Are Routine Postoperative Laboratory Tests Really Necessary After High Tibial Osteotomy Surgery?

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Abstract

Background: The purpose of this study was to assess the necessity and cost-effectiveness of routine postoperative laboratory tests for patients undergoing high tibial osteotomy (HTO) surgery.

Methods: A prospective study was conducted and 513 patients with symptomatic isolated medial compartment osteoarthritis received HTO surgery from January 2015 to May 2020 were included in this study. The associations between different clinical factors and postoperative clinical treatment were analyzed. Finally, A logistic regression analysis was performed to detect independent risk factors for patients requiring postoperative clinical treatment.

Results: In this study, 482 patients had completed the full set of postoperative laboratory studies within 3 days after surgery were included in the present study. However, only a small proportion of the patients with anemia (3.9%), hypoalbuminemia (4.1%), and abnormal serum potassium levels (3.5%) required clinical intervention after surgery. Binary logistic regression model analysis showed that body mass index (BMI), preoperative hemoglobin level, estimated blood loss and operative time were the independent risk factors correlated with postoperative blood transfusion in patients with HTO surgery. Female gender and preoperative albumin level were independent risk factors for patients who had requiring albumin supplementation after HTO surgery. Finally, preoperative potassium was the independent risk factors for patients required potassium supplementation postoperatively.

Conclusions: based on the analysis, we conclude that routinely ordering postoperative laboratory texts after HTO surgery are both unnecessary and cost inefficient for most of the patients. However, for patients with identified risk factors, routine postoperative laboratory tests are still needed.

Background

Medial opening wedge high tibial osteotomy (HTO) is an established treatment for medial compartment knee osteoarthritis with varus deformity [1]. As joint preservation surgery, the procedures is intended to restoring the mechanical axis of the lower limb, transferring the load from medial compartment onto the non-affected lateral compartment, and subsequently delay osteoarthritis progression [2].

Many surgeons will routinely perform laboratory tests within 3 days after major orthopedic surgery. Postoperative laboratory tests are ordered to investigation of many critical clinical details and prevent potential serious complications [3]. However, with the concept of clinical practice guidelines for minimizing invasive surgery technique was gradually introduced to the field of HTO surgery, which extensively improving perioperative blood management and patient satisfaction. Meanwhile, the widespread use of tranexamic acid is a successful milestone of perioperative blood management and perioperative care pathways [4, 5].

Cost effectiveness is an increasingly important consideration in the delivery of health care. Recently, several studies have consistently revealed that routine postoperative laboratory tests are not necessary

for patients after major orthopedic surgery, unless patients had a history of disease associated with an abnormal laboratory test [6-8]. However, few studies have reported the necessity for routine laboratory tests for patients after HTO surgery.

Thus, this study aimed to evaluate the necessity and cost-effectiveness of routine postoperative laboratory tests for patients after HTO surgery. In addition, we investigate the correlations between the clinical parameters and abnormal postoperative laboratory test results, and identify the risk factors associated with abnormal laboratory test related requiring postoperative clinical intervention.

Materials And Methods

2.1. Patient selection

This prospective study was approved by the medical research ethics committee of our hospital. Patients with symptomatic isolated medial compartment OA who had undergone HTO surgery with normal preoperative laboratory test results from January 2015 to May 2020 were included in the present study.

Diagnosis of patients with OA primarily relies on clinical evidences, standing X-rays and magnetic resonance imaging (MRI). The operative therapy was indicated depending on the degenerative process, and evaluated by the X-ray classification of Kellgren-Lawrence (K-L) grade. All patients had an identical operative approach. An initial knee arthroscopy was performed to treat any intraarticular pathology. Patients were allowed to walk non-weight-bearing with two crutches for six weeks, and full weight-bearing was permitted six weeks after surgery.

Patients undergoing HTO for other indications (cartilage resurfacing or ligament reconstruction), and previous tibia or femur fracture were excluded from the study. Furthermore, Patients presenting with a history of antiplatelet therapy, malignant tumors, significant hematologic disorders, and infectious or systematic inflammatory disease were excluded from this study.

