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Original article

Do tourniquet and drainage influence fast track in total knee arthroplasty? Our results on 151 cases

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Summary. *Background:* Fast track in total knee replacement (TKR) is a widely used protocol. Tranexamic acid proved to be effective in reducing perioperative bleeding without increasing thromboembolic risk. The aim of this study was to assess if tourniquet and suction drainage might affect perioperative blood loss and post-operative functional recovery after TKR. *Methods:* 151 patients, who underwent to TKR, were assessed and divided into three homogeneous groups: group A (51 patients) in which both tourniquet and suction drainage have been applied (tourniquet has been release before wound closure); group B (50 patients) in which neither tourniquet nor suction drainage have been used; group C (50 patients) in which only tourniquet has been used. Perioperative intravenous tranexamic acid and post-operative low-molecular-weight heparin have been administered. Trend of haemoglobin values, transfusion rate, pain, ability to obtain 90 degrees of flexion and length of stay were analysed. *Results:* The average intra-operative blood loss was statistically higher in group B in comparison to other two groups. Haemoglobin values were lower in group A in comparison to group C in the third and fifth post-operative days. Patients in group A had higher transfusion rate, higher pain and had more difficulties in reaching a 90 degrees of knee flexion than the other two groups. There was one infection in group A. No differences in length of stay. *Conclusion:* Suction drain seems to be associated to lower haemoglobin values, higher transfusion rate, higher pain and slower functional recovery. Short-term tourniquet does not influence post-operative bleeding and rehabilitation program. (www.actabiomedica.it)

Key words: total knee replacement, blood loss, tourniquet, suction drainage, tranexamic acid

Background and aim of the work

Total knee arthroplasty (TKR) is one of the most common surgical operations in orthopaedics. Fast track protocol introduced in general surgery by Kehlet H. (1) is now applied in total hip and total knee replacement in several orthopaedic realities, aiming to improve the functional recovery of the patients without increasing complications, making easier the return to daily activities. Blood loss is particularly severe after TKR: a decrease of haemoglobin level from 2 to 4 g/dL is reported (2). So, with a view on fast track, blood loss management is important for avoiding cardiovascular complications related to anemia. In fact, the reported 30-day incidence of acute myocardial infarction after total hip replacement and TKR varies from 0.3% to 0.9% (3). Suction drains are routinely used in orthopaedics (4), because of the theoretical advantages of lower incidence of hematomas, wound complications, joint swelling, infections and, of improving rehabilitation, but their use is not justified by literature (5, 6). Some orthopaedic surgeons usually clamped the suction drain, but also this aspect is an age-old practice, not based on evidence (7). Intravenous and/or intra-articular tranexamic acid, acting as an inhibitor of plasminogen activation, reducing hyperfibrinolysis, has proved to be effective in reducing peri-operative bleeding in major orthopaedic surgery without increasing thromboembolic complications (8, 9). Finally the use of pneumatic tourniquet and the

timing of tourniquet release are controversial too (10, 11).

Given these premises, we wondered if these aspects could affect fast track protocol in our unit. Thus, the purpose of the present study was to assess the influence of closed suction drainage and tourniquet on peri-operative bleeding and functional recovery after total knee arthroplasty.

