Original Article

Comparision of blood loss between computer assisted and conventional total knee arthroplasty

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Abstract

Background: Bleeding during total knee arthroplasty (TKA) can cause significant morbidity and mortality. One proposed benefit of computer assisted TKA is decreased bleeding as the femoral canal is not invaded. This study assessed blood loss between computer assisted surgery (CAS) and conventional TKA.

Materials and Methods: 73 consecutive patients (37 males, 36 females) underwent primary TKA between 2006 and 2009. Thirty eight patients underwent navigated TKA and 35 underwent conventional TKA for symptomatic osteoarthritis of the knee. These patients were matched for age, gender, and body mass index (BMI). Average age was 70.3 years (range 47-91 years). Mean BMI was 30 (range 17-49). Average preoperative hemoglobin was 13.26 g/dL (range 8.7-18.4 g/dL) in the navigated group and 13.47 g/dL (range 9.6-15.8 g/dL) in the conventional group ($P = 0.9$). Average tourniquet time was 110 min (range 90-150 min) in the navigated group and 96.7 min (range 60-145 min) in the conventional group ($P = 0.77$).

Results: Average postoperative hemoglobin in the navigated group was 10.34 g/dL (range 7.5-14.8 g/dL) and in the conventional group was 10.03 g/dL (range 7.5-12.2 g/dL) ($P = 0.17$). Six patients in both groups required blood transfusions. The mean drain collection was 599 mL (range 150-1370 mL) in the navigated group and 562 mL (range 750-1000 mL) in the conventional group ($P = 0.1724$). These results suggest that there is no significant reduction in blood loss in CAS TKA.

Conclusion: These results suggest that there is no significant difference in blood loss in CAS TKA and conventional TKA. This study also highlights the heterogeneity of methods used in studies related to CAS TKA. We believe that there is a need for a large multicenter prospective randomized controlled trial to be performed before a consensus can be reached on the influence of CAS techniques on blood loss during primary TKA.

Key words: Blood loss, computer navigated total knee arthroplasty, conventional total knee arthroplasty

Introduction

Total knee arthroplasty (TKA) is one of the most commonly performed elective orthopaedic procedures in the United Kingdom (UK). Data from the UK National Joint Registry show that the number of TKAs performed annually is increasing.[1] TKA can be associated with significant postoperative blood loss requiring blood transfusion and hematinics.[2,3] One source of bleeding during this procedure is the femoral canal, which is breached to allow passage of an intramedullary rod in the conventional technique. In computer-assisted (navigated) TKA (CAS TKA), surface probes are used to guide component position instead of intramedullary devices. It is therefore anticipated that blood loss may be lower as the medullary cavity is not breached[4] with the navigated technique. This study was performed to compare the blood loss and the transfusion rates between patients who underwent navigated and conventional TKA.

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Access this article online	
Quick Response Code:	Website: www.ijoonline.com
	DOI: 10.4103/0019-5413.106906

Materials and Methods

73 consecutive patients (37 males and 36 females) who underwent primary TKA by or under the direct supervision of a consultant orthopedic surgeon (SRS) between September 2006 and December 2009, were included in the study. Thirty eight patients underwent navigated TKA and 35 underwent conventional TKA. Patients who underwent revision surgery and complex primary total knee arthroplasty in cases with significant deformity or bone defects which would require any procedure other than a standard primary arthroplasty procedure were excluded.

A tourniquet was used In all cases. Surgical exposure of the knee was performed via a medial parapatellar approach. Femoral intramedullary jigs were used in the conventional group and navigation was done with the use of Imageless Stryker navigation system II-cart (precision 3.0) (Stryker Leibinger GmbH and Co. Kiel, Germany) and tracker pins inserted into the femur and tibia. A fixed bearing cemented prosthesis was used in all cases (Scorpio NRG) (Scorpio, Stryker Ltd, Ireland). The patella was not resurfaced in any patient. One redivac suction drain was routinely used in all patients and removed within 24 h. The threshold for transfusion was hemoglobin (Hb) concentration less than 7.5 g/dL in accordance with hospital protocol. Demographic and clinical data were recorded.

Statistical analysis was performed using the Student's *t*-test (Graph Pad Prism software, Graph Pad, California, USA). The level of significance for this study was set at $P < 0.05$.

