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ORIGINAL ARTICLE

The Impact of Total Synovectomy on Blood Loss and Knee Function. A Prospective Randomized Study

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Abstract: *Synovial proliferation is a common intraoperative finding during total knee arthroplasty (TKA) and many studies have proposed synovectomy for the reduction of postoperative pain. We included 180 patients that were split into two groups, one which received a total synovectomy (TS) and the other with partial synovectomy (PS). We measured the amount of intra- and post-operative bleeding as well as perceived pain (using the Visual Analogue Scale) and knee function (using the Knee Society Knee Score) at 4 and 12 weeks. The blood loss during the surgical procedure was 367.77 ± 115.71 mL for TS, while the other group recorded 295.55 ± 106.17 mL ($p < 0.05$). Regarding postoperative bleeding, the TS group aspirated 533.77 ± 281.65 mL, which was significantly higher than the PS group (404.44 ± 211.55 mL, $p < 0.05$). No significant differences were recorded between the TS and PS groups regarding pain and knee function at 12 weeks. Total synovectomy demonstrated significantly higher blood loss and lower postoperative hemoglobin levels, even though knee function and pain level did not show improvements. We consider that the decision of performing synovectomy should rely on the clinical indication and, if conditions allow for it, a limited resection should be attempted*.

Keywords: *synovectomy; total knee arthroplasty; osteoarthritis; therapeutic method; pathophysiology; surgical technique; joint replacement*

INTRODUCTION

Osteoarthritis is common in the elderly population and is the most frequent condition affecting the synovial joints, especially the knee. Restricted range of motion, discomfort, and local pain are the main symptoms deriving from progressive cartilage deterioration of the articular surface of the knee joint [1,2]. A decisive role in cartilage degrading is played by chronic inflammation of the synovial membrane, known as synovitis [3,4]. Furthermore, residual synovial tissue can be associated with postoperative impingement and decreased range of motion [4,5].

Total knee arthroplasty (TKA) is regarded as a radical effective treatment for patients with end-stage knee osteoarthritis [6,7]. This intervention is typically reserved for individuals who experience severe, persistent pain and mobility issues that cannot be adequately addressed through more conservative interventions such as anti-inflammatory medications or physical therapy. In advanced osteoarthritis, patients experience continuous pain that is unresponsive to typical anti-inflammatory medications, and radiographic imaging shows a narrowing of the joint space and the formation of bony growths known as osteophytes [8].

During total knee arthroplasty, surgeons often identify synovial proliferation in patients with osteoarthritis or other inflammatory conditions [3,9-11]. This proliferation of the synovial membrane can contribute to inflammation and

cartilage degradation, leading to decreased joint function and increased pain. Surgical synovectomy involves excising the proliferated synovial membrane and was shown to improve joint function and reduce pain in patients with osteoarthritis [3,9,10]. However, while this procedure can be effective in reducing pain and inflammation, it also carries risks and potential complications that need to be carefully evaluated on a case-by-case basis.

Usually, the surgeon opts for the type of synovectomy depending on intraoperative assessment or personal preferences. Therefore, some surgeons perform total synovectomy as a mandatory step in the surgical technique of total knee arthroplasty, while other surgeons rather avoid performing total synovectomy because they consider it a substantial factor in postoperative bleeding [12-14]. Some researchers suggested that total synovectomy influences postoperative blood loss and operative time without being beneficial in terms of postoperative pain and knee function [12,15].

Decreasing postoperative discomfort and pain is essential to achieve a fast and efficient recovery and to improve the patient's living quality [16,17]. The primary objective of this study is to assess the influence of synovectomy performed during total knee arthroplasty for knee osteoarthritis on blood loss, postoperative pain, knee range of motion, and function.

MATERIALS AND METHODS

1. Study design

We conducted a prospective single-center randomized controlled trial between January 2022 and June 2022. A total of 180 patients were included and split into two even groups, one which received a total synovectomy (TS) and another with partial synovectomy during total knee replacement (PS). The randomization was performed by an independent doctor using sealed envelopes. The envelopes were stored in a box. The envelopes were drawn before surgery and contained instructions regarding the surgical technique.

