Preliminary Report

Estimation of Blood Loss in Transurethral Resection of Prostate (TUR-P) by Urine-Strip

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Objectives: *Blood loss in transurethral resection of prostate (TUR-P) operation is estimated by the difference between pre- and post-operative hemoglobin (Hb) concentration. The authors introduced a novel practical method to estimate blood loss in the patients who were surgically managed with TUR-P operation.*
Material and Method: *Complete blood count was collected pre-operative, immediate post-operative, and 24-hour post-operative to determine red blood cells and Hb concentration. Hemoglobin of irrigating fluid was measured by standard spectrophotometry and blood loss was estimated by the authors' calculation. Irrigating fluid was frozen and thawed to completely hemolyse the red blood cells, then it was tested by urine-strips and calculated for red cells using estimating cell ranges given by the product's prescription. The correlation between these indicators was evaluated.*
Results: *Calculated blood loss detected by spectrophotometric method has no correlation with immediate post-operative or 24-hour post-operative Hb concentration. However, it had a significant positive correlation with calculated blood loss by urine-strip technique ($r = 0.897$, $p = 0.01$).*
Conclusion: *Urine-strip method can be used to estimate total blood loss in irrigating fluid in patients with TUR-P operation. This is practical and useful in immediate post-operative evaluation of blood loss to consider the need of blood transfusion.*

Keywords: *Estimation of blood loss, Transurethral resection of prostate, Urine-strip, Spectrophotometry, Hemoglobin, Irrigating fluid*

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Estimation of blood loss in transurethral resection of prostate (TUR-P) is very difficult and subjective. Hemoglobin (Hb) is not a distinctive determination due to the hemoconcentrational state occasionally found in preoperative patients who have to stop drinking and received inadequate intravenous fluid, and hemodilutional state found in postoperative patients with fluid absorption[1]. Jansen H (1978) introduced the photometric method to measure free Hb in the hemolysed irrigant fluid[2]. The research using this method has been limited because it has to use some sophisticated apparatus such as portable photometer for hemoglobin detection (HemoCue photometer)[3-6]. For a few decades, surgeons generally estimated the amount of blood loss and requirement of blood transfusion of TUR-P patients by weak evidences such as length of operation, weight of prostate resected, transfusion rate, postoperative bladder irrigation, duration of catheterization and length of hospital stay[7,8]. However, these indicators are unreliable and may cause delayed or unnecessary blood transfusion, which subsequently increases comorbidity and hospitalization.

In the present study, the authors investigated a new technique to determine the amount of blood loss by using urine-strip as an indicator. The authors expected that it is practical, easy to use, reliable and early detectable.

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Material and Method

Between March 2006 and April 2006, 11 patients who underwent TUR-P in King Chulalongkorn Memorial Hospital were enrolled in the present cross-sectional analytic descriptive study. All patients who had a history of chronic hemolytic or rhabdomyolytic disease or had received a blood transfusion within 3 months before and during TUR-P were excluded. Informed consents were received from all patients prior to blood and specimen collection. The research protocol was approved by the Ethical Committee, faculty of Medicine, Chulalongkorn University.

Blood was collected prior to the operation, immediate post-operative period and 24-hour post-operation. Total Hb and number of red blood cells (RBCs) were measured. Volume of irrigating fluid used during operation was recorded. At the end of the operation, 10 milliliters of irrigating fluid was collected. Complete RBCs hemolysis was performed using freeze and thaw technique. The resultant was centrifuged at 3000 rpm for 10 minutes twice to separate cellular debris. Hb concentration was determined by spectrophotometer.

The treated irrigating fluid was diluted into 1:10, 1:100, 1:200, 1:400, 1:800, 1:1,600, 1: 3,200, and 1:6,400 and filled in the plate and tested by the urine-strip. Blood loss was calculated by two methods

1. Calculated blood loss by urine-strip. Urine-strip (Combur^5 Test□ D, Roche) was used to check for positive value for RBCs in each diluents and the last diluting fluid which appeared for 1+ erythrocyte (10 cell/□L) or 2+ erythrocyte (25 cell/□L) was noted (1+ was preferable). The authors calculated the number of RBC loss in irrigating fluid by power of dilution and the range of RBCs given by the product's instruction as below;

A;

Calculated RBCs (cells/μL) = [RBCs range] x [Power of dilution]

RBC range = 10 if the result was 1+
= 25 if the result was 2+ (referred to the product's instruction)

