Original Article

AN EVALUATION OF INTRA-OPERATIVE AND POST-OPERATIVE BLOOD LOSS IN TOTAL KNEE ARTHROPLASTY AT THE NATIONAL ORTHOPAEDIC HOSPITAL, LAGOS

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ABSTRACT

BACKGROUND:
Total knee replacement is a rewarding and reliable procedure, producing a lasting relief to severe knee pains. However, significant blood loss usually in the post-operative period may be a challenge, necessitating prompt restoration of circulating blood volume to minimize morbidity and mortality.The aim of this study was to evaluate blood loss after total knee replacement

PATIENTSAND METHODS:
A prospective study of blood loss after Total Knee Arthroplasty in 53 patients in the National Orthopaedic Hospital, Lagos. Consecutive patients with established indications, presenting for total knee arthroplasty were recruited into the study after obtaining their consent.

RESULTS:
The mean intra-operative blood loss was 342.4 mls, with a range of 50 - 1500 mls.The mean post-operative blood loss and total blood loss were 603.6 mls and 940.3 mls respectively, showing a strong positive correlation ($r = 0.884$, $p < 0.01$).The average pre-operative and post-operative haemoglobin concentration were 12.5 ± 1.2 g/dl and 9.8 ± 0.9 g/dl, respectively.The mean haemoglobin loss was 2.6 ± 1.2 g/dl ($r = 0.46$, $p < 0.001$).

CONCLUSION:
Post-operative blood loss as measured by suction drainage, is a good predictor of total blood loss, showing a strong and positive correlation.

KEYWORDS: Total Knee Arthroplasty, Blood loss, Tourniquet, Surgical time.

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INTRODUCTION

Total knee replacement is a rewarding and reliable procedure in patients with severe knee pain associated with functional limitation with or without knee deformity. The benefits of the procedure is gratifying, especially in the elderly, if patient selection is appropriate and ideal. The procedure however, may be associated with significant blood loss usually in the post-operative period. Although the use of a tourniquet minimizes the intra-operative blood loss, the post-operative blood loss, as measured in suction drainage and as calculated from the decline in haemoglobin, can be considerable.[1] This often necessitates prompt restoration of circulating blood volume to minimize morbidity and mortality. This in itself poses a danger, as the risks of homologous blood transfusion cannot be over emphasized. Measures to minimise intra-operative blood loss, including optimal pre-operative physiological status, use of appropriate surgical approach, gentle and delicate tissue dissection, surgical expertise, rational use of electrocautery, and others should be employed during this procedure.

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OBJECTIVES

1. To evaluate blood loss after total knee replacement
2. To evaluate effect of surgical time and Tourniquet duration on blood loss

PATIENTS AND METHODS

Study Design

A prospective study of blood loss after Total Knee Arthroplasty in 53 patients in the National Orthopaedic Hospital, Lagos between January 2013 and December 2014.

Inclusion Criteria

- Patients with no Previous Thrombo-embolic phenomenon
- Patients with no Renal pathology
- Patients with no Hepatic pathology
- Patients that give consent

Exclusion Criteria

- History of bleeding disorder
- Patients on anticoagulants for established Venous Thrombo-embolism
- Patients with Renal pathology
- Patients with Hepatic pathology
- Patients that do not give consent

Study Technique

Approval for the study was obtained from the Ethics and Research committee of the hospital, following development of a study protocol. Consecutive patients with established indications, presenting for total knee arthroplasty were recruited into the study after obtaining their consent.

Patients' demographic parameters, complaints and associations, diagnosis, surgical approach, type of anaesthesia, pre-operative and post-operative haemoglobin concentration, duration of tourniquet use, duration of surgery, intra-operative and post-operative blood loss, and number of blood units transfused were recorded on the designed proforma.

As part of the study protocol, preliminary estimation of blood volume in a partially and fully soaked gauze pack (abdominal pack) and swab was done by weighing the wet and dry gauze pack and swabs; and subtracting the values of dry weight from wet weight. This is shown in table 1.

	Volume in GAUZE PACK (ml)	Volume in SWAB (ml)
Partially Soaked	50	10
Fully Soaked	100	20
Fully Soaked and Dripping	150	40

Table 1: Volume of blood lost into Swabs and Gauze packs.

Surgery was done under regional or general anaesthesia using either the standard medial parapatellar approach to arthrotomy, or the subvastus approach. All procedures were done under tourniquet with strict asepsis; while ensuring dissection along surgical planes, judicious use of electrocautery and gentle soft tissue dissection. A redivac suction drain was used for all patients.