2.2. Data collection

HTO was performed or directly supervised by a consultant surgeon. All the patients' demographics and clinical characteristics were carefully recorded, including: age, gender and body mass index (BMI), comorbidities (diabetes mellitus, high blood pressure, alcohol consumption status and smoking status), and surgery related factors (intraoperative blood loss and transfusion, operative time and tranexamic acid use), preoperative and postoperative routine laboratory test results, and any medical intervention that is directly related to abnormal laboratory values (including: blood transfusion, albumin supplementation, electrolyte supplementation).

In our institution, normal laboratory values are defined as follows: hemoglobin (115–150g/L), and platelets (125–350*10^9/L), alanine

aminotransferase (9-50IU/L), aspartate aminotransferase (15-40IU/L), albumin (40–55g/L), creatinine (44-115umol/L), blood urea nitrogen(1.70-8.30mmol/L), uric acid (170-420ummol/L), serum sodium (137–147mmol/L), serum potassium (3.5–5.3mmol/L) and serum calcium (2.0–2.6mmol/L). An abnormal preoperative or postoperative laboratory test results will be identified if recorded outside of the corresponding reference interval.

Aggressive interventions were not routinely performed for patients with abnormal preoperative laboratory tests before HTO surgery, unless they met the criteria for clinical intervention. Patients with levels of hemoglobin <70 g/L or symptomatic anemia with a hemoglobin level of <100 g/L, albumin level <30 g/L, and serum potassium <3.5 mmol/L were considered to require clinical intervention [9]. During the study period, all HTO surgery patients' routine underwent intravenous injection of 1.5 g tranexamic acid 30 minutes before the incision, which also received articular injection of 0.5g tranexamic acid after it was sutured.

2.3. Statistical analysis

Frequencies or percentages will be calculated for qualitative data, and mean value ± standard deviations will be calculated for quantitative data. Qualitative and quantitative variables were analyzed using Chi-square test and independent samples t tests. Binary logistic regression model was used to identify the independent risk factors for patients with abnormal laboratory test results who required postoperative clinical treatment. Receiver operating characteristic (ROC) curve was used to assess the predictive value of risk factors for postoperative clinical treatment. All analysis was performed by SPSS Version 22 (SPSS Inc. Chicago IL). And $P < 0.05$ was considered statistically significant.

Results

3.1. Patient demographics

A total of 513 patients were evaluated, of these patients, 482 patients had completed the full set of postoperative laboratory studies within 3 days after surgery were included, of note, 6.8% (38) of patients received medical intervention that is directly related to the abnormal laboratory values. The majority of abnormal postoperative laboratory test results were hypoalbuminemia, which accounts for 44.0% (212cases) of the patients. However, only a small proportion of the patients with anemia (3.9%), hypoalbuminemia (4.1%), and abnormal serum potassium levels (3.5%) required clinical intervention after surgery (Table 1).

3.2. Risk Factors for Patients Requiring Postoperative Clinical Treatment

Based on the analysis, there were no statistically significant differences on age and comorbidities between HTO patients with and without postoperative blood transfusion ($P > 0.05$, respectively). However, the BMI, estimated blood loss and operative time were significantly higher in patients with postoperative blood transfusion compared to those without postoperative blood transfusion ($p<0.001$, respectively).

And the preoperative hemoglobin level was significantly lower in patients with postoperative blood transfusion than those of non postoperative blood transfusion patients (p<0.001). Furthermore, female genders were more likely required blood transfusion (Table 2). Binary logistic regression analysis indicated that BMI (OR = 0.584, P=0.004), preoperative hemoglobin level (OR =1.205, P <0.001), estimated blood loss (OR = 0.991, P <0.001) and operative time (OR =0.976, P <0.024) were the independent risk factors correlated with postoperative blood transfusion in patients with HTO surgery (Table 3).

For patients who had and had not required postoperative albumin supplementation, the univariate and binary logistic regression analysis results showed that female (OR =0.163, P =0.001) and preoperative albumin level (OR =1.453, P <0.001) were independent risk factors for patients who had requiring albumin supplementation after HTO surgery (Tables 4 and 5).

Of the 17 patients with postoperative potassium, 17 received potassium supplementation and were compared with those who did not require potassium supplementation, and significant differences were found for preoperative potassium and operative time (P < 0.05; Table 6). Furthermore, the binary logistic regression analysis was carried out to identify the independent risk factors for potassium supplementation in patients with HTO surgery. The results showed that preoperative potassium (OR =19.870, P <0.001) were the independent risk factors for patients required potassium supplementation postoperatively (Table 7).