Power of dilution = power of diluting concentration of the last detectable result (800, 1600, 3200, etc)

Then the authors used the calculated RBCs to calculate the amount of blood loss with the equation below;

B;

$$\text{Calculated blood loss (L)} = \frac{\text{Calculated RBCs(cell/L) x irrigating fluid volume(L)}}{\text{Preoperative RBCs concentration (cell/μL)}}$$

Or the authors can integrate both equations (A & B) into;

$$\text{Calculated blood loss (L)} = \frac{\text{[RBCs range] x [Power of dilution] x irrigating fluid volume(L)}}{\text{Preoperative RBCs concentration (cell/μL)}}$$

Then, if the authors used the dilution that was the last detectable for 1+, the authors can simplify the equation into;

$$\text{Calculated blood loss (L)} = \frac{\text{10 x [Power of dilution] x irrigating fluid volume(L)}}{\text{Preoperative RBCs concentration (cell/μL)}}$$

Power of dilution = power of diluting concentration of the last seen 1+ result (1600, 3200, etc)

2. Calculated blood loss by spectrophotometer, using the same diluting fluid to determine the hemoglobin (Hb) concentration by measure the absorbance (OD) at the wavelength of 415, 450 and 700 nm to calculate by the equation of

$$\text{Hb (mg/dL)} = 154.7\,A415 - 130.7\,A450 - 123.9\,A700$$ [9,10]

And then use the equation below;

$$\text{Calculated blood loss (L)} = \frac{\text{Hb concentration in diluting fluid (mg/dL) x irrigating fluid volume (L)}}{\text{Hb in blood at pre-operation (g/dL) x } 10^3}$$

Statistical analysis

Program SPSS version 13□ for Windows was used to calculate the correlation coefficient between:

1) Number of RBCs in sample detected by urine-strip and Hb concentration in sample detected by spectrophotometer;

2) Calculated blood loss (RBCs from urine-strip) and calculated blood loss (Hb form spectrophotometer);

3) Calculated blood loss (RBCs from urine-strip) and change of number of RBCs and Hb concentration in blood between preoperative and postoperative periods;

4) Calculated blood loss (Hb from spectrophotometer) and change of number of RBCs and Hb

concentration in blood between preoperative and postoperative periods.

Results

RBCs number and Hb concentration in blood samples are shown in Table 1. Mean of RBCs and standard deviation in blood (10^6/□L) pre-operation, immediate post-operation and 24-hour post-operation were 4.82(0.41), 4.64(0.43), 4.40(0.52), respectively. Mean of Hb and standard deviation in blood (g/dL) pre-operation, immediate post-operation and 24-hour post-operation were 14.66(1.42), 13.96(1.36), 13.07(1.44), respectively.

Mean and standard deviation of volume of irrigating fluid used (L), Hb concentration in irrigating fluid (mg/dL), blood loss calculated by spectrophotometry (L), blood loss calculated by urine-strip (L) were 13.50(8.79), 155.742(82.831), 0.154(0.114), 0.202(0.206), respectively (Table 2).

Fig. 1 shows the significant correlation between calculated blood loss by spectrophotometry and urine-strip with the Pearson's correlation coefficient of 0.867 ($p = 0.01$).

The significant associations between calculated blood loss by spectrophotometry with immediate post-operative and 24-hour post-operative hemoglobin concentration were not observed in the present study as shown in Fig. 2.

The linear regression of calculated blood loss by Hb concentration and number of RBCs in fluid was calculated as follows:
Estimated blood loss that was calculated by hemoglobin concentration in fluid = 0.48*; estimated blood loss that was calculated by number of RBC in fluid (r^2 = 0.752).

Discussion

It is clear that patients who undergo TUR-P have their RBCs and Hb concentration decreased. However, the authors cannot estimate the exact amount of blood loss from comparison of pre- and post-operative Hb concentration because of the post-operative hemodilutional state. Considering that almost all of the blood loss in the operation is via tissue resection and washed out by irrigating fluid, the authors could obtain as accurate as possible amount of blood loss if the authors were able to measure the amount of blood contained in the irrigating fluid. The spectrophotometric method is reliable but it is not convenient to use as a special apparatus (HemoCue) is needed. In the process to determine the amount of blood in irrigating fluid, the authors used the urine-strip, a semi-quantitative blood indicator that is inexpensive, easy to store and use, as a detector. With organic hydroperoxide that has hemolytic ability on the strip, it is able to detect both intact RBCs and free hemoglobin in the fluid. To determine

