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Original Article

Orthopaedics Section

Effect of Obesity and Hypertension on Blood Loss and Blood Transfusion Requirements in Primary Elective Total Knee Arthroplasty: A Prospective Clinical Study

VIKRAM INDRAJIT SHAH[1], SACHIN UPADHYAY[2], KALPESH SHAH[3]

ABSTRACT

Introduction: Identifying risk factors of operative blood loss is imperative toward establishing an effective blood management implementation strategy and further minimise the requirement for perioperative blood loss and transfusion.

Aim: To investigate whether the factors like obesity and hypertension affect blood loss and transfusion requirements in primary elective Total Knee Arthroplasty (TKA).

Materials and Methods: A prospective clinical study was conducted at Shalby Hospitals in Ahmedabad, Gujarat, India, from November 2017 to November 2019, on 91 patients recruited for primary elective TKA. The subjects were divided into two groups, i.e, group A (normotensive and non obese; n=46) and group B (Hypertensive and obese; n=45). Charlson-Deyo co-morbidity score was given to each patient as a measure of surgical risk. Data on intraoperative and postoperative blood loss, blood parameters (drop in haemoglobin, haematocrit value), and incidence of transfusion rates were recorded and assessed. All patients had standardised protocols of anesthesia, postsurgical and rehabilitation care protocols following surgery. Fisher's-exact test, Chi-square test, and Student's t-test was used for statistical analysis. Pearson's correlation was performed to identify factors associated to blood loss. The p-value <0.05 was considered significant. Statistical Package for Social Sciences (SPSS) version 22.0 was used.

Results: The intraoperative, postoperative and total blood loss (drop of haemoglobin and haematocrit) were significantly greater in the hypertensive and obese patients (p-value <0.001). The immediate postoperative day 1 haemoglobin and day 1 and 2 haematocrit were significantly better in the normotensive and non obese patients (p-value <0.001). Significantly greater number of hypertensive and obese patients required blood transfusion (p-value=0.045). There was a positive correlation between intraoperative blood loss and operative time in both groups (R^A=0.04, p-value=0.74; R^B=0.09, p-value=0.52) although statistically insignificant. Hypertensive and obese patients required longer hospitalisation (p-value <0.001). Three patients from group B were diagnosed to develop pulmonary embolism while admitted in hospital which was managed successfully by intensivists without any fatality.

Conclusion: Hypertension and obesity were associated with greater blood loss and transfusion requirement compared to non obese and normotensive patients undergoing primary elective TKA.

Keywords: Charlson-Deyo co-morbidity score, Haemoglobin, Haematocrit, Postoperative blood loss, Pulmonary embolism, Risk factors

INTRODUCTION

Total Knee Arthroplasty (TKA) has become widely accepted as the treatment of choice for patients with end-stage of knee arthritis and these can significantly alleviate pain and restore functional outcome and enhances the quality of life for these patients [1]. Significant proportion of patient reporting with degenerative knee disease require surgical intervention. The TKA involves substantial intraoperative blood loss owing to bone cuts and extensive soft-tissue release usually leads to an allogenic or autologous blood transfusion. Transfusions are usually safe, at-times associated with transfusion-related adverse event and potential infectious hazards [2,3]. Several previous reports have shown that blood transfusion increased the risk of surgical-site infections, serious complications, longer hospital length of stay, and even mortality [4-6].

Further, it increases the cost and more use of resources [7]. Autodonation lead to unnecessary low postoperative haemoglobin levels and otherwise unnecessary transfusions [8]. The incidence of transfusion requirement and amount of blood loss following TKA appears highly variable in available literatures [5-9]. No single factor attributed to blood loss during surgery necessitating transfusion. Indeed, significant information gaps remain in understanding the common associated risk factors such as hypertension and obesity besides the demographic variables like age and gender [10]. A previous study identified preoperative hypertension and/or being overweight/obese as potential risk factor for poor haemodynamic control during Total Joint Arthroplasty (TJA) [11]. In this light, identifying potentially high-risk patients requiring transfusion are vital to formulate strategies for addressing the issue of blood loss and transfusion rate.