Methods

203 consecutive patients underwent to TKR from September 2016 to November 2018 in our unit (Orthopaedics and Trauma Unit – St. Polo's Hospital in Monfalcone, Italy). We excluded 52 patients because of coagulopathy disorders, anticoagulant and antiplatelet therapy (table 1: list of eligibility criteria). At the end we considered 151 patients that we divided in three homogenous groups based on usage of tourniquet and suction drainage: group A (51 patients – both tourniquet and suction drainage had been used), group B (50 patients – both tourniquet and suction drainage had not been used) and group C (50 patients – only tourniquet had been used). Characteristics of the groups are described in table 2. Tourniquet had been inflated for the whole surgical time at 300 mmHg and released before wound closure in groups A and C. Tourniquet had been inflated just for cementation phase in group B. Suction drainage had not been clamped and had been removed in the first post-operative day. All patients signed a proper informed consent form. Three different orthopaedic surgeons implanted the TKR using medial parapatellar approach, tibial extramedullary guide and femoral intramedullary guide after proper pre-operative planning. The type of implants used were Triathlon® (Stryker, Kalamazoo, USA) and Attune® (DePuy Synthes, Warsaw, USA). The same peri-operative fast track protocol had been applied in all three groups. Particularly, intravenous (iv) Cefazoline 2 g was administered 30 minutes before surgery. Two doses of intravenous tranexamic acid (15 mg/kg) were infused 20 minutes before surgery and after 4 hours. The antalgic therapy was periarticular infiltration with 60 mL of Ropivacaine 7.5%, Paracetamol 1 g iv every 8 hours and Oxycodone/Naloxone 10/5 mg 1 tablet every 12 hours. Thromboprophylaxis (Enoxaparine 4000 IU) started 12 hours after the operation. The knee was holded at 60-degrees of flexion for 4 hours, then the patients started continues passive motion for 30 minutes.

The haemoglobin values have been recorded in the pre-operative period, in the immediate post-op (T0),

Table 1. List of eligibility criteria

Inclusion criteria	Exclusion criteria
• Age between 50 to 85 years • ASA status ≤3 • Primary total knee replacement	• Contraindication to tranexamic acid • Antiplatelet or anticoagulant therapy • Coagulopathy disorders (i.e. hepatopathy, hemopathy…) • History of thromboembolism • Platelet count <150,000 mm3 • aPTT ratio and INR >1.20 • Serum creatinine >1.5 mg/dL

ASA status = American Society of Anesthesiologists

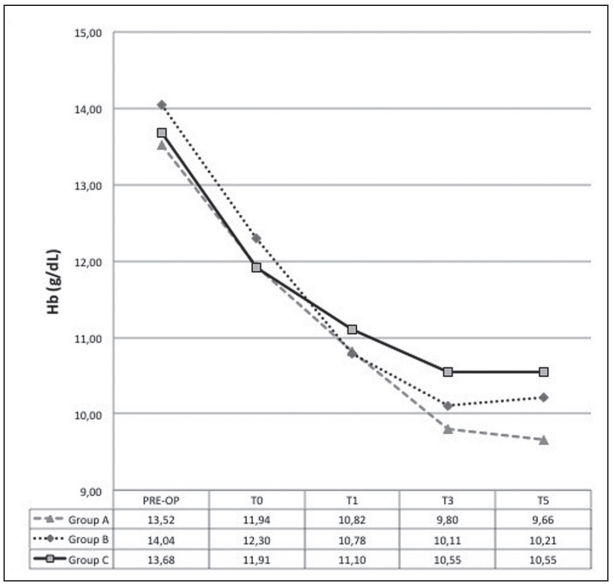
Table 2. Characteristics of the groups

	Group A (n=51)	Group B (n=50)	Group C (n=50)
Tourniquet applied	Yes	No	Yes
Suction drained applied	Yes	No	No
Tranexamic acid iv	Yes	Yes	Yes
Average age (years)	73 (51-83)	70 (53-81)	75 (58-85)
Sex (Female/male ratio)	1.7	2.2	1.5
Average ASA status	2.31	2.06	2.18

iv = intravenous

in the first, third and fifth post-operative days (T1, T3, T5 respectively). Intra-operative blood loss and percentage of blood transfusions have been measured in each group; blood loss in the suction drain at 24 hours has been recorded only for group A. All patients have also been clinically and functionally evaluated using the Numeric Rating Scale (NRS) at T0, T1 and T3, assessing the ability to reach a knee flexion of 90 degrees 6 hours after surgery, and recording the length of stay and possible haemorrhagic and thromboembolic complications.

Graph Pad Prism 6 and Microsoft Excel have been used for statistical analysis. All parameters have been compared in the three groups. Because the considerate variables had non-normal distribution, non parametric Mann-Whitney test (two-tailed) has been applied, considering a value as statistically significant if $p < 0.05$.