Table 1. Number of blood RBCs and hemoglobin concentration separated by timing of operation

No.	RBCs in blood			Hb in blood		
	Pre-operative (10^6/□L)	Immediate post-operative (10^6/□L)	Post-operative day 1 (10^6/□L)	Pre-operative (g/dL)	Immediate post-operative (g/dL)	Post-operative day 1 (g/dL)
1	4.56	4.24	3.78	14.7	13.0	11.7
2*	5.06	ND	4.64	15.7	ND	13.6
3	5.21	5.02	5.05	14.8	13.9	13.9
4	4.94	4.81	4.87	13.8	13.4	13.2
5	4.86	5.08	4.43	14.9	14.9	13.1
6	5.43	5.15	5.15	16.5	15.5	15.6
7	4.83	4.47	4.03	15.0	14.0	12.2
8	5.05	4.84	4.63	16.4	15.6	14.8
9	4.05	3.98	3.64	12.2	12.0	10.8
10	4.20	4.05	3.92	12.3	12.0	11.5
11	4.78	4.74	4.25	15.0	15.3	13.4
Mean	4.82	4.64	4.40	14.66	13.96	13.07
SD	0.41	0.43	0.52	1.42	1.36	1.44

ND = no data

* Immediate post-operative sample of this patient cannot be analyzed within 2 hours after collection and was excluded from the data

Table 2. Volume of irrigating fluid, Hb concentration and RBCs in irrigating fluid, calculated blood loss by Hb and RBCs

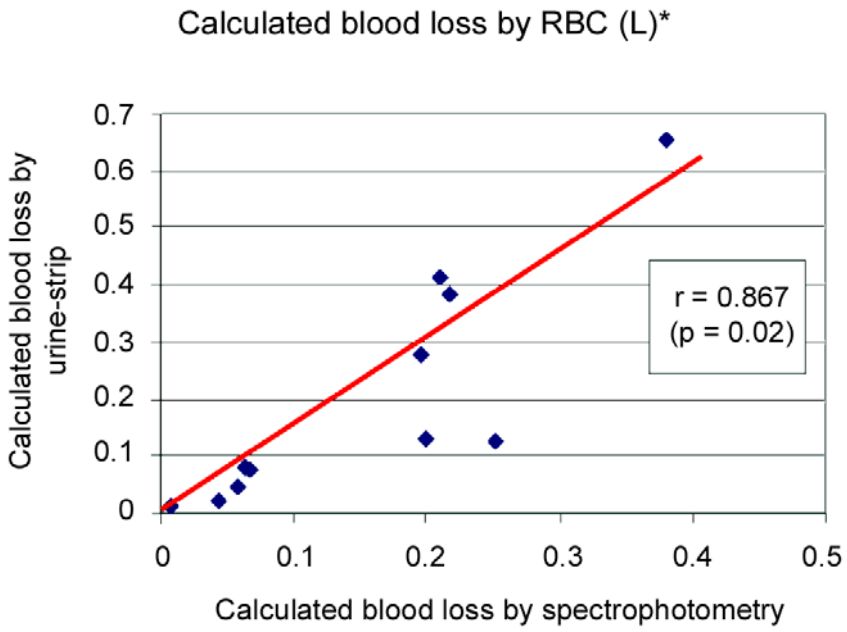
No.	Volume of irrigating fluid used (L)	Hb conc. in irrigating fluid (mg/dL)	Blood loss calculated by spectrophoto-metry (L)*	Value of positive RBCs by urine-strip (cell/□L)	Power of dilution	Blood loss calculated by urine-strip (L)**
1	37.3	150.27	0.381	2+ (25)	3200	0.654
2	10.0	99.92	0.064	2+ (25)	1600	0.079
3	16.0	223.44	0.251	2+ (25)	1600	0.127
4	6.8	89.84	0.044	1+ (10)	1600	0.022
5	15.8	187.77	0.199	2+ (25)	1600	0.130
6	3.0	44.41	0.008	2+ (25)	800	0.011
7	13.8	62.87	0.058	1+ (10)	1600	0.045
8	9.4	117.03	0.067	2+ (25)	1600	0.074
9	14.0	170.05	0.195	2+ (25)	3200	0.277
10	10.9	283.18	0.211	2+ (25)	6400	0.415
11	11.5	284.38	0.218	2+ (25)	6400	0.385
Mean	13.5	155.742	0.154			0.202
SD	8.79	82.831	0.114			0.206