The current study aimed to analyse prospectively whether obesity and hypertension affect blood loss and transfusion requirements in primary elective TKA.

MATERIALS AND METHODS

This prospective clinical study was conducted at Shalby Hospital in Ahmedabad, Gujarat, India, from November 2017 to November 2019, after receiving approved from the Institutional Review Board (ECR/711/InST/GJ/2015/RR-18/01-2017). The study was approved by the Scientific Review Committee and the Institutional Review Board of the participating Health Service. Written Informed consent (about the surgical technique, risks and potential complications) was provided according to the Declaration of Helsinki and obtained from all participating patients.

Sample size calculation: Sample size was estimated using formula of simple random sampling for infinite population and assumptions were considered based on the total measured blood loss of 0.663 litres in primary uncomplicated total knee arthroplasty [9]. At 95% confidence intervals (5% α), 80% power and 0.1 absolute precision, a power analysis determined that a sample of minimum 86 subjects were required.

$$n=\frac{z_{2(1-\alpha/2)}\times p\times(1-p)}{d^2}$$

Confidence level: conventional=95%=1-α; therefore, α=0.05 and $z_{(1-\alpha/2)}$=1.96=value of the standard normal distribution corresponding to a significance level of 0.05 (1.96 for a 2-sided test at the 0.05 level).

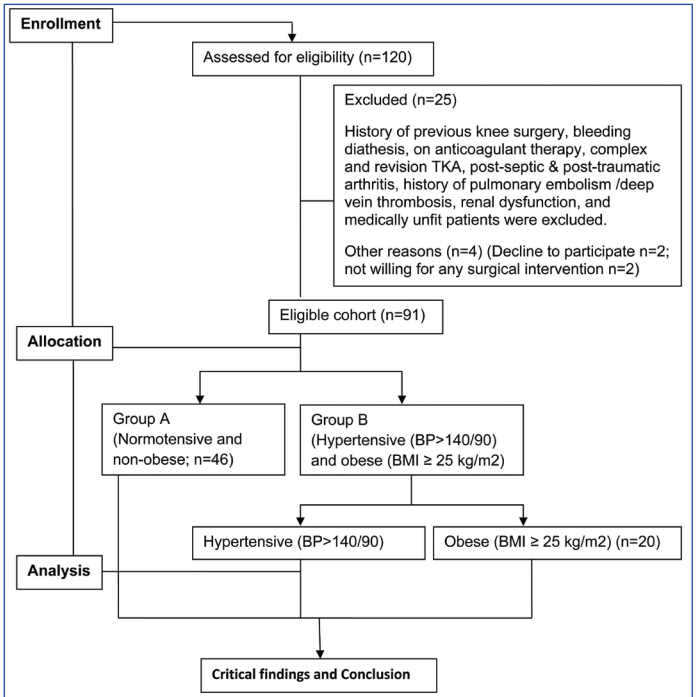
Inclusion criteria: A total of 120 patients with primary Kellgren-Lawrence grade 3 and 4 knee osteoarthritis and relentless knee pain despite 6 months of conservative treatment were included in the study [12].

Exclusion criteria: Twenty five patients with history of previous knee surgery, bleeding diathesis, on anticoagulant therapy, complex and revision TKA, postseptic and post-traumatic arthritis were excluded. Also, patient with history of pulmonary embolism/deep vein thrombosis, renal dysfunction, and medically unfit patients (unacceptable medical risk or medical co-morbidities had not been sufficiently optimised) were also excluded. Further, four patients for other reasons like declining to participate and unwillingness for the surgery led to their exclusion.

Therefore, 91 patients were recruited into the study and divided into:

- Group A (n=46): Normotensive and non obese
- Group B (n=45): Hypertensive (BP>140/90) [13] and obese; (BMI ≥25 kg/m^2) [14]. Further, based on Body Mass Index (BMI) and blood pressure, the subjects in group B were categorised into obese and hypertensive:
    - Hypertensive: n=25 and
    - Obese: n=20

The flow chart for the study is shown in [Table/Fig-1].



[Table/Fig-1]: Flowchart showing distribution of study participants.