All patients had post-operative DVT prophylaxis with subcutaneous Clexane 1mg/kg/day, from 2nd day of surgery, for 48 hours and subsequently oral Xarelto 10mg daily for 2 - 4 weeks.

Intra-operative blood loss was calculated by counting the number of swabs and gauze packs, and estimating the volume of blood as shown in table 1. Blood loss was also measured by calculating the amount of blood in the suction, after subtracting the volume of irrigation fluid used; blood lost on the drapes was also estimated. The total intra-operative blood loss was obtained by summation of blood loss to all these points. Post-operative blood loss was calculated by measuring the blood volume within the closed suction reservoir bottle within the first 72 hours.

The effect of surgical time and duration of tourniquet use on blood loss was evaluated by dividing patients into two groups. Group 1patients had surgical time or Tourniquet time < 2 hours, while Group 2 patients had surgical time or > 2 hours.

Statistical Analysis

Data was collected and summarized on a spreadsheet, and analyzed using the statistical package for social sciences version 17 (SPSS 17). Statistical significance of tested variables was assessed using the independent t-test and the Levene's test for equality of variances. A P-value of 0.05 or less was taken as significant, at 95% confidence interval.

Outcome Measure

The outcome measures were intra-operative and post-operative blood loss after total knee replacement.

RESULTS

A total of 53 patients who had total knee arthroplasty was studied. Age range was between 25 and 80 years, with a mean age of 61.4 ± 8.8 years. Female patients accounted for the majority of cases with 90.6%, giving a Female : Male ratio of 9.6 : 1. The average duration of symptoms was 4.2 years. Twenty patients (37.7 %) had a left Total Knee Arthroplasty, while 33 patients (62.3%) had right Total Knee Arthroplasty.

All patients had a primary total knee arthroplasty in this study. A medial parapatellar arthrotomy was done in 48 (90.6%) patients, while 4 (7.5%) patients had a subvastus approach to arthrotomy; one patient with a valgus knee had a lateral parapatellar arthrotomy.

The average duration of surgery was 2.1 ± 0.5 hours, with 35 (66.0%) of the total procedures done within 2 hours and 18 (34.0%) lasting over 2 hours. Tourniquet use lasted an average of 2.1 ± 0.5 hours, with a maximum time of 3 hours.

The results of pre- and post-operative parameters and blood loss are shown in the charts and tables below. The average pre-operative and post-operative haemoglobin concentration were 12.5 ± 1.2 g/dl and 9.8 ± 0.9 g/dl, respectively. (figures 1 and 2) The mean haemoglobin loss was 2.6 ± 1.2 g/dl (r = 0.46, p < 0.001).

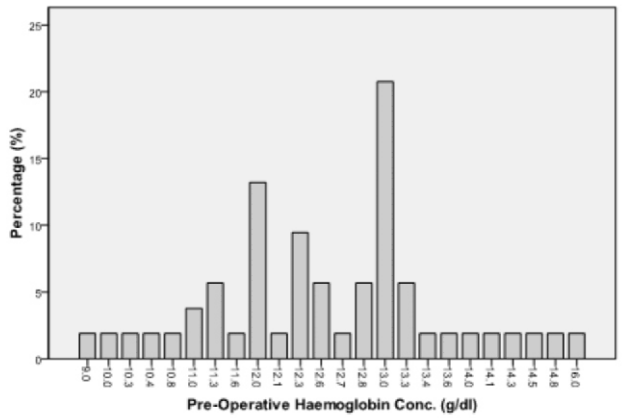

Figure 1: Pre-operative Haemoglobin Concentration

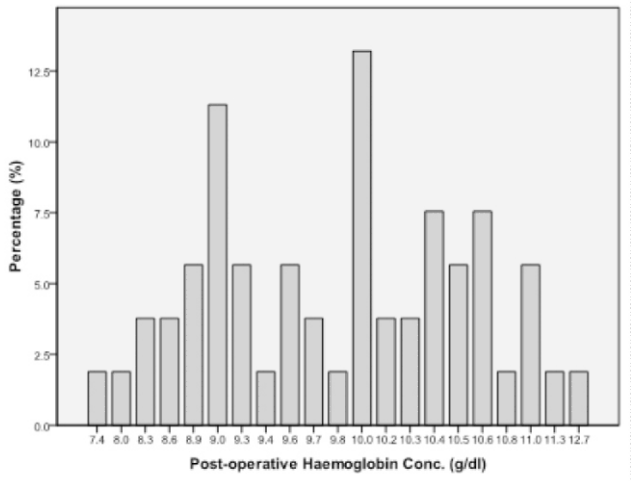

Figure 2: Post-operative Haemoglobin Concentration

The mean intra-operative blood loss was 342.4 mls, with a range of 50 - 1500 mls. (figure 3). Five patients (9.4%) had intra-operative blood transfusion with two pints of blood each. The mean post-operative blood loss and total blood loss were 603.6 mls and 940.3 mls respectively, showing a strong positive correlation (r = 0.884, p < 0.01)

The Post-operative blood loss measured as drain effluent volume within the first 72 hrs, is shown in table 2; the average duration of drain use is also shown. The results of intra-operative and post-operative blood loss in the 2 groups of patients are shown in tables 3 - 6 , as assessed by the independent T-test.