Graphic 1. Trend of haemoglobin values in the three groups: pre-operative, T0 (immediate post-op), T1 (the first post-op day), T3 (the third post-op day), T5 (the fifth post-op day)

Results

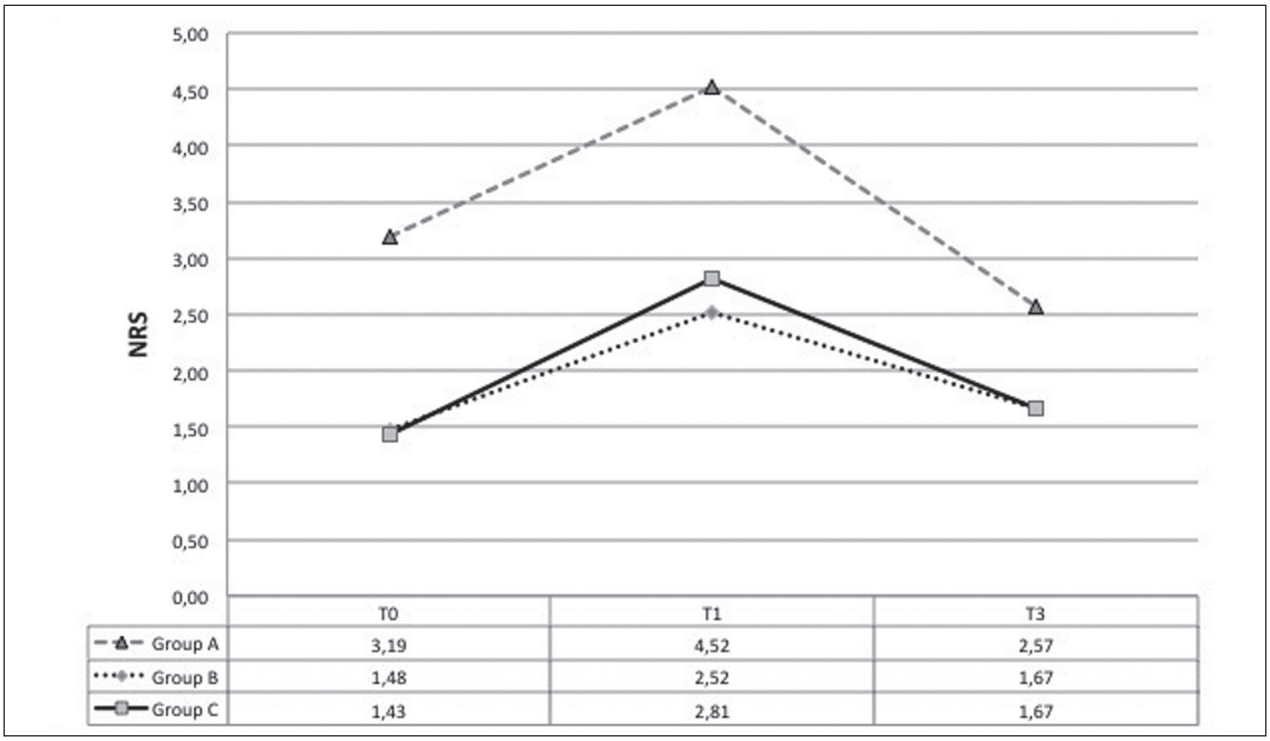
The trend of haemoglobin values and their differences in the three groups were described in graphic 1. Particularly, there was a statistically significant difference in T3 and T5 between group A and group C (T3: 9.80±1.35 g/dL versus 10.55±1.37 g/dL, p=0.049; T5: 9.66±1.36 g/dL versus 10.55±1.34 g/dL, p=0.024).

The average intra-operative blood loss was statistically higher without tourniquet inflation (group B) in comparison to group A and C (group B 607.14±171.13 mL versus group A 199.00±106.19 mL versus group C 168.42±101.67 mL, $p < 0.0001$). The average blood loss in the suction drain in group A was 553±284 mL. As regards the blood transfusions, group A (in which suction drain had been inserted) had higher transfusion rate (group A 20.00% versus group B 2.86% versus group C 5.00%). The results are summarised in table 3.