Procedure

Demographic variables, including age, gender, and severity of diseases, deformity and co-morbidity (hypertension, obesity, diabetes, optimised states of renal/cardiac/liver/pulmonary co-morbidities) were recorded. Medical co-morbidity was measured using the Charlson-Deyo co-morbidity index [15]. The haematological parameters (drop in Haemoglobin (Hb), haematocrit value) were recorded at baseline, on first and second Postoperative Day (POD). A uniform transfusion protocol was maintained for all participants in the study [16]. Postoperative blood transfusion was given if the Haematocrit (Hct) was less than 27% or any patient who had a postoperative Hb <8.0 g%. Venous doppler was performed prior to surgery and on 4th postoperative day to rule out Deep Vein Thrombosis (DVT).

All patients were operated by a designated arthroplasty team without tourniquet using standard approach under spinal anesthesia [17]. Authors have not used tranexamic acid prior to surgery.

Joint balancing was achieved using standard bone cuts and appropriate soft tissue release. Intraoperative haemostasis was achieved using electrocoagulation. All had cemented posterior stabilised metal backed press fit condylar sigma fix bearing prosthesis. Pulsed lavage technique was used to clean the wound. Arthrotomy was closed in layers without any closed suction drain and staplers were used and covered by an occlusive dressing. All patients received standard chemoprophylaxis for VTE {received Apixaban (Eliquis) 2.5 mg twice for two weeks} [18] and followed a standard protocol of rehabilitation [17].

In all the cases, Intraoperative blood loss [19] was estimated using an electric weighing scale with an accuracy of 0.1 mg (Alexandra Scale Pvt. Ltd. Gujarat, India). The blood volume in the suction cylinders and the number of saturated blood stained mops were used to quantify the blood loss. As all these measurements were carried out before using the pulse lavage thus the fluid volume used during the lavage was excluded. Postoperative blood loss was calculated using two methods:

- The first was the Blood Loss Estimation Using Gauze Visual Analogue method (clinical) during first and second check dress using dry surgical gauze (10×10 cm) as no closed suction drain was used [20].
- The second method was based on haematocrit balance using Gross equation [21]. This includes the volume of blood lost due to extravasation in the tissues.

Gross formula is given as under [21]:

Estimated blood loss=Estimated blood volume×(Hct initial-Hct final)/Hct average

Where Estimated blood volume=body weight in kg×70 mL/kg

Total blood loss (clinical) was determined by adding intraoperative and postoperative blood loss.

Outcomes measures: Intraoperative, postoperative, and total blood loss (clinical method and Gross equation), incidence of transfusion rates, mean postoperative Hb levels on POD 1 and 2 were the primary end-points. The drop in Hb and Hct was calculated between the lowest postoperative level and the baseline value. Duration of stay in hospital, and complications within the postoperative days were secondary analytic focus. Authors also performed a subgroup analysis to separately compare the above mentioned parameters in obese and hypertensive patients.

STATISTICAL ANALYSIS

All data presented as mean±Standard Deviation (SD) and range. During evaluation, numerically-coded categorical variables were cross tabulated; Fisher's-exact test or Chi-square was applied as required. If the frequency was <5, Fisher's-exact p-value was provided; Chi-square p-values were used for all other estimates. Pearson's correlation was performed to identify factors associated to blood loss. To test the difference between independent means, Student's t-test was used. Significance was attributed to a p-value <0.05. Analysis was performed using Statistical Package for Social

Sciences (SPSS) for Windows software, version 22.0 (SPSS, Inc., Chicago, IL, USA).

RESULTS

The study population included 91 patients comprising of 38 males and 53 females of mean age 68.37±5.17 years (range 62-80). Baseline parameters were similar for both group A and group B [Table/Fig-2].