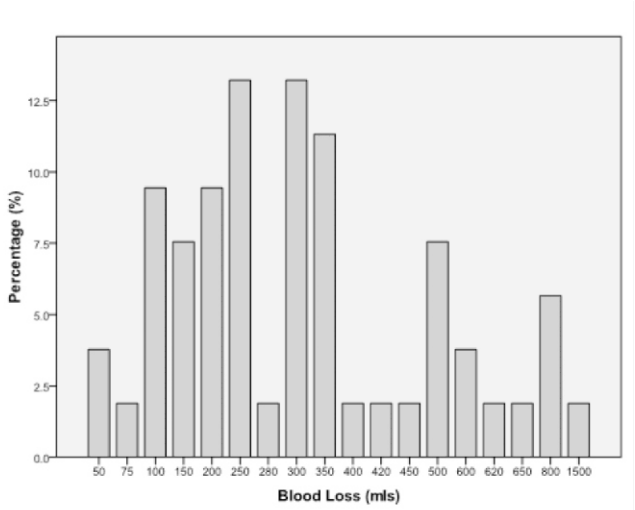

Figure 3: Intra-operative Blood loss

	REDIVAC EFFLUENT DAY 1 (mls)	REDIVAC EFFLUENT DAY 2 (mls)	REDIVAC EFFLUENT DAY 3 (mls)	REDIVAC DURATION (Days)
Mean	421.7	151.1	30.9	2.5
Std. Error of Mean	37.6	17.3	5.1	0.1
Median	350.0	100.0	0.0	2.5
Mode	150.0	50.0	0.0	2.0
Std. Deviation	271.3	125.1	36.8	0.5
Range	900.0	580.0	150.0	1.0
Minimum	100.0	20.0	0.0	2.0
Maximum	1000.0	600.0	150.0	3.0

Table 2: Post-operative Blood Loss as measured by drain effluent within first 72 hrs

	Duration of Surgery Group	Mean	Std. Deviation	Std. Error Mean
INTRA-OPERATIVE BLOOD LOSS (mls)	Group A(<2 Hrs)	288.43	190.8	32.3
	Group B(>2 Hrs)	447.22	317.8	74.9
REDIVAC EFFLUENT DAY 1 (mls)	Group A(<2 Hrs)	394.12	251.59	43.15
	Group B(>2 Hrs)	473.89	305.89	72.09
REDIVAC EFFLUENT DAY 2 (mls)	Group A(<2 Hrs)	142.65	114.55	19.65
	Group B(>2 Hrs)	167.22	145.11	34.20
REDIVAC EFFLUENT DAY 3 (mls)	Group A(<2 Hrs)	26.97	37.71	6.56
	Group B(>2 Hrs)	38.33	35.18	8.29

Table 3: Independent t-test - Blood Loss and Duration of Surgery

	Levene's Test for Equality of Variances		t-test for Equality of Means			
	F	Sig.	t	Sig. (2 tailed)	Mean Difference	Std. Error Difference
INTRA-OPERATIVE BLOOD LOSS (mls)	2.3	0.13	-2.3	0.03	-158.8	69.8
REDIVAC EFFLUENT DAY 1 (mls)	0.54	0.46	-1.01	0.32	-79.77	79.07
REDIVAC EFFLUENT DAY 2 (mls)	0.48	0.49	-0.67	0.51	-24.57	36.66
REDIVAC EFFLUENT DAY 3 (mls)	0.05	0.83	-1.05	0.29	-11.36	10.79

Table 4:Independent samples t-test for equality of means - Blood Loss and Duration of Surgery

	DURATION OF TOURNIQUET	Mean	Std. Deviation	Std. Error Mean
INTRA-OPERATIVE BLOOD LOSS (mls)	< 2 Hours	323.6	323.6	40.5
	> 2 Hours	369.6	369.6	55.6
REDIVAC EFFLUENT DAY 1 (mls)	< 2 Hours	389.6	270.7	55.2
	> 2 Hours	454.8	277.4	53.4
REDIVAC EFFLUENT DAY 2 (mls)	< 2 Hours	154.2	140.2	28.6
	> 2 Hours	152.2	113.6	21.9
REDIVAC EFFLUENT DAY 3 (mls)	< 2 Hours	25.6	29.7	6.2
	> 2 Hours	36.7	42.1	8.1