Pain measured as NRS was higher in group A in comparison to the other two groups. The NRS values are described in graphic 2. Patients in group B and C were better in obtaining a 90 degrees of knee flexion at 6 hours after surgery (group B 92.5% versus group C 87.5% versus group A 62.5%, $p<0.05$). There were no statistically significant differences in terms of length of stay (group A 8.53 days versus group B 7.56 days versus group C 7.53 days). We had one early periprosthetic infection in group A; neither hematomas nor cardiovascular nor thromboembolic complications had been recorded in the other two groups.

Table 3. Results in the different groups. NA = not applicable

	Group A (n = 51)	Group B (n = 50)	Group C (n = 50)	
Blood loss:				
• intra-operative (mL)	199.00±106.19	607.14±171.13*	168.42±101.67	p<0.0001
• suction drain (mL)	553±284	NA	NA	
Transfusion rate	20.00%*	2.86%	5.00%	p<0.0001
Ability to 90 degrees	62.5%*	92.5%	87.5%	p<0.05
Lengh of stay (days)	8.53 (4-18)	7.56 (4-12)	7.53 (4-11)	p>0.05
Complications	1 infection	0	0	



	T0	T1	T3
Group A	3,19	4,52	2,57
Group B	1,48	2,52	1,67
Group C	1,43	2,81	1,67

Graphic 2. Trend of pain measured with NRS: T0 (immediate post-op), T1 (the first post-op day), T3 (the third post-op day)

Conclusions

Fast track protocol in TKR is widely used in all over the world. Several orthopaedics surgeons still use suction drain and/or tourniquet, although their use is not supported by scientific data, but it is related to our beliefs and routine behaviours (4, 6, 12). Thus in the present study we wondered if these practice could influence blood loss and functional recovery after TKR.

Doubts regarding the usefulness of the suction drain had been reported in the late 1980's, when Reilly TJ et al. (13) reported more than twice blood transfusions given to the patients whose knees were drained with a greater decrease in haemoglobin level than the non-drained group. Hematoma is always a complication feared by orthopaedic surgeons. In fact it can be colonized by bacteria and it can swell the joint and increase the pain, creating discomfort to the patient and delaying his/her rehabilitation. Although correlation between suction drainage and periprosthetic infections is not supported (5-7), this is described in different animal study (14, 15) and also in some clinical studies in general surgery (16, 17), because suction drain might be an entryway for bacteria. Sorensen AI et al. (18) reported positive drain tip cultures and an increased risk of infection only when the drain removal occurred after 6 days. In our study we had one early infection in the group in which suction drain had been used.

Even if Lee QJ et al. reported better clinical results inserting the drainage (19), in the literature the absence of drainage is not associated to increased amount of hematomas and periprosthetic infections (2, 12), but to a higher need for transfusions (2, 30). In the present study use of suction drainage was associated to a greater decrease in haemoglobin level and to a higher transfusion rate (20% versus <5%). In the literature blood transfusions after TKR are reported up to 50% of TKR in the different case series (2). Transfused patients can develop immunological, infectious, cardiovascular complications and death (20), so guidelines and protocols for describing the proper use of blood products are applied in every hospital (21, 22). The bleeding control in the perioperative time is fundamental for reducing blood transfusions and their

potential risks and for avoiding complications related to anemia. Especially in a fast track protocol, different strategies are applied. Proper surgical technique, particularly addressed to soft tissue sparing, use of electrocautery, compressive dressing, post-operative knee flexion, cryotherapy (23), tranexamic acid, clamping of the suction drain when applied (24, 25), are treatment that can improve the bleeding (22, 26). Intravenous and/or topical tranexamic acid is commonly used in orthopaedic surgery and its effectiveness is widely demonstrated without increasing thromboembolic complications (8, 9, 27). In fact tranexamic acid acts against fibrinolysis that in surgical patients is pretty high and it is associated to high mortality rate (28). Clamping the suction drainage for few hours after surgery might help in reducing blood loss and requirement for blood transfusion (24), creating a tamponade effect, but the usefulness of this practice and the duration of drain clamping are debated in the literature (25).