Characteristics	Group A (n=46) (Mean±SD)	Group B (n=45) (Mean±SD)	p-value
Age (years)	68.02±4.89	68.73±5.54	p-value=0.5183; 95% CI: (2.8853-1.4653)
Gender			
Male	21	17	χ^2=0.57 p-value=0.44;
Female	25	28	
Severity of disease (Kellgren and Lawrence system) [12]			
Grades III	15	16	χ^2=0.0879 p-value=0.766
Grade IV	31	29	
Deformity (in degree) (Varus/Valgus)	15.9±1.03	16.1±1.20	p-value=0.28
Charlson-Deyo co-morbidity index [15]	2.5±0.744	2.64±0.922	p-value=0.4270; 95% CI: (0.48860-0.20860)
Preoperative haemoglobin (gm/dL)	13.21±1.5	13.19±1.4	p-value=0.9477; 95% CI: (0.5847-0.6247)
Preoperative haematocrit (%)	36.31±3.8	35.59±3.3	p-value=0.3376; 95% CI: (0.7638-2.2038)

[Table/Fig-2]: Clinico-demographic variables of the study subjects (N=91).

Both groups were similar in terms of age (p-value=0.5183), gender (p-value=0.44), severity of disease (p-value=0.766), deformity (p-value=0.28), preoperative Hb (p-value=0.9477), preoperative Hct (p-value=0.3376) and Charlson-Deyo co-morbidity index (p-value=0.4270). Average Charlson score was 2.69± 0.957. Nine patients (9.8%) had Charlson score ≥4. The patients in group B had significantly longer surgical time than group A (66.31±8.679 vs. 47.739±3.07 min; p-value <0.001 [Table/Fig-3].

The intraoperative (p-value <0.001), postoperative (visual analogue method) (p-value <0.001), and total (clinical method and Gross equation) blood loss (p-value <0.001) were significantly greater in the group B. The total measured blood loss by clinical method in group A and B amounted to 246.49±110.21 mL and 385.55±168.01 mL respectively in a primary TKR (p-value <0.001). The difference in mean intraoperative blood loss was 128 mL (p-value=0.0001), postoperative blood loss was 10.98 mL (p-value <0.005), total blood loss (clinical) was 139 mL (p-value <0.001), and total blood loss (Gross equation) was 361 mL (p-value <0.001) between the two groups.

Postoperative haematological parameters like haemoglobin and haematocrit presented significant differences between the group A and B. Importantly, the drop in Hb and Hct on postoperative day 1 (p-value <0.001) and day 2 (p-value <0.001) were significantly more in the group B. A significantly greater percentage of patients in the group B required blood transfusion during the study (p-value=0.045). A total of 7 (7.7%) patients needed postsurgical blood transfusion of which 1 (1.09%) was in the group A and 6 (6.66%) in the group B. No transfusion associated complications were found in the study. Patients in group B had significantly longer average stay in the hospital (p-value <0.001). On subgroup analysis, obese patients overall had

Parameters	Group A (n=46) Mean±SD	Group B			p-value
		Total (n=45) Mean±SD	Hypertensive (n=25) Mean±SD	Obese (n=20) Mean±SD	
Operative time (minutes)*	47.739±3.07	66.31±8.679	66.04±8.43	66.65±9.19	p^{AB}<0.001**; p^{HO}=0.8178
Intraoperative blood loss (mL)	238.02± 21.04	366.11±33.92	354.8±33.83	380.25±29.00	p^{AB}<0.001**; p^{HO}=0.0107*
Blood loss					
First check dressing	5.21±1.31	11.73±1.44	11.6±1.26	11.9±1.67	p^{AB}<0.001**; p^{HO}=0.4957
Second check dressing	3.26±0.84	7.711±2.65	7.68±2.69	7.75±2.68	p^{AB}<0.001**; p^{HO}=0.9312
			19.28±1.96 (total postoperative)	19.54±2.02 (total postoperative)	
Total blood loss (clinical method) [20]	246.49±110.21	385.55±168.01			p^{AB}<0.001**
Total blood loss- Gross formula [21]	484.1±260.8	846±373.5			p^{AB}<0.001**
Postoperative haemoglobin (gm/dL)					
Day 1	12.09±0.45	11.28±0.53	11.22±0.60	11.36±0.43	p^{AB}<0.001**; p^{HO}=0.3849
Day 2	11.51±0.56	10.85±0.56	10.84±0.55	10.87±0.59	p^{AB}<0.001**; p^{HO}=0.8611
Drop in haemoglobin (gm/dL)					
Day 1	1.12±0.16	1.91±0.07	1.90±0.08	1.94±0.07	p^{AB}<0.001**; p^{HO}=0.0855
Day 2	1.71±0.11	2.34±0.22	2.28±0.21	2.43±0.21	p^{AB}<0.001**; p^{HO}=0.0218*)
Postoperative haematocrit (%)					
Day 1	33.54±4.60	30.77±0.99	30.96±1.07	30.55±0.86	p^{AB}<0.001**; p^{HO}=0.1715
Day 2	32.84±1.80	30.43±1.12	30.54±1.14	30.3±1.12	p^{AB}<0.001**; p^{HO}=0.4833
Drop in haematocrit (%)					
Day 1	2.77±0.70	4.82±0.50	4.92±0.19	4.76±0.58	p^{AB}<0.001**; p^{HO}=0.2012
Day 2	3.47±0.54	5.16±0.41	5.2±0.36	5.12±0.48	p^{AB}<0.001**; p^{HO}=0.5262
Blood transfusion (no. of patients)#	1	6	2	4	χ^{2AB}=3.9895; p^{AB}=0.045785 χ^{2HO}=1.3846; p^{HO}=0.2393
Length of hospital stay (day)	4.23±0.52	6.03±0.82	5.9±1.09	6.2±0.09	p^{AB}<0.001**; p^{HO}=0.22