Results

The average age of patients in this cohort was 70.3 years (range 47-91 years, SD: 9). Mean body mass index (BMI) was 30 (range 17-49 Kg/m^2, SD: 5.51). The indications for surgery included osteoarthritis (n= 70) and inflammatory arthropathy (n= 3). The left knee was replaced in 29 patients and right knee in 40 patients. Four patients underwent bilateral TKA performed as separate surgical procedures. Fifty-five patients had varus deformities and 18 patients had valgus deformities of their affected knees. A cruciate retaining prosthesis was used in 17 patients and cruciate substituting prosthesis in 56 patients. All patellae were left unresurfaced [Table 1].

The average preoperative Hb was 13.26 g/dL (range 8.7-18.4 g/dL) (SD: 1.83, 95% CI: 12.68-13.84) in the navigated group and 13.47 g/dL (range 9.6-15.8 g/dL) (SD: 1.4, 95% CI: 13.01-13.93) in the conventional group ($P = 0.9$). The average tourniquet time was 110 min (range 90-150 min) in the navigated group and 96.7 min (range 60-145 min) in the conventional group ($P = 0.77$). The average postoperative Hb in the navigated group was 10.34 g/dL (range 7.5-14.8 g/dL) (SD: 1.44, 95% CI: 9.89-10.79) and 10.03 g/dL (range 7.5-12.2 g/dL) (SD: 1.35, 95% CI: 9.59-10.47) in the conventional group ($P = 0.17$). Six patients in both groups required blood transfusions. Six patients in the navigated group and eight patients in the conventional group were placed on hematinics [Table 2].

In the group with varus knees, the average angle of varus deformity was 5° (range 4°-10°), while in the valgus group, the average valgus deformity was 10° (range 5°-15°). Post surgery knees in the navigated group had a mean 1.5° valgus (range 0°-3°) compared to 2.5° in the non-navigated group (range 1°-3°) ($P > 0.5$). The mean drain collection was 599 mL (range 150-1370 mL) in the navigated group and 562 mL (750-1000 mL) in the conventional group ($P = 0.1724$). General anaesthesia was used in all cases. No fibrinolytic agents were used.

Table 1: Comparing the demographics, clinical and surgical details of patients in both groups

Demographic data	Navigated	Conventional
Number of patients	38	35
Age (mean (SD))	69.7 (9.14)	71.08 (8.91)
Sex (F:M)	17:21	19:16
Indication-osteoarthritis/inflammatory	37/1	33/2
Varus/valgus	30/8	25/10
ASA I-II-III	3-21-13	3-25-6
BMI (mean (SD))	29.1 (5.03)	30.24 (6.05)
Left/right	17/21	14/21
Cruciate substituting/cruciate retaining	29/9	27/8
Surgeon-Consultant/Registrar	16/22	15/20

Discussion

TKA can result in significant blood loss.[5] The average reduction in Hb concentration after TKA has been estimated to be 3.85 g/dL.[6] Up to 18% of these patients are graded III-IV according to the American Society of Anaesthesiologists, implying that they have significant co-morbidities.[1] The potential cardiovascular risks of acute blood loss and low Hb in this group mean that they often require blood transfusions to maintain hemodynamic stability. There are concerns, however, about the risks of immunological adverse reactions and disease transmission after allogenic blood transfusion.[7]

Several techniques have been employed to minimize bleeding during TKA. These include the use of diathermy, tourniquets,[8] local infusions of norepinephrine,[9] minimally invasive surgery,[10] antifibrinolytic agents,[11] and sealing of the intramedullary canal after removal of the intramedullary jigs.[2] The position of the knee also influences blood loss as

Table 2: Parameters used to estimate blood loss in the conventional and navigated groups

Parameters	Navigated	Conventional	*P* value
No. of patients	38	35	-
Preoperative Hb (mean (SD))	13.26 (1.83)	13.47 (1.4)	-
Tourniquet time (min)	110	96.7	*P*=0.041
Drain (mL)	599	562	*P*=0.17
Postoperative Hb (mean (SD))	10.34 (1.44)	10.03 (1.35)	*P*=0.17
Transfusion	6	6	-
Hematinics	6	8	-

well as the use of low power suction drains,[12] along with keeping these clamped for 4 h post surgery[13,14] [Table 2].