Blood transfusions are associated to longer length of stay in hospital, delayed rehabilitation programs and increased costs (29, 30). Bierbaum BE et al. reported up to a 20% increase in hospital costs and a 20 to 25% increase in the length hospitalization in transfused patients (26). Different studies showed that better blood management is associated to cost reduction. Mehra T et al. observed that reduction in the blood transfusions by 27% allowed saving more than 2 million USD in a year (31).

Routine use of tourniquet in TKR is another point of discussion. It allows a better view for the surgeon creating a bloodless surgical field and it seems to reduce intra-operative bleeding, but these aspects are not supported by scientific studies (32). Also its role in cementing technique could be just theoretical (33). In the present study there were no differences in haemoglobin levels drop down and in transfusion rate using or not the tourniquet. Even if tourniquet is described as one of the most important risks for thromboembolism (32) and associated to several complications (34-36), in the present study tourniquet was not associated to higher complication rate, particularly neurovascular deficit, skin necrosis, thromboembolic events and difficulties in quadriceps recruitment. In fact tourniquet can be safely applied following some simple recommendations to avoid ischemia-reperfusion injury, and limiting its long duration use (36, 37). Dennis DA et al. (38) reported reduced quadriceps strength during the first 3 months after TKR and lower intra-operative blood loss when tourniquet had been used. Even if reduction of quadriceps electromyographic signal has been described at the first post-operative period, it is not shown the initial quadriceps damage leads to long-term muscular atrophy and weakness (39). In fact the presence of lot of confounding factors should be considered. Different inflation timing and period, different inflation pressure and pre-operative muscular conditions might prevent proper comparisons. In the present study tourniquet has not been associated to late functional recovery, to prolonged length of stay and to higher pain level, but a correlation with the use of drainage has been observed. In fact patients with drainage had worse pain (this difference remained statistically significant not only in the immediate post-operative time, but also in the first and third post-operative days) and less ability to flex the knee. Only clinical quadriceps recruitment and not a leg-raise test had been evaluated.

Finally the timing of tourniquet release during TKR is also controversial. Tourniquet can be release either before or after wound closure. According to different Authors, both might bring to some advantages and influence perioperative bleeding in different ways. Early release should allow better identification of vascular injuries, reducing post-operative complications and improving patellar tracking assessment (10, 40), instead late release preceded by compressive dressing should reduce surgical time and limit the bleeding creating a tamponade effect (41). Actually, review and meta-analysis did not confirm these aspects (5, 42). Rama KR et al. (11) described higher total blood loss in early tourniquet release even if there was a higher early re-operation rate in late tourniquet release (0.3% versus 3.1%). In our study we did not analysed this aspect, because tourniquet had always been released before wound closure.

The present study has some limits. It is not a prospective randomized control study. The groups are made of small number of patients. Patients in each group had been operated for the most part by the same surgeon; so surgical technique and expertise of the single surgeon might have influenced bleeding. Blood loss

in each group has been measured and not calculated (for example with Gross's method, 43). In literature measured total blood loss is often underestimated compared to calculated blood loss (44).

In a fast track protocol for TKR not to use the suction drainage should become common practice, even if the decision should be personalized on patient's risks factors. Avoiding the drainage in association of other elements of blood management, like tranexamic acid, might help in reducing the blood transfusion rate, improving patient's functional recovery, reducing not only the costs related to length of stay and patient's management, but also the social costs. As regards the decision to use or not to use the tourniquet, even if intra-operative blood loss might be reduced, there is no agreement about reduction of total blood loss. Thus the literature does not prove against its use, as long as surgical time is short, rehabilitation program starts early and patient's thromboembolic risks factors are identified.

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