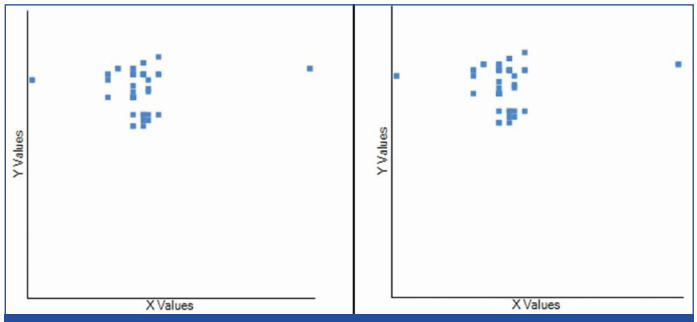
[Table/Fig-3]: Comparative analysis of different parameters of two cohorts.
p^{AB}: Group A and Group B; p^{HO}: Hypertensive and Obese

a longer operative time (p-value=0.8178), greater intraoperative (p-value=0.01) and postoperative blood loss {first check dressing (p-value=0.49); second check dressing (p-value=0.93)} and have higher drop of Hb and Hct on postoperative day 1 (p-value for Hb=0.0855; p-value for Hct=0.2012) and day 2 (p-value for Hb=0.0218; p-value for Hct=0.5262) than in hypertensive groups [Table/Fig-2].

In addition, these patients have higher transfusion rates (χ^2=1.3846; p-value=0.2393) and require longer hospitalisation (p-value=0.22). There was a positive correlation between intraoperative blood loss and operative time in both groups (R^A=0.04, p=0.74; R^B=0.09, p-value=0.5253) [Table/Fig-4,5,6].

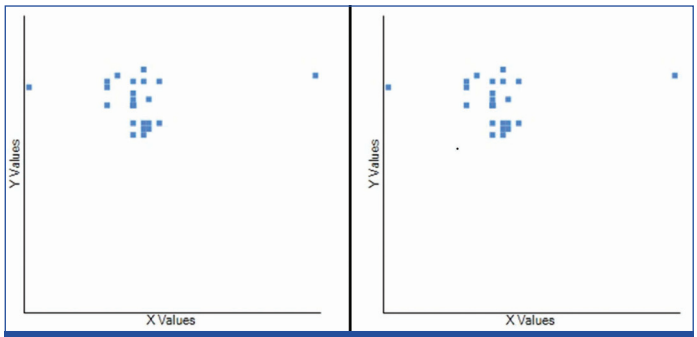
Characteristic	Groups	Pearson's coefficient	p-value
Intraoperative blood loss and operative time	A (n=46)	R^A=0.04	p^A=0.74
	B (n=45)	R^B=0.09	p^B=0.5253
Operative time and the intraoperative blood loss	Hypertensive (H) (n=25)	R^H=0.049	p^H=0.81
	Obese (n=20)	R^O=0.14	p^o=0.53

[Table/Fig-4]: Pearson's correlation coefficient for intraoperative blood loss and operative time.