The inclusion criteria were patients with late-stage knee arthritis. We excluded from our study patients with revisions and cases requiring a more significant constraint than a posterior stabilized TKA (constrained or hinged knee). We also excluded patients with acute coronary diseases, neurological diseases, infectious conditions, coagulation disorders, and a history of deep vein thrombosis or pulmonary embolism.

This paper was approved by the "Foisor" Orthopaedics Clinical Hospital Ethics Committee of Bucharest, Romania, approval number 6384/2021. Written informed consent was obtained from all patients included in this study. The procedures were conducted by international ethical standards and the 1964 Helsinki Declaration.

A radiological assessment was performed using plain X-rays, including an anteroposterior, lateral, and full weight-bearing lower limb, to develop proper preoperative digital planning.

2. Surgical Technique

All TKA procedures were performed according to a standard protocol by a single highly experienced orthopedic surgeon in our institution, specialized in TKA. The implant of choice was the Zimmer Biomet NexGen implant system. Preoperatively, 1 g of tranexamic acid was administered to all cases, and an additional 1 g after the procedure. All patients received spinal anesthetic with a femoral nerve block. A tourniquet was installed after three minutes of elevating the lower limb and was inflated up to 320 mm Hg before the incision and deflated after the implantation to perform hemostasis. We used a midvastus approach, an extramedullary tibial guide, an intramedullary femoral guide, and a measured resection technique. Wound closure was performed in a layered fashion and all patients received a deep drain. The drain was clamped for three hours and then released and removed 24 hours after surgery. The rehabilitation protocol was similar for both groups and began on the first day after surgery. Physical therapy was continued either at home or in a specialized clinic. All cases received Heparin for deep vein thrombosis prophylaxis for 30 days.

We recorded preoperative data, which included age, gender, knee range of motion, hemoglobin values, bleeding, and comorbidities. Knee function was measured using the Knee Society Knee Score (KSKS). The amount of bleeding was assessed by measuring the postoperative hemoglobin and bleeding during and after the surgery. Intraoperatively we measured the amount of blood aspiration by taking into account the amount of physiological serum used for lavage and the operative time. After the surgical procedure, we measured the amount of blood aspirated through the drains and hemoglobin. All complications were recorded throughout the study. For the functional evaluation, we measured flexion, extension, the Visual Analogue Scale (VAS), and KSKS score after 4 and 12 weeks. A blind independent observer evaluated all the measurements.

3. Outcome measures

The Visual Analogue Scale is a measure used to evaluate the patient's perspective of pain level. It may be dependent on the patient's mental status but is very frequently used to correlate with knee function evaluation [17,18].

The KSKS contains questions in 2 sections: knee score (pain, range of motion, stability) and function (walking distance,

ability to climb stairs, walking aids) [19]. Both measures were provided to patients for answering in the hospital and during follow-up visits.

4. Statistical analysis

All values were calculated as mean values ± standard deviation. The statistical analysis was developed using the Student t-test and Mann-Whitney U test for comparison between groups. A p-value lower than 0.05 was considered statistically significant. The data was analyzed for Windows OS using SPSS version 28.0 (SPSS Inc., Chicago, IL).

RESULTS

We recorded 180 cases split into two even groups. The patient characteristics are displayed in Table 1.

The blood loss measured during the surgical procedure was 367.77 ± 115.71 mL for the total synovectomy, while the second group recorded 295.55 ± 106.17 mL of blood loss ($p < 0.05$). Regarding postoperative bleeding, the TS group aspirated 533.77 ± 281.65 mL, which was significantly higher than the PS group, where we recorded an aspiration of 404.44 ± 211.55 mL (Table 2).