Table 5: Independent samples t-test - Blood Loss and Duration of Tourniquet use

	Levene's Test for Equality of Variances		t-test for Equality of Means			
	F	Sig.	t	Sig. (2-tailed)	Mean Difference	Std. Error Difference
INTRA-OPERATIVE BLOOD LOSS (mls)	0.87	0.36	-0.66	0.51	-46.03	69.7
REDIVAC EFFLUENT DAY 1 (mls)	0.05	0.82	-0.85	0.41	-65.23	76.94
REDIVAC EFFLUENT DAY 2 (mls)	0.04	0.84	0.05	0.96	1.94	35.57
REDIVAC EFFLUENT DAY 3 (mls)	2.82	0.10	-1.05	0.29	-11.01	10.49

Table 6: Independent samples t-test for equality of means - Blood Loss and Duration of Tourniquet use

DISCUSSION

Total knee arthroplasty is often associated with significant blood loss, most of which occur post-operatively, requiring blood transfusion to maintain the physiologic status and ensure adequate wound healing. Efforts are constantly being made to minimize the rate of blood loss, especially intra-operatively with the use of tourniquet; however studies show that this does not necessarily affect the post-operative blood loss, as measured in the suction drainage and decline in haemoglobin concentration.[1] The rate of blood replacement could be quite significant, and this raises the concern about safety of blood and blood products, with its associated morbidity and mortality.

This study evaluates blood loss following total knee arthroplasty, and considers the effect of surgical time and duration of tourniquet use on intra-operative and post-operative blood loss. The mean total blood loss in our series was 940.3 mls, which is lower compared to the results of Lotke et al[1] and Kalairajah et al[2], 1518 mls and 1747 mls respectively. Intra-operative blood loss averaged about 342.4 mls, with only 5 patients of the 53 studied requiring intra-operative blood transfusion (2 units each). This is different from the report by Sutherland and Schurman,[3] who transfused 31 of their 47 patients. The mean post-operative blood loss of 603.6 mls correlates with that documented by Lotke et al[1] (511 mls). This also is a reflection of the total operative blood loss, with a strong and positive correlation with post-operative blood loss($r = 0.884$, $p < 0.01$). In our study, the mean post-operative blood loss as measured by suction drain effluent decreased significantly from day 1 to day 3, with an average suction drainage of 2.5 days. A significant decline in Haemoglobin concentration was observed in this series, with a mean haemoglobin loss of 2.6 ± 1.2 g/dl post-operatively. This was statistically significant ($p < 0.001$) with a moderate positive correlation, and underscores the importance of restoring the oxygen carrying capacity of blood to ensure good wound healing.

There was a significant difference in intra-operative blood loss when surgical time exceeded 2 hours, as determined by the independent t-test and Levene's test for equality of variance ($p = 0.03$). However, no significant difference occurred in the post-operative blood loss, or with duration of tourniquet use; although intra-operative and post-operative blood loss showed more variation around the mean with tourniquet time > 2 hours.

Despite the peculiarities of our environment, the late presentation of patients, severe deformities, bone loss and soft tissue contractures, our average surgical time of 2.1 ± 0.5 hrs was similar to that documented by Yasunaga et al,4 127 ± 47 min.

Nakahara et al[5] postulated possible explanations for increased bleeding after removal tourniquet, including reactive hyperemia secondary to prolonged ischaemia and an increase in fibrinolytic activity after release. This was further reinforced by the concept of continuous bleeding from venous sinuses of the cut cancellous bone, with bleeding potentiated by the suction drainage reported by Wittmann and Ring.[6] In our practice, we ensure adequate exposure, dissection along surgical planes, judicious use of electrocautery, adequate haemostasis before cementing, and use of an extra-articular drain. In challenging and prolonged cases, in which tourniquet use > 2 hrs, we have also deflated the tourniquet to minimise the risk of tissue and bone ischaemia as much as possible, while controlling blood loss and achieving haemostasis in order to complete the procedure.

CONCLUSION

Post-operative blood loss as measured by suction drainage, is a good predictor of total blood loss, showing a strong and positive correlation. The risk of significant post-operative blood loss after total knee arthroplasty should be emphasized in the pre-operative planning period, in order to ensure necessary steps to minimize such risks, ensure restoration of blood volume and prevent post-operative morbidity and mortality.

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