[Table/Fig-5]: Scatter diagram showing positive correlation between intraoperative blood loss and operative time in group A (normotensive and non obese); X-operative time in min; Y- intraoperative blood loss (ml) R^A=0.04; P^A=0.74.
[Table/Fig-6]: Positive correlation between intraoperative blood loss and operative time in group B (Hypertensive and obese); X-operative time in min; Y- intraoperative blood loss (mL) R^B=0.09; P^B=0.5253. (Images from left to right)

Although statistically insignificant, Likewise, factors such as hypertension and obesity showed a positive correlation between operative time and the intraoperative blood loss but not very significant (R_H=0.049, p_H=0.81; R_O=0.14, p_o=0.53) [Table/Fig-4,7,8].



[Table/Fig-7]: Positive correlation between intraoperative blood loss and operative time in Hypertensive; X-operative time in min; Y- intraoperative blood loss (mL) R_H=0.049; P_H=0.81.
[Table/Fig-8]: Positive correlation between intraoperative blood loss and operative time in obese; X-operative time in min; Y- intraoperative blood loss (ml) R_O=0.14; P_O=0.53. (Images from left to right)

A total of three patients had a postsurgical systemic complication and all of which were from group B. These patients were diagnosed to develop pulmonary embolism while admitted in hospital which was managed successfully by intensivists without any fatality. Vascular insult occurred in a single obese patient which was managed by immediate repair by vascular surgeons without any limb threatening complications.

DISCUSSION

Excess perioperative blood loss can be a major cause of morbidity or even mortality in total knee replacement surgery. Obesity and hypertension is widely regarded as a significant risk factor [11]. In the present study, the obese and hypertensive patients had significantly greater blood losses and blood transfusion requirements compared to the group having non obese and normotensive patients. Intraoperative haemodynamic control is considered as main driving forces behind improved surgical outcome [11]. In a retrospective cohort study by Nwachukwu BU et al., 118 consecutive patients who underwent Total Joint Arthroplasty (TJA) were included [11]. The authors identified preoperative hypertension and/or being overweight/obese as potential risk factor for poor haemodynamic control during TJA. Furthermore, in the view of orthopaedic surgery, Mortazavi SM et al., suggest that poor haemodynamic control are associated with increased risk of perioperative stroke after TJA [22]. A subgroup analysis confirmed that there is greater intraoperative and postoperative blood loss in obese patients than in hypertensive patients.

The blood transfusion rate in obese patients in present study was on the higher side compared with the hypertensive patients, despite having a similar preoperative haemoglobin value. This finding, although insignificant, suggests that intraoperative blood loss influences transfusion rate.

In the present study, both the hypertension and obesity showed a positive correlation between operative time and blood loss. This study found that hypertensive patients had greater amount of blood loss compared to normotensive. The present study results are similar to Durasek J et al., who identify the factors affecting major blood loss in patients undergoing TKA [23]. Durasek J et al., concluded that patients with hypertension had a significantly greater amount of blood loss volume and increased blood transfusion requirement as compared to normotensive patients. In addition, Nwachukwu BU et al., in a retrospective analysis have identified hypertension as a significant risk factor for poor haemodynamic control in patients undergoing total joint arthroplasty [11].

There is controversy in the available evidences concerning the perioperative blood loss and risk of blood transfusion postsurgery. Whilst some authors conclude that obesity did not affect the amount of perioperative blood loss or incidence of blood transfusion [9,24,25], others have found obesity correlated with increased perioperative blood loss and blood transfusion rates [26,27]. Consistent with previous studies, the findings of present analysis showed that obesity was associated with increased intraoperative, postoperative blood loss and higher blood transfusion rate.