3.3. The diagnostic accuracy of risk factors for predicting postoperative clinical treatment

The ROC curve was analyzed to determine the values of risk factors for predicting postoperative clinical treatment in patients with HTO surgery. The accuracy was analyzed by the area under the curve (AUC). The results were demonstrated in Table 8. The results indicated that preoperative hemoglobin level had the highest diagnostic accuracy for predicting transfusion in patients with HTO surgery (AUC = 0.947, P<0.001)

Discussion

The concept of clinical practice guidelines for minimizing invasive surgery technique was gradually introduced to the field of HTO surgery, which extensively improving perioperative blood management and patient satisfaction. Meanwhile, the widespread use of tranexamic acid is a successful milestone of perioperative blood management and perioperative care pathways [9]. Cost effectiveness is an increasingly important consideration in the delivery of health care. Many studies have recommended reducing the use of duplicative and limited clinical value laboratory tests, improving the quality of care and reducing the cost of medical expenses [10].

Smetana et al [11] illustrated that the more laboratory tests performed on patients, the more likely they are to find something abnormal. Recently, several studies have consistently revealed that routine postoperative laboratory tests are not necessary for patients after major orthopedic surgery, also suggested the majority of the information provided by these abnormal test results was considered to be

of no clinical significance, only patients with risk factors should undergo routine postoperative laboratory tests [9, 10]. Wu et al [9] showed that up to 88.4% of patients after primary total hip arthroplasty had abnormal postoperative laboratory results, only 6.8% of those patients required a postoperative medical intervention, which indicated that routine postoperative laboratory tests are unnecessary for most patients. Serum laboratory tests are routinely ordered after HTO, and these infrequently abnormal serum laboratory values rarely require active intervention (7.8%), which indicated that routine postoperative laboratory tests are not necessary for most patients after HTO surgery.

Park et al [12] found that risk factors for transfusion are higher BMI, estimated blood loss, and lower preoperative hemoglobin levels. Wu et al [9] retrospectively reviewed 349 patients who underwent primary elective unilateral total hip arthroplasty from January 2016 to November 2018 at a single institution, and the long operation time and low preoperative hemoglobin level were most predictive. Halawi et al [13] found that BMI> 35 kg/m2, anemia and estimated blood loss > 250mL was an independent risk factor for transfusion. Greco et al [14] propose that routine postoperative laboratory tests should be considered in patients presenting with a preoperative hemoglobin level below 130 g/l and postoperative clinical symptoms or signs of significant blood loss. Similarly, we also identified BMI>23.15 kg/m2, preoperative hemoglobin level <112.5 g/L, estimated blood loss>225ml and operative time >164.5mins as independent risk factors for the requirement for a blood transfusion after HTO surgery.

In a retrospective study, Lin et al [10] investigated 1915 patients with lumbar spinal surgery, and found that the incidences of abnormal postoperative serum albumin was 77.36%, however, only 1.95% of those patients required albumin supplementation. In our study, we demonstrated an incidence of abnormal postoperative serum albumin as great as 44.0% in HTO patients, and the incidence of albumin supplementation was 4.1%, slightly greater than that reported by Lin et al [10]. Hart et al [15] reported that female gender was an independent risk factor associated with the need for clinical treatment, the reason might be that female patients are always accompanies with a greater chance to anemia and hypoproteinemia. Wu et al [9] showed that female gender, long operation time, and low preoperative albumin level were risk factors for patients requiring albumin supplementation. In the present study, we found that risk factors for albumin supplementation are female gender and low preoperative albumin level, which is in accordance with previous studies.

In a retrospective study, Kildow et al [7] investigated the basic metabolic panel values results of 767 patients found that the incidences of potassium abnormalities were 25.2% after total joint arthroplasty, and illustrated that female gender and advanced age were risk factors for electrolyte abnormalities. Lin et al [10] reported that the incidence of abnormal electrolytes was low and the predictive value was small, and 0.92% of the patients undergoing lumbar spinal surgery were diagnosed with hypokalaemia required postoperative clinical treatment. Likewise, Greco et al [14] demonstrated an incidence as great as 15.5% for patients who were provided electrolyte supplementation after total joint arthroplasty, and confirmed that preoperative potassium level associated with required postoperative clinical treatment with a threshold identified at a preoperative potassium level of 4mmol/L. In line with previous studies, we found that 3.55% of patients required potassium supplementation after HTO surgery. The preoperative

potassium was lower in patients with potassium supplementation and identified as an independent risk factor for postoperative clinical treatment. The cutoff value of it was 3.45mmol/L, it suggested that preoperative potassium level <3.45mmol/L predicted patient at a high risk of postoperative clinical treatment.

