Original Article

Intraoperative cell salvage transfusion in patients undergoing posterior urethroplasty: Its efficacy of reducing allogeneic blood transfusion, safety, and cost

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Abstract

Background: A significant blood loss may be encountered with complex urethroplasty surgery. Blood management aims at reducing allogeneic blood transfusion (ABT) because of limited supply, associated risks, and cost. Intraoperative cell salvage (ICS) has been used in different urological and nonurological surgeries to achieve this goal. However, no study evaluated its role in perineal urethroplasty.

Objectives: We set out to determine the efficacy of reducing ABT, safety, and cost of ICS in posterior urethroplasty.

Methods: We reviewed the charts of all patients who underwent posterior urethroplasty between 2012 and 2017. We collected data for patients' demographics, pre- and postoperative hemoglobin level, ICS volume, complications, equivalent ABT units saved, and cost.

Results: Seventy patients with a median age of 27.5 ± 10.2 years underwent posterior urethroplasty. Of the 70 patients, 20 (28.57%) required ICS intraoperatively with a median of 441 ml/patient, equivalent to 1.47 units per patient of allogenic blood. No patient needed intraoperative ABT, whereas two patients required transfusions postoperatively. The median pre- and postoperative hemoglobin levels were 124.2 ± 9.2 and 110.3 ± 12.6 g/dl, respectively. There were no significant complications noted while using ICS. There was a 41% cost reduction of equivalent ABT units.

Conclusions: ICS is safe and effective in reducing ABT during posterior urethroplasty. In our hospital, it is associated with a significant cost reduction of blood transfusion.

Keywords: Allogenic blood transfusion, cost, intraoperative cell salvage transfusion, perineal urethroplasty

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Received: 04.07.2021, **Accepted:** 06.10.2022, **Published:** 17.10.2022

INTRODUCTION

Blood loss during urethroplasty

Perineal urethroplasty has long been considered the standard surgery for posterior urethral injury after pelvic trauma. A challenging dissection and rich vasculature of the perineum may lead to greater blood loss requiring intraoperative and postoperative blood transfusion. The amount of blood loss depends on the complexity of the surgery and the surgeon's experience.[1] In an experienced surgeon's series, failed anastomotic urethroplasty for pelvic

Access this article online	
Quick Response Code:	Website: www.urologyannals.com
	DOI: 10.4103/ua.ua_119_21

How to cite this article: Altaweel W, Mehmood S, Seyam R. Intraoperative cell salvage transfusion in patients undergoing posterior urethroplasty: Its efficacy of reducing allogeneic blood transfusion, safety, and cost. Urol Ann 2022;14:377-82.

fracture strictures was associated with an average blood loss of 383 (233–1434) ml.[1] More extensive dissection during transpubic urethroplasty is associated with a high blood loss averaging in one report 650 ml (500–900) ml.[2] Blood loss has fallen gradually because of better patient selection, improved surgical techniques, and more extended surgeon experience.[3] Blood loss, however, remains challenging in perineal urethroplasty and cannot be predicted. Therefore, operative room readiness for replacement of blood loss is always necessary. An anticipated loss of more than 500 ml of blood may indicate blood replacement.[4] Cross-matching one or more blood units for allogeneic blood transfusion (ABT) is a routine before surgery, even with the most experienced surgeon.

Blood transfusion management recommendations

Endeavors to conserve blood transfusion evolved to address the issues of donation shortage and increasing cost.[5] Guidelines agree that every effort should be made to decrease the need for ABT.[6] A restrictive strategy or even avoidance of transfusion is encouraged.[6] Alternative techniques and protocols to reduce ABT in perioperative management are recommended.[6] Intraoperative cell salvage (ICS) is recommended as a safe, effective, and economical substitute for ABT.[6] Advantages of ICS may allow a more liberal strategy of transfusion. ICS is a technique in which blood is collected from the operative field, anticoagulated, washed, and filtered before re-infused into the patient either intraoperatively or immediately after surgery. Various specialties reported the efficacious use of ICS in the perioperative period with subsequent reduction in ABT rate.[7,8]

Intraoperative cell salvage in urologic surgery

The main concerns are the safety of ICS in the clean-contaminated field of urethral stricture surgery, the ease of application, and the cost.[9] Several reports indicated that ICS was safe in urological surgery, refuting the early concerns of urine contamination and spreading malignant cells.[10-16] Recent reports of ICS in urology oncological surgery demonstrated no added oncological adverse outcomes. ICS did not increase complications or adverse outcomes in open radical prostatectomy, radical cystectomy, open nephrectomy for renal tumors, or partial nephrectomy.[11-15,17] Kinnear *et al*. reviewed the use of ICS in the urology oncology surgery series.[10] Although the evidence level is low, ICS did not affect the oncological outcome and was associated with a lower cost than ABT.[10]