* Calculated blood loss by spectrophotometry, using Hb concentration (L) =

$$\frac{\text{Hb concentration in diluting fluid (mg/dL) x irrigating fluid volume (L)}}{\text{Hb in blood at pre-operation (g/dL) x } 10^3}$$

** Calculated blood loss by urine-strip, using RBCs concentration (L) =

$$\frac{\text{[RBCs range] x [Power of dilution] x irrigating fluid volume (L)}}{\text{Preoperative RBCs concentration (cell/μL)}}$$



Pearson's correlation between calculated blood loss by Hb and RBCs is 0.867 (p = 0.01)

Fig. 1 Correlation between calculated blood loss by spectrophotometry and urine-strip (n = 11)

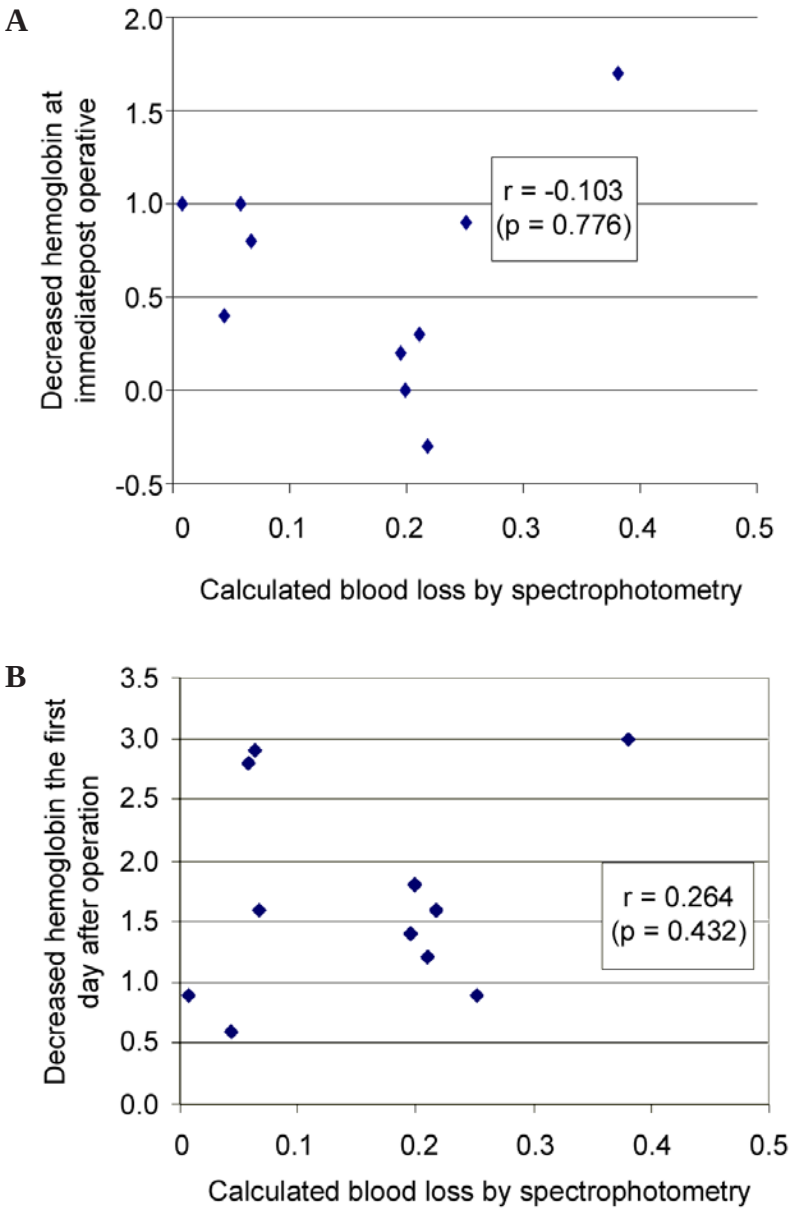


Fig. 2 Correlation between calculated blood loss by spectrophotometry with immediate post-operative (A) (n = 10) or 24-hour post-operative (B) (n = 11) hemoglobin concentration