Table 1: Baseline characteristics of the study groups

	Total synovectomy	Partial synovectomy	p-value
Age (years)	70.41±7.25	70.8±7.23	0.71
Gender (M/F)	41/49	44/46	0.77
Preoperative hemoglobin (g/dL)	13.24±1.22	13.22±1.18	0.90

Table 2: Postoperative parameters of the study groups

	Total synovectomy	Partial synovectomy	p-value
Intraoperative bleeding (mL)	367.77±115.71	295.55±106.17	<0.05
Postoperative bleeding (mL)	533.77±281.65	404.44±211.55	<0.05
Postoperative hemoglobin (g/dL)	11.43±1.26	11.88±1.22	<0.05
VAS[1] score (4 weeks)	3.39±1.50	3.79±1.32	0.058
VAS score (12 weeks)	1.3±1.01	1.41±0.89	0.43
KSKS[2] score (4 weeks)	82.28±4.09	82.42±4.46	0.83
KSKS score (12 weeks)	87.9±3.7	88.33±4.11	0.47
Operating Room time (min.)	96.5±7.93	92.2±6.37	<0.05

[1] VAS=Visual Analogue Scale; [2] KSKS=Knee Society Knee Score

The mean preoperative hemoglobin was 13.24 ± 1.22 g/dL for the TS group and 13.22 ± 1.18 g/dL for the PS group ($p = 0.90$). Postoperatively, a statistically significant decrease was recorded in the two groups, the hemoglobin dropping to 11.43 ± 1.26 g/dL and 11.88 ± 1.22 g/dL, respectively, ($p < 0.05$). However, after four weeks, the VAS score was 3.39 ± 1.50 in the TS group and 3.79 ± 1.32 in the PS group, while KSKS was 82.28 ± 4.09 and 82.42 ± 4.46, respectively. Both scores' differences between groups were not significant. At the three months follow-up, both parameters showed improvements for both groups. VAS score was 1.3 ± 1.01 for the TS group, while PS patients had a score of 1.41 ± 0.89. ($p = 0.43$) KSKS score showed no statistically significant differences after three months, the results being 87.9 ± 3.7 and 88.33 ± 4.11, respectively ($p = 0.47$). However, we recorded significant differences regarding the operative room time between groups: 96.5 ± 7.93 minutes for the TS group and 92.2 ± 6.37 minutes for the PS group, respectively ($p < 0.05$).

Regarding complications, we recorded 7 cases of deep vein thrombosis in the total synovectomy group and 5 cases in the partial synovectomy group.

We recorded wound complications in three cases in the first group and two patients in the second group. Also, we noticed hemarthrosis following drain removal in 20 cases that underwent total synovectomy and 5 cases with partial synovectomy.

DISCUSSION

The synovial tissue is regarded as a critical component in the locomotor function [20,21]. The synovial tissue of the knee joint plays multiple roles, including the secretion of synovial fluid that lubricates the joint, providing nutrients to the articular cartilage, protection against infection, and removal of waste products from the joint. The aforementioned functions are responsible for the maintenance of the health and proper functioning of the knee joint. On the other hand, progressive joint degeneration, which leads to osteoarthritis, is caused by the involvement of bone, cartilage, and synovial pathological processes [21,22]. For this reason, synovectomy is performed to relieve pain or to attempt the prevention of cartilage and/or

bone destruction and to improve knee function [23,24].

During a total knee arthroplasty, total synovectomy may be performed for different reasons. One reason is to remove any inflamed or diseased synovial tissue that may be present in the joint, with the aim of improving joint function and reducing pain and inflammation. Another reason is to prevent the formation of a pseudo capsule, a thick layer of scar tissue that can form around the artificial joint and cause complications. However, total synovectomy may also have drawbacks, such as an increased risk of infection and reduced lubrication and nutrition of the articular cartilage [21,22]. The decision to perform a total synovectomy during a total knee arthroplasty should be taken individually, for each patient, by weighing the potential benefits and risks. Furthermore, proper planning of the procedure is essential to ensure shorter operating times and faster recovery; this includes digital radiological planning, choosing the ideal implant type and model, and controlling the patient risk factors [25-27].

Our study aimed to evaluate the influence of synovectomy on postoperative results and blood loss following total knee replacement. The intraoperative and postoperative blood loss was found to be significantly higher after total synovectomy compared to the partial synovectomy group. We found variable results regarding average blood loss in the literature, which ranged between 300 and 2500 mL [12,28-30]. This variability may be explained by the different surgical techniques, thromboprophylaxis treatments, or implant types that were applied. In our paper, the total synovectomy group had a blood loss from drains of 533.77 ± 281.65 mL for the total synovectomy group compared to the second group, which had 404.44 ± 211.55 mL blood loss. We consider this to be one of the main reasons behind the preference of some surgeons to avoid total synovectomy.