Clinical relevance

The UK Association of Anaesthetists updated its guidelines in 2018 to encourage wider use of cell salvage to conserve blood as part of patient blood management program.[4] The guideline recommends ICS when the expected blood loss during surgery is >500 ml in adults. Practice guidelines indicate that visual assessment of the operative field is an essential indicator of blood loss.[6] Cross-matching of at least one unit of blood is routine in urethroplasty. The indication to transfuse is, however, a joint decision between the surgeon and the anesthesiologist. Brisk bleeding in the surgical field, especially early on, may persuade the surgeon to request a transfusion. The availability of ICS rather than ABT may determine the choice of method of blood replacement.

Cost relevance

When ICS and ABT are clinically equivalent, the cost difference becomes a relevant factor. Therefore, reduction of the cost is a justifiable goal in the health-care system. However, conflicting results of the comparative cost between the two blood replacement methods exist. In addition, factors affecting the cost difference depend on the hospital setup, blood management protocols, and equipment and staff availability. Therefore, knowledge of cost in our hospital is warranted.

Goals of the study

To our knowledge, currently, there is no study reporting the use of ICS during posterior urethroplasty as an alternative to ABT. Therefore, the primary objective of this study is to evaluate the efficacy and safety of ICS in urethroplasty as an alternative to ABT in clean-contaminated surgery with excessive urine soiling. Our secondary objective was to compare the cost of ABT and ICS.

METHODS

Study setup

We carried out a retrospective review of a prospectively collected cohort of patients undergoing posterior urethroplasty in our hospital. We included all patients undergoing surgery from 2012 to 2017. A cell saver equipment and a standing-by technologist were available during all the surgeries.

Indication of transfusion and method choice

The indications of blood replacement were conjoint decisions between the urologist and the anesthesiologist. According to visual inspection of the field of surgery, the decision was based on the subjective estimation of blood loss and difficulty to control bleeding.

The priority of the blood replacement method was ICS. Whenever it was possible to avoid ABT, ICS was used. The choice of ICS rather than blood transfusion was not randomly allocated. Factors that lead to choosing ICS

included complex cases where there are an anticipated excessive dissection and bleeding, expected prolonged surgery, and unavailability of blood.

Surgical technique

All procedures were done by a single surgeon using the same technique. Urethral defect length was measured by ascending and descending urethrogram and confirmed intraoperatively by metal sounds. A planned perineal incision or a combined abdominoperineal approach was used. If a tension-free direct anastomosis was not possible ancillary procedures such as inferior wedge pubectomy, supracrural rerouting was utilized.

Techniques of intraoperative cell salvage

The process included blood collection from the intraoperative surgical field. Blood was then processed by a cell saver machine (AutoLog Autotransfusion System, Medtronic, USA), by washing with saline, anticoagulation, and centrifugation in a standard protocol. The processed, packed red blood cells were re-transfused either immediately or within 4 h postoperatively.

Data analysis

Collected data included patient's characteristics, stricture description, type and duration of surgery, preoperative hemoglobin, estimated blood loss, the volume of blood transfused intraoperatively and/or postoperatively, postoperative hemoglobin, transfusion-related complications, and cost. Descriptive statistics are reported.

Cost analysis

The cost of all items used in ICS was calculated and compared with a similar amount of allogenic blood saved intraoperatively. The ICS-processed red blood cell volume in ml was divided by 300 to get the equivalent volume of a unit-packed cell of allogeneic blood. Then, the cost per unit of allogenic blood transfusions was calculated. The cost included all items used per unit for allogeneic blood, and ICS was taken from the hospital blood bank and perfusionist in charge, respectively. Prices are shown in Saudi Arabian Riyal (SAR) and equivalent USA dollar (USD).

RESULTS

Patients and outcome

A total of 70 patients with a median age of 27.5 ± 10.2 years underwent posterior perineal urethroplasty from 2012 to 2017 of the 20 (28.57%) required ICS. The patients' characteristics at baseline are shown in Table 1. All the patients had primary urethral anastomosis. Auxiliary procedures included buccal mucosa grafting and techniques to reduce the tension of the anastomosis [Table 2]. Postoperative variables including blood loss are listed in Table 3.

Complications

Five patients (three patients without ICS and two patients with ICS) developed low-grade fever managed with antipyretics. Two patients, one in each developed perineal hematoma, were managed with perineal pressure packing and bed rest. No other transfusion-related complications were noted.