Furthermore, significant drop in postoperative haemoglobin and haematocrit values in these patients was noted. This difference was attributable to the fact that the greater surface area of subcutaneous fat exposed leads to more tissue fluid loss. This may also elucidate greater intraoperative losses, not of tissue fluid but of blood, from more arterial and venous bleeding points [28]. In addition, Nwachukwu BU et al., identified that being overweight/obese was independently associated with an increased risk for poor haemodynamic control [11]. Although the exact pathophysiological is largely unknown, autonomic dysfunction could provide a plausible explanation [29]. Also, the increased surgery time further contributes to increased intraoperative blood loss and inturn transfusion rate. A one minute increase in anesthesia time leads to increase of 3.167 mL total blood loss in total knee arthroplasty [30].

The present study demonstrated a significant difference between the group A and B regarding the operative times (p-value <0.001). This may be attributed to increase surgical bleeding that inturn significantly compromised the optimal view of the operative field [31]. Secondly, the surgeon took few minutes to effectively and efficiently manage hemostasis.

In addition, a relatively longer length of skin incision and extensile soft tissue dissection for adequate exposure significantly influence the operative time in obese patients. Further, the additional layers of adipose tissue make visualisation of the structures of knee joint difficult. This restricted visualisation of the operative field results to technical errors related to imprecise bone cuts, more damage to soft tissue structures, and poor positioning of the prosthesis [32]. Thus, authors believe that the obesity and hypertension should be considered as potential risk indicator for prolonged surgical time when performing TKA. The current study finding is supported by the results of prior literature that showed that obesity was related to longer surgical time in patients undergoing unilateral TKA [33]. This critical information will allow arthroplasty team to appropriately utilise the operating theatre time and resources.

There are conflicting reports concerning the association of length of surgery and blood loss in patients undergoing TJA. Some studies have identified a positive association between these variables [9,28] while others failed [34,35]. The results from present study corroborate the previous findings demonstrating a positive correlation between the apparent total blood loss and surgical time [9,28]. Notably, gender difference could affect surgical total blood loss, with greater amount in male patients compared with female patients. In the present study there is significantly more perioperative blood loss in male patients than in female patients. These findings from present study also received agreement from several scholars who also showed that male experience greater blood loss than female in TKA [9,35].

In the current study, on subgroup analysis of group B there was no statistically significant difference between the obese and hypertensive groups with regard to postoperative blood loss, drop in Hct and day 1 Hb level although the intraoperative blood loss, total blood loss, postoperative day 2 Hb and transfusion rate was significantly higher in obese patients. This may be attributable to poor haemodynamic control in obese patients [11].

Authors found that there was significant difference in length of stay between group A and B patients. Obese and hypertensive patients were likely to stay longer in hospital. Delayed postsurgical rehabilitation, blood transfusion and in-patient complications could be the plausible factors [36]. Thus authors believe that factors such as obesity and hypertension significantly influence Length of Stay (LOS) following TKA.

In the current study, the apparent total blood loss was on the lower side compared with the other scholars [9,35,37-42] [Table/Fig-9].

The lower value is probably attributed to different method employed for the measurement of postoperative blood loss. Authors stated that previous literature have focused on the blood loss estimation by draining in the postoperative period but have not evaluate the amount of blood lost after a tourniquet release in the compression dressing or in the blood soaked in the tissues [43-45]. Also, they have not assessed the blood soaked gauge while dressing. In the present study, the authors have used visual analogue method instead of negative suction drain. This method may increase the precision of blood loss assessment and reduces the consequences related to over or underestimation of blood loss [20]. Authors believe that using drain after replacement diminished the tamponade effect and thus increases blood loss. Likewise, the study found no difference in the incidence of wound infection, dehiscence or haematoma formation between drained and without drainage [46]. Further, increased transfusion reflected greater blood loss associated with drain. Authors have not used tourniquet in any of the case. The authors were skeptical concerning the use of tourniquet. A meta-analysis and systematic review concluded that using tourniquet during the surgery does not reduce the transfusion requirement rather showed a trend for greater complications compared to non tourniquet patients [47].

