Arts. 2024 Mar 1;6(3):4208-13.
12. Feng L. Distention Medium in Hysteroscopy. InPractical Manual of Hysteroscopy 2022 Aug 31 (pp. 51-63). Singapore: Springer Nature Singapore.
13. Shahzad I, Awan KH, Yousuf MA, Manzoor M, Pathan GM, Kumar S. Transurethral Resection of Prostate: A Continuing Battle of Irrigating Fluids. Insights-Journal of Health and Rehabilitation. 2024 Oct 19;2(2 (Health & Allied)):34-9.
14. VIRKAR ND, NERURKAR AA, PATKAR GA. Effect of Saline Irrigation for Transurethral Resection of Prostate on Acid Base and Electrolyte Status-A Prospective Cohort Study. Journal of Clinical & Diagnostic Research. 2022 Jan 1;16(1).
15. Jeje EA, Alabi TO, Ojewola RW, Ogunjimi MA, Tijani KH, Asiyanbi GK. Monopolar transurethral resection of the prostate using water as the irrigation fluid: Our initial experience. Nigerian Postgraduate Medical Journal. 2021 Jul 1;28(3):175-80.