Cost comparison

A total of 20 patients received ICS-packed cell transfusion with a median of 441 ml per patient. None of the patients received intraoperative ABT. Postoperatively, two patients required additional ABT. The cost comparison between ABT and ICS is shown in Table 4. ICS had comparatively less cost per unit of blood than ABT.

Neither the initial ICS machine cost nor the blood bank equipment was included in the cost analysis. The average blood salvaged equals 1.4 units of ABT. Calculating the difference in cost shows a 1030 SAR (274.7 USD) saved per patient [Table 5]. The total saving for the 20 patients, therefore, was 30688 SAR (8183.5 USD).

Table 1: Preoperative characteristics of patients

	Non-ICS patients	ICS patients
Total number of patients	50	20
Age (years)	27.5±10.2	29.0±8.55
Preoperative Hb (g/l)	146.5±16.6	124.2±9.2
Preoperative hematocrit	0.446±0.21	0.402±0.14
Preoperative WBC	6.21±1.58	6.87±1.82
Weight (kg)	68.7±22.9	64.44±18.64
Length of stricture (cm)	2.0±0.4	3.8±0.8

ICS: Intraoperative cell salvage, Hb: Hemoglobin, WBC: White blood cell

Table 2: Auxiliary procedures during urethroplasty in a patient who had intraoperative cell salvage

Procedure	*n* (%)
Corporal body separation	7 (35)
Inferior pubectomy	8 (40)
Supracrural rerouting	2 (10)
Abdominoperineal approach	2 (10)
Urethral mobilization alone	1 (5)
Total	20 (100)

Table 3: Patient outcomes

	Non-ICS patients	ICS patients
Total number of patients	50	20
Postoperative Hb (g/l)	123.0±15.6	110.3±8.6
Postoperative hematocrit	0.36±0.12	0.321±0.10
Postoperative WBC	12.83±2.34	13.52±2.66
Operative time (min)	173.5±47.9	224.8±56.4
Blood loss (ml)	332±54.2	441.0±74.8
Length of hospital stay (days)	5.2±1.4	5.6±1.8

ICS: Intraoperative cell salvage, Hb: Hemoglobin, WBC: White blood cell

Table 4: Cost comparison of per unit allogeneic blood transfusion and cell saver kit per patient

Per unit cost of allogeneic blood		Cell saver kit cost per patient	
Items	**Cost SAR (USD)**	**Items**	**Cost SAR (USD)**
Whole blood bag, blood separation, and red cell filtration	225 (60)	Bowl 225 ml	521 (138.93)
Antibody ID	35.50 (9.46)	Suction tube	142 (37.86)
Blood group, antibody screen	31.05 (8.28)	ACDA	60 (16.0)
RhD and K phenotype	36.64 (9.77)	LDF	242 (64.53)
Unit ABO and RhD re-type	13.80 (3.68)	Conn tube	15 (4.0)
Cross-match	17.25 (4.60)		
Irradiation label	7 (1.86)		
ISBT label	2 (0.53)		
NAT test (HBV, HIV, and HCV)	118 (31.46)		
HBsAg	91 (24.26)		
HBc Abs total	75 (20.0)		
HBc Abs IgM	145 (38.66)		
HBs Abs	91 (24.26)		
HCV serology	125 (33.33)		
Malaria	52 (13.86)		
HIV-1, HIV-2 serology	187 (49.86)		
Syphilis	125 (33.33)		
Total cost	1377.24 (367.26)		980 (261.33)

ACDA: Acid-citrate-dextrose anticoagulant solution, HBV: Hepatitis B virus, HCV: Hepatitis C virus, HIV: Human immunodeficiency virus, ISBT: International Society of Blood Transfusion, LDF: Leukocyte depletion filter, NAT: Nucleic acid amplification test, SAR: Saudi Riyal, USD: USA dollar

Table 5: Cost of intraoperative cell salvage and its equivalent cost of allogenic blood in 20 patients

	Values
Cost of ICS	
Mean ICS-processed RBC (ml)	441
Mean equivalent allogenic blood (unit)	1.47
ICS cost per patient SAR (USD)	980 (261.3)
Total cost in 20 patients SAR (USD)	19,600 (5226.7)
Cost of equivalent ABT	
Cost per unit pack of allogenic blood SAR (USD)	1377 (367.2)
Mean cost of allogenic blood per patient SAR (USD)	1.47×1377=2024 (539.7)
Total equivalent ABT (unit)	31.2
Total cost SAR (USD)	1377×31.2=42,962 (11,456.5)
Amount saved per patient SAR (USD)	2024-980=1044 (278.4)
Total cost saved SAR (USD)	42,962-19,600=23,362 (6229.9)