Study	Year	Blood loss (mL)
Mylod AG Jr et al., [37]	1990	686 (490-990) RA 583 (315-925)OA
Cushner FD and Friedman RJ, [35]	1991	805 mL
Raut VV et al., [36]	1993	1215 (400-2050) mL
Benoni G and Fredin H [39]	1996	1410±480 (placebo) 730±280 (prophylactic TA)
Tanaka N et al., [40]	2001	785 (670-880; control group) 776 (393-1,159; preoperative TA) 896 (495-1310; intraoperative TA) 528 (252-925; preoperative+intraoperative TA)
Prasad N et al., [9]	2007	664±209 mL 657 (230-1050)OA 690 (320-1270)RA
Hu Y et al., [41]	2018	1346±671 mL TA
Meng Y et al., [42]	2018	499.93±148.06 mL (actual blood loss; obese TA) 209.17±87.09 mL (intraoperative; obese TA) 49.67±40.43 mL (postoperative; obese TA) 578.07±186.74 mL (actual blood loss; obese non TA) 212.14±84.03 mL (intraoperative; obese non TA) 57.14±51.97 mL (postoperative; obese non TA)
Current study	2022	246.49±110.21 mL (Total blood loss; normotensive and non obese) OA 385.55±168.01 mL (Total blood loss; hypertensive and obese) OA 380.25±29 mL (intraoperative; obese) 19.54±2.02 mL (postoperative; obese) 354.8±33.83 mL (intraoperative; hypertensive) 19.28±1.96 mL (postoperative; hypertensive)

[Table/Fig-9]: Comparison of Scholars on total blood loss (mL) [9,35,37-42].
*TA: Tranexamic acid; RA: Rheumatoid arthritis; OA: Osteoarthritis

In the present study, tranexamic acid was not used prior to surgery. as it may lead to significant underestimation of blood loss and thus give false confidence in the results [39,40]. The transfusion requirement in current study has been low compared with other scholars [9, 35]. This could be attributed to meticulous dissection, reduced mean operative time, use of cemented implants, plugging the femoral intramedullary canal and not using drain [37]. This study also highlights that obese and hypertensive patients have greater transfusion requirements. Inaddition, obese patients require more transfusion than hypertensive patients. This finding, although insignificant, suggests that intraoperative blood loss influences transfusion rate.

A total of 3 patients had a postsurgical systemic complication and all of which were from group B. Two patients were diagnosed to develop pulmonary embolism while admitted in hospital which was managed successfully by intensivists without any fatality. Study by Holst AG et al., identified that hypertension, smoking, and obesity were important risk factors for VTE [48]. Vascular injury during surgical procedure occurred in single obese patient. Authors believe that obese patients were more prone for the vascular insult owing to complicated surgical exposure and limited visualisation due to excessive layers of adipose tissue [49].

Limitation(s)

Firstly, the sample size was small, so additional investigation in a larger cohort is required. Secondly, impact of changing of categorisation of obesity on blood loss and transfusion requirement was not assessed. Thirdly, the functional outcome was not investigated. Fourth, only adverse health outcome events that occured within the primary hospitalisation could be investigated, data on postdischarge events were not assessed.

CONCLUSION(S)

Both hypertension and obesity were associated with greater blood loss and transfusion requirement, require longer hospitalisation compared to non obese and normotensive patients undergoing replacement surgery. Intraoperative blood loss influences transfusion rate. Likewise, these patients were more likely to have adverse effects. Operative time showed a positive correlation with the blood loss. The present study quantifies the potential risk in the hypertensive and obese patients undergoing TKA and will aid in preoperative planning and consent.

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PARTICULARS OF CONTRIBUTORS:
1. Director and Head, Department of Knee and Hip Arthroplasty, Shalby Hospitals, Ahmedabad, Gujarat, India.
2. Professor, Department of Orthopaedics, Netaji Subhash Chandra Bose Medical College, Jabalpur, Madhya Pradesh, India.
3. Senior Arthroplasty Surgeon, Department of Knee and Hip Arthroplasty, Shalby Hospitals, Ahmedabad, Gujarat, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Sachin Upadhyay,
House No. 622, Poonam Sneh Nagar, State Bank Colony,
Jabalpur, Madhya Pradesh, India.
E-mail: drsachinupadhyay@gmail.com

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