Computer-assisted surgery (CAS) has been used experimentally since the 1980s. Its introduction to orthopedic practice occurred nearly a decade ago at the turn of the century. Proposed advantages of CAS TKA include decreased blood loss[15] among others. The major reason for this is that the intramedullary canal of the femur is not breached during CAS surgery. A large number of studies have been published assessing the benefits of this technique. The results have been equivocal, however, and no clear consensus has been reached on its benefits. Conteduca *et al*.[16] in their well designed study found that there was decreased blood loss in the CAS group compared to a cohort in which the standard technique was used. It is difficult to compare these results to the results of the current study as their practice differs significantly. Their tourniquet pressure was 450 mmHg versus 350 mmHg in our series, they left drains in for 48 h versus 24 h in our study, and their transfusion threshold was different (7 g/dL vs. 8 g/dL). Likewise, Kalairajah *et al*.[15] also found a significant decrease in blood loss in the CAS group. The number of patients included in their study was low, however, and little information is presented on how well matched their cohorts were. Their perioperative practice also differed significantly with three suction drains being used, again making direct comparison with this study difficult. Reported blood loss in patients having TKA with the standard technique in the previous studies is higher than that reported by other authors (1500 mL)[17,18] and is significantly higher than the average blood loss (562 mL) in the current study [Table 3].

Other authors have found conflicting results, however. Chang *et al*.[19] reported no significant difference in blood loss between the CAS and open techniques, although they looked at a minimally invasive open technique.

The current study has also demonstrated no significant difference in blood loss between our conventional and CAS TKA when performed using the same surgical technique.

Table 3: Comparisons with published series (Blood loss and Tourniquet times)

	Blood loss/ml (range)		
	CAS	Conventional	*P* value
Author			
Conteduca *et al*.[16]	1677 (500-2364)	1974 (450-3930)	*P*=0.0283
Kalairajah *et al*.[15]	1351 (715-2890)	1747 (1100-3030)	*P*=0.001
Present study	599 (150-1370)	562 (750-1000)	*P*=0.17
	Tourniquet time/min (range)		
Conteduca *et al*.[16]	90 (80-110)	75 (60-85)	*P*<0.001
Kalairajah *et al*.[15]	89 (55-125)	74 (40-132)	*P*=0.002
Present study	110 (90-150)	96.7 (60-145)	*P*=0.041

There was no significant difference in postoperative limb alignment, drop in postoperative Hb, or transfusion requirements between the two groups. The tourniquet time was increased in the navigated group. While this was not statistically significant, it is in keeping with previous reports[15,16] [Table 1]. CAS is a relatively expensive technique compared to conventional surgical techniques in knee arthroplasty. In our unit, each navigated knee costs approximately £500 more than a non-navigated TKA. There also is no convincing evidence of significant clinical benefits in TKA. Added to this is a significant increase in operative time for navigated procedures.[19] The results of this study suggest that CAS techniques do not reduce blood loss during primary TKA. While blood loss has been used a measure of the benefits of CAS TKA, the primary aim of the computer-assisted technique is not to reduce bleeding. To consider blood loss is therefore an unusual endpoint for CAS TKA. The results of this study suggest that if surgery is performed carefully and done well, the amount of bleeding is unaffected by the use of CAS techniques.

Navigated TKA has emphasised the importance of accurate component alignment. In the same way the surgeon also must adhere to the principles of soft tissue balancing during the procedure to help achieve accurate alignment. handling. Though it takes longer to perform, this time is not significant and is associated with no increased morbidity with respect to blood loss.

The main limitations of this study are that it is retrospective and nonrandomized. It does, however, present the results of a well matched consecutive series of patients from a nonspecialist center. We believe that these results are therefore relevant to the majority of practicing orthopedic surgeons. There is a need for a large multicenter prospective randomized controlled trial is to be performed before a consensus can be reached on the influence of CAS techniques on blood loss during primary TKA.

Our results suggest that there is no difference in the blood loss in CAS TKA and conventional TKA. This study also highlights the heterogeneity of methods used in studies relating to CAS TKA.

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How to cite this article: Mohanlal PK, Sandiford N, Skinner JA, Samsani SR. Comparision of blood loss between computer assisted and conventional total knee arthroplasty. Indian J Orthop 2013;47:63-6.

Source of Support: Nil, **Conflict of Interest:** None.