Our study also revealed a significantly lower postoperative hemoglobin level after synovectomy. This result was also recorded in other papers [12,21,31]. However, some studies concluded that even though the bleeding rates are higher, the blood transfusion threshold is not reached when total synovectomy is performed, therefore the two surgical techniques do not yield statistically significant differences in this regard [15,21].

Another significant result of this study was that total synovectomy demonstrated some postoperative improvements but these were not statistically significant compared to the other group and did not show any differences regarding pain relief, despite the considerable blood loss difference. It is well known that the synovium, as well as other articular structures like muscles, joint capsules, or ligaments, is well-innervated and could be a source of pain in osteoarthritis [32,33]. Even though synovectomy reduces knee pain, especially in cases with pathological synovial tissues, the VAS score in our study did not show any significant differences during the follow-ups. Also, the KSKS score showed no significant differences after 4 weeks or after 12 weeks. This result is also reported by other authors who also recorded increased concealed bleeding, higher drainage, and longer operative time in patients that underwent total synovectomy [12]. Moreover, similar studies evaluating the quality of life and complications recorded no significant improvements regarding these parameters [34].

Literature data have indicated that total synovectomy during total knee arthroplasty may be linked to an increased incidence of certain complications such as deep vein thrombosis, hemarthrosis, and wound complications [12,21,33-37]. However, it is essential to note that the available data is currently limited. Therefore, additional investigations with a larger sample size are required to establish a more robust statistical correlation on this subject. Despite this observation, it should be noted that individual patient characteristics and other factors may also contribute to the occurrence of these complications.

One major limitation of our study is that it was conducted in a single center, which may limit the generalization of our results to other study populations. Additionally, we did not evaluate hematocrit levels or blood transfusion requirements, which are important factors that could reveal further associations between total synovectomy and blood loss. Furthermore, we acknowledge that more extended follow-up periods could be beneficial in the thorough evaluation of the functional outcomes and risk of synovial recurrences associated with total synovectomy during total knee arthroplasty. Additionally, it is important to note that our study did not assess the risk of other potential complications that could arise from this procedure. Therefore, while our study provides important insights into the potential risks and benefits of total synovectomy during total knee arthroplasty, additional research with a larger sample size and more extended follow-up periods are needed to fully understand the implications of this procedure for patients undergoing knee arthroplasty.

CONCLUSIONS

Patients with total synovectomy associated with total knee arthroplasty experienced a notably more significant amount of blood loss and lower postoperative hemoglobin levels than the control group. However, no statistically significant differences were observed between the two groups in terms of knee function and pain level. Further multicenter studies with longer follow-up times are required to more comprehensively assess the potential complication rate and risk of synovial

recurrence associated with total synovectomy during total knee arthroplasty. Ultimately, more comprehensive research is required to determine the optimal approach to synovectomy and to provide the most beneficial outcomes for patients undergoing total knee arthroplasty.

Conflicts of interest and sources of funding

The authors declare no conflict of interest. This research received no external funding.

Authors' contribution

M.-A.P. and L.L.P. planned the clinical study and contributed to the concept and design of the study. M.E.G., D.C.C., and A.L. contributed to the data analysis and interpretation as well as to the translation and the critical revision of important intellectual content. C.S. and R.C. contributed to the writing of the manuscript and performed revision, language, and textual editing of the final version. All authors contributed to the original draft preparation of the manuscript. All authors have read and agreed to the published version of the manuscript.

Patient consent for publication

Informed consent was obtained from all subjects involved in the study.

Ethics approval and consent to participate

All procedures performed in this paper were by the 1964 Helsinki Declaration and its later amendments or comparable ethical standards and according to the national ethical standards. The study received approval from the "Foisor" Orthopaedics Clinical Hospital Ethics Committee of Bucharest, Romania, approval number 6384/2021 (date of approval 10th of December 2021). Informed consent was obtained from all individual participants included in the study.

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