To the best of our knowledge, this study will be the first study in to evaluate the necessity of postoperative laboratory tests for Chinese patients after primary HTO. Although the results were interesting, the limitations of this study still existed. First of all, this is a single tertiary academic center study, and a relative small sample may result in bias to the outcomes. Secondly, our transfusion criteria were somewhat subjective, as our protocol set a restrictive transfusion strategy hemoglobin level <70 g/L or symptomatic anemia with a hemoglobin level < 100 g/L, which might limit the generalizability of the study findings. Thus, further study with large sample and multi-center investigation is necessary to verify the efficacy of these risk factors for predicting postoperation medical intervention in patients following HTO surgery.

Conclusion

In summary, based on the analysis, only a small number of patients required postoperative clinical interventions in response to abnormal laboratory values, we conclude that routinely ordering postoperative laboratory studies after HTO surgery are both unnecessary and cost inefficient. However, for patients with identified risk factors, routine postoperative laboratory tests are still needed. We recommend to selectively consider obtaining a postoperative complete blood count in patients presenting with a BMI>23.15 kg/m2, preoperative hemoglobin level <112.5g/l, estimated blood loss >225ml and operative time >164.5mins. Further, we suggest that selectively consider obtaining a postoperative basic metabolic panel in patients with a preoperative potassium level <3.45mmol/l, female gender and preoperative albumin level <38.95g/L. However, larger sample sizes and multicenter studies are necessary to verify our results.

Abbreviations

HTO:high tibial osteotomy; BMI:body mass index; MRI: magnetic resonance imaging; K-L: Kellgren-Lawrence; ROC: Receiver operating characteristic; AUC: under the curve;

Declarations

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The first and second author (Min Lan and Si Nie) contributed equally to this study and share the first authorship.

Authors' Contribution:

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Min Lan and Si Nie. The first draft of the manuscript was written by Min Lan and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

All the data will be available upon motivated request to the corresponding author of the present paper.

Ethics approval and consent to participate

This study was approved by the ethics committee of the Jiangxi Provincial People's Hospital Affiliated to Nanchang University

Consent for publication

Written informed consent was obtained from each patient to authorize the publication of their data

Conflicts of Interest:

No benefits in any form have been or will be received from any commercial party related directly and indirectly to the subject of this manuscript.

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Tables

Table 1. Results of Routine Laboratory Tests for Patients Undergoing HTO Surgery

Laboratory Test (n=482)	ALTR (n; %)	PCTR (n; %)
Routine blood test		
Hemoglobin	106(22.0%)	19(3.9%)
Platelets	36(7.5%)	0 (0)
Liver function test		
Alanine aminotransferase	6(1.2%)	0 (0)
Aspartate aminotransferase	178(36.9%)	
Albumin	212(44.0%)	20(4.1%)
Renal function test		
Creatinine	77(16.0%)	0 (0)
Blood urea nitrogen	2(0.4%)	0 (0)
Coagulation function		
PT	30(6.2%)	0 (0)
APTT	50(10.4%)	0 (0)
Electrolytes		
Serum sodium	32(6.6%)	0 (0)
Serum potassium	17(3.5%)	17(3.5%)
Serum calcium	19(3.9%))	0 (0)

ALTR: abnormal postoperative laboratory test result; PCTR: postoperative clinical treatment required; PT: prothrombin time; APTT: activated partial thromboplastin time;HTO: high tibial osteotomy

Table 2. Postoperative Blood Transfusion for Patients with Abnormal Hemoglobin after HTO Surgery

Factor	Treatment Group (n=19)	No Treatment Group (n=463)	P value
Age (years)	53.58±5.99	53.30±5.92	0.846
Gender (n)			0.032
Male	8	317	
Female	11	146	
BMI (kg/m2)	26.25±3.35	23.04±2.88	p<0.001
Smoking: n(%)	3(15.8%)	133（28.7%）	0.219
Alcohol use: n(%)	2(10.5%)	94（20.3%）	0.142
Diabetes mellitus: n(%)	31(5.8%)	30（6.5%）	0.390
High blood pressure: n(%)	4(21.1%)	61(13.2%)	0.306
Preoperative hb level (g/L)	104.05±14.33	135.94±12.20	p<0.001
Estimated blood loss (mL)	489.47±216.40	233.05±87.34	p<0.001
Operative time (minutes)	174.62±47.62	145.74±23.25	p<0.001