the correlation of urine-strip and spectrophotometric technique, the authors have to freeze and thaw irrigating fluid for complete hemolysis of RBCs[11]. Since the irrigating fluids that the authors used were sterile water and 5% dextrose water (isotonic solution), the authors additionally employed the freeze and thaw technique to lyse completely RBCs in the fluid. Hb concentration then was measured and calculated by free-Hb method (spectrophotometric method), which could represent the real amount of Hb in irrigating fluid rather than the other, cyanmethemoglobin method. The authors found that the result of blood loss detected in irrigating fluid by urine-strip is strongly correlated to the amount of blood loss determined by the spectrophotometric

method (Fig. 1), which means that the urine-strip can detect the amount of blood loss as accurately as the spectrophotometer does. On the other hand, immediate and 24-hour post-operative Hb concentrations, which are commonly used, have no correlation with the spectrophotometric method (Fig. 2A and B).

About urine-strip technique, it is very convenient, needing only an autopipette, plate for dilution and urine-strip as the tools, takes less than five minutes to run the process and calculate with the given equation. These processes can be done in the recovery room or in the operating room for early determination of blood loss.

Even though this urine-strip method is reliable, there could be some technical errors depending on the observer's skill in diluting and interpreting process. An error would make the estimation of blood loss vary approximately 0.5-2 times of actual blood loss. To minimize this, the authors suggest that a technician should perform all tests and duplication is strongly recommended. Finally, estimation of blood loss is just a guide, not confirmative criteria to evaluate a requirement of blood or intravenous fluid transfusion. The decision needs experienced physicians to evaluate the patient's clinical state and look for other indications for blood transfusion if calculated blood loss is indecisive.

Estimation of blood loss in TUR-P by urine-strip technique is not the best technique for detection, but is practical and useful in immediate post-operative evaluation of blood loss.

Conclusion

To estimate blood loss in irrigating fluid in TUR-P operation, urine-strip method can be used. It is reliable and accurate as spectrophotometric method, and useful in immediate post-operative evaluation of blood loss. However, comparison of pre-operative and post-operative Hb difference, which is commonly used, has no correlation with blood loss.

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การประมาณปริมาณเลือดที่สูญเสียจากการผ่าตัดต่อมลูกหมากผ่านท่อปัสสาวะโดยอาศัยแผ่นตรวจกรองปัสสาวะ

วัฒนชัย อึ้งเจริญวัฒนา, ชนธีร์ บุญยะรัตเวช, ปิยะรัตน์ โตสุโขวงศ์, ฐสิณัส ดิษยบุตร

วัตถุประสงค์: *การศึกษาการใช้แผ่นตรวจกรองปัสสาวะ เพื่อประมาณปริมาณเลือดที่สูญเสียผ่านทางท่อปัสสาวะในการผ่าตัดต่อมลูกหมากผ่านท่อปัสสาวะ*

วัสดุและวิธีการ: *เปรียบเทียบความเข้มข้นของเม็ดเลือดแดงและฮีโมโกลบินในเลือดก่อนผ่าตัด หลังผ่าตัดทันทีและหลังผ่าตัดเป็นเวลาหนึ่งวัน กับปริมาณเลือดที่คำนวณจากความเข้มข้นฮีโมโกลบินในน้ำสวนล้าง โดยวิธีสเปคโตรโฟโตเมทริกกับความเข้มข้นของเม็ดเลือดแดงในน้ำสวนล้างโดยแผ่นตรวจกรองปัสสาวะ*

ผลการศึกษา: *ปริมาณเลือดที่เสียออกจากร่างกายจากการคำนวณความเข้มข้นฮีโมโกลบิน โดยวิธี สเปคโตรโฟโตเมทริกไม่มีความสัมพันธ์กับความเข้มข้นของฮีโมโกลบินหลังผ่าตัดทันทีหรือหลังผ่าตัดนานหนึ่งวัน แต่สัมพันธ์กับปริมาณเลือดที่สูญเสียจากร่างกายคำนวณจากความเข้มข้นเม็ดเลือดแดงจากการตรวจแผ่นตรวจกรองปัสสาวะ*

สรุป: *การใช้แผ่นตรวจกรองปัสสาวะตรวจความเข้มข้นเม็ดเลือดแดงในน้ำสวนล้าง สามารถใช้ประเมินปริมาณเลือดที่สูญเสียผ่านท่อปัสสาวะได้ วิธีการสะดวกและใช้ประกอบการประเมินความจำเป็นให้เลือดได้ แต่พบความผิดพลาดได้หากผู้ทดสอบไม่มีความชำนาญ*