SAR: Saudi Riyal, USD: USA dollar, ABT: Allogeneic blood transfusion, ICS: Intraoperative cell salvage, RBC: Red blood cell

DISCUSSION

The benefit of Intraoperative cell salvage

The development and use of cell savers accompanied the rising risk of ABT contamination with hepatitis virus in the 1980s and HIV shortly after.[18] Better blood banking protocols, more strict indications for transfusion, and the development of minimally invasive surgery led to a decrease in overall transfusion rates in the USA.[19] However, the need to reduce reliance on ABT remains a prime goal. The advantages of cell salvage include reducing the need for ABT, higher quality transfusion, reduction of adverse effects related to storage of banked blood, alloimmunization and risk of infection transmission, and more cost-effectiveness.[14,20,21] Misconceptions about ICS have delayed its wide application in perioperative blood management.[22] There were concerns about its cost, efficacy, proper indications, and contraindications.[22] However, a driving force to reduce ABT, the rising cost of a professionally managed ABT on the one hand, and a better understanding of the safety, broader applicability, and ease of use of ICS have helped increase utilization of the latter.[22] Intraoperative use of ICS is safe with an extremely low rate of adverse events.[23] A meta-analysis of RCTs on patient blood management interventions reported that the benefit is limited to reducing ABT. However, no significant advantage was there for hospital mortality or cost-saving.[24] These studies, however, included in addition to ICS, other strategies such as preoperative iron therapy, restrictive ABT protocols, and interventions to manage bleeding.[24] Restrictive blood transfusion with a threshold indication of hemoglobin between 7 and 8 g/dl reduced the need for ABT by 43% and did not impose more risk on hospital mortality.[25]

On the other hand, liberal blood transfusion was not associated with better outcomes.[25] These reviews enforce the idea that the main goal of blood management protocols is to reduce reliance on the ABT rather than providing a clinical benefit. Furthermore, our patients were young and probably would have tolerated well bleeding without the need for blood transfusion. However, one may argue that preparedness for unexpected bleeding in posterior urethroplasty is mandatory by cross-matching of units of blood. The alternative for this preparedness is having the cell saver in standby mode.

Clinical benefit

Reported blood loss in contemporary series of perineal urethroplasty is low. Urethroplasty using buccal mucosa

for long anterior urethral stricture in one series ranged between 164 and 202 ml blood loss and 133 and 108 ml in another.[26,27] The rate of ABT in perineal urethroplasty is not high, but it cannot be predicted preoperatively because of altered anatomy due to traumatic injury. Our study has not used even a single unit of allogeneic blood intraoperatively, and two patients who bled profusely required ABT postoperatively. These benefits are similar to reports of reduction of rate and volume of ABT in other surgeries.[28,29] In urologic surgery where there are urine contamination and potential of dissemination of malignant cells, ICS was safe and was not associated with adverse long-term clinical outcomes.[30,31] Significant contamination may challenge ICS in perineal urethroplasty with bacteria because of the presence of a suprapubic catheter and the urethral stricture itself compared to cases of radical prostatectomy or cystectomy. The risk is still there despite antibiotic prophylaxis. However, in this series, we report no perioperative sepsis in the ICS group. There were only three patients who had a low-grade fever which was managed conservatively with antipyretics.

Cost

The cost of ICS is a critical consideration. It must consider the economic gains of reducing the amount of ABT and a low risk of blood transfusion reaction and risk of infection.[32] Some studies showed that ICS is more costly than ABT, while others did not.[11-13,33] The difference may depend on the ICS protocol in the operative theater and the level of scrutiny of the blood bank in preparing for ABT. In our study, preparing a unit of allogeneic blood is costly because of vigilant screening for infectious disease [Table 5]. Compared to ICS, ABT was 41% more expensive per patient.

Study limitations

This study is limited because of the relatively small sample size and retrospective design. Thus, the bias of over-transfusion and selection exists. The cost of equipment and personnel in both the blood bank and ICS were not included in the analysis. The study did not compare ICS with a restricted blood management protocol where no transfusion is indicated according to stringent hemoglobin cutoff concentration value.

CONCLUSIONS

Our study supports that ICS in patients with a high risk of bleeding while doing posterior urethroplasty can reduce the volume and rate of ABT and its associated transfusion risks. ICS is not associated with adverse events in this clean-contaminated field of surgery. ICS is cost-effective when compared with the cost per unit of ABT. A prospective randomized study in a larger group of patients may provide answers comparing ICS to a conservative blood management protocol.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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