BMI: body mass index; HTO: high tibial osteotomy; hb: hemoglobin

Table 3. Risk Factors for Postoperative Blood Transfusion in Patients Undergoing HTO Surgery

Risk factor	odds ratio	95 % confidence interval	P value
Gender	2.819	0.339-23.453	0.338
BMI	0.584	0.404-0.845	0.004
Preoperative hb level	1.205	1.096-1.325	p<0.001
Estimated blood loss	0.991	0.986-0.996	p<0.001
Operative time	0.976	0.955-0.997	0.024

BMI: body mass index; HTO: high tibial osteotomy

Table 4. Clinical Characteristics of Patients Who Required Postoperative Albumin Supplement

Factor	Treatment Group (n=20)	No Treatment Group (n=462)	P value
Age (years)	54.65±6.71	53.26±5.88	0.303
Gender (n)			0.032
Male	7	318	
Female	13	144	
BMI (kg/m2)	23.87±3.99	23.14±2.92	0.283
Smoking: n(%)	2(10.0%)	134（29.0%）	0.064
Alcohol use: n(%)	2(10.0%)	94（20.3%）	0.392
Diabetes mellitus: n(%)	3(15.0%)	30（6.5%）	0.150
High blood pressure: n(%)	3(15.0%)	63(13.6%)	0.746
Preoperative Albumin (g/L)	34.99±4.02	42.27±5.22	p<0.001
Estimated blood loss (mL)	285.00±190.64	241.34±102.47	0.076
Operative time (minutes)	141.25±16.86	147.12±25.50	0.308

BMI: body mass index

Table 5. Risk Factors for Patients Requiring Postoperative Albumin Supplementation

Risk factor	odds ratio	95 % confidence interval	P value
Gender	0.163	0.057-0.470	0.001
Preoperative Albumin level	1.453	1.268-1.664	p<0.001

Table 6. Clinical Characteristics of Patients Who Required Postoperative Potassium Supplementation

Factor	Treatment Group (n=17)	No Treatment Group (n=465)	P value
Age (years)	54.00±6.86	53.29±5.89	0.627
Gender (n)			0.159
Male	7	318	
Female	10	147	
BMI (kg/m2)	23.30±3.74	23.16±2.94	0.852
Smoking: n(%)	1(5.9%)	135（29.0%）	0.051
Alcohol use: n(%)	1(5.9%)	95（20.4%）	0.216
Diabetes mellitus: n(%)	2(11.8%)	31（6.7%）	0.327
High blood pressure: n(%)	3(17.6%)	63(13.5%)	0.716
Preoperative Potassium (g/L)	3.68±0.53	4.10±0.38	0.006
Estimated blood loss (mL)	264.71±158.87	242.37±105.41	0.401
Operative time (minutes)	136.59±11.24	147.25±25.51	0.002

BMI: body mass index

Table 7. Risk Factor for Patients Requiring Postoperative Potassium Supplementation

Risk factor	odds ratio	95 % confidence interval	P value
Preoperative Potassium	19.870	4.805-82.166	p<0.001
Operative time	1.025	0.997-1.054	0.082

Table 8. Cutoff Values of Risk Factors for Patients Requiring Postoperative Clinical Treatment

Treatment	Risk factors	Cut-off value	Sensitivity	Specificity	AUC	p
Transfusion	BMI	23.15	89.5%	55.3%	0.770	<0.001
	Preoperative hb level	112.5	78.9%	97.0 %	0.947	<0.001
	Estimated blood loss	225	89.5%	81.2 %	0.888	<0.001
	Operative time	164.5	63.2%	81.4%	0.669	0.003
Albumin	Female gender	-	-	-	0.669	0.010
	Preoperative albumin level	38.95	95.0%	76.4 %	0.879	<0.001
Potassium	Preoperative potassium	3.45	41.2%	97.4%	0.707	0.004

BMI: body mass index; AUC: area under the curve.

Supplementary Files

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