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Efficacy of rapid recovery protocol for total knee arthroplasty: a retrospective study

İsmet KÖKSAL[1], Mesut TAHTA[2], Mehmet Emin ŞİMŞEK[3], Metin DOĞAN[4], Murat BOZKURT[4]

[1]Yenimahalle State Hospital, Department of Orthopaedics and Traumatology, Ankara, Turkey
[2]Atatürk Training and Research Hospital, Department of Orthopaedics and Traumatology, İzmir, Turkey
[3]Atatürk Training and Research Hospital, Department of Orthopaedics and Traumatology, Ankara, Turkey
[4]Yıldırım Beyazıt University Faculty of Medicine, Atatürk Training and Research Hospital, Department of Orthopaedics and Traumatology, Ankara, Turkey

Objective: Our aim was to compare the clinical results and cost-effectiveness of a rapid recovery protocol for total knee arthroplasty (TKA) with a current standard protocol.

Methods: The study included patients undergoing primary elective TKA with at least 6 months of follow-up. The rapid recovery protocol was applied to 96 patients (Group 1) and the standard protocol to 108 (Group 2). All patients underwent standard TKA. All pre-, peri-, and postoperative procedures in the treatment and follow-up of patients were appropriately standardized to the philosophies of the different treatment plans. The postoperative length of hospital stay, total financial cost, postoperative surgical infection, 6-month American Knee Society scores, and knee range of motion (ROM) were compared between the groups.

Results: A total of 169 patients were included. Group 1 patients had significantly shorter postoperative length of hospital stay ($p=0.021$), significantly lower mean total financial cost ($p=0.041$), significantly lower infection rates ($p=0.034$), and significantly higher 6-month knee function scores ($p=0.032$). In comparison with Group 2, Group 1 knee flexion ($p=0.04$) and extension ($p=0.48$) ROM at 6 months postoperatively were both significantly improved.

Conclusion: Application of the rapid recovery protocol to patients who underwent TKA reduced costs and infection rates and improved functional results.

Keywords: Accelerated discharge; cost-effectiveness; rehabilitation; total knee arthroplasty.

Total knee arthroplasty (TKA) is one of the most successful orthopedic procedures for improving quality of life.[1] Long-term results have indicated that TKA can provide a pain-free and comfortable life with increased functional capacity for up to 2–3 decades following surgery.[2] Reduction in perioperative complications, accelerated recovery, and shorter hospital stays are now being evaluated as new goals in the current treatment and rehabilitation of TKA patients.[3]

A rapid recovery algorithm was developed and applied to TKA cases in the USA in the 1990s to provide standardization of procedures. This rapid recovery algo-

Correspondence: İsmet Köksal, MD. Yenimahalle Devlet Hastanesi, Ortopedi ve Travmatoloji Kliniği, Ankara, Turkey.
Tel: +90 850 – 222 07 24 e-mail: ismetkoksal@hotmail.com

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Table 1. Comparison of demographic data between the two patient groups.

	Group 1	Group 2	p
Age (median)	64 (56–79)	68 (55–77)	0.49
Gender (Male, %)	45.2	47.1	0.21
Side (Left, %)	39.1	42.3	0.44
Body mass index (kg/m^2)	31.6±6.2	31.2±7.1	0.67
Preoperative need for walking aid (%)	16.6	18.8	0.91
ASA classification (%)			
I	29.2	30.5	0.34
II	45.8	44.4	0.46
III	25	25.1	0.29
IV	–	–	–

ASA: American Society of Anesthesiologists.

rithm is defined as an interdisciplinary treatment protocol which aims to shorten recovery time and provide better clinical outcomes.[4]

The purpose of this study was to compare the clinical results and cost-effectiveness of a rapid recovery protocol for TKA with a current standard protocol.

Patients and methods

In 2012, the rapid recovery protocol was started as the standard program for patients undergoing TKA in our clinic. Therefore, patients evaluated for this study were treated and followed up between 2011 and 2013.

The study included all patients undergoing primary elective TKA with at least 6 months of follow-up. The rapid recovery protocol was applied to 96 patients starting in 2012 (Group 1), and the standard protocol was applied to 108 patients prior to 2012 (Group 2) (Table 1).

Our routine clinical study content includes preoperative examination and follow-up examinations at 1, 3, 6, and 12 months postoperatively. We also have pre- and postoperative 6-month American Knee Society scoring (AKSS) system[5] and knee goniometric range of motion (ROM) measurements. All measurements were made by the same physiotherapist, and data were recorded in the patient registry.

Postoperative length of hospital stay, total financial cost, postoperative surgical infection rates, 6th month AKSS function scores, and 6th month knee flexion–extension ROM data were collected from registry files of the patients and compared between the two groups.

Both procedures were standardized as appropriate to the philosophy of the different treatment plans (Table 2).

Prior to surgery for all Group 1 patients, operating room regulations and two videos of pre- and postoperative physiotherapy lessons in the Arthroplasty School.[4]

Visual presentations and information were given on complications that may be encountered in the postoperative period, including pain and problematic movements and activities. Additionally, information was given on regulation of pre- and postoperative nutrition and their positive effects on wound healing, as well as the intra- and postoperative damage that may occur from smoking cigarettes (and other similar substances) and recommendations for stopping smoking. The patients were given a list of necessary items that should be at the bedside in the preoperative hospitalization period, official pro-

Table 2. Summary of the different applications in the treatment plans of the groups.

Group 1	Group 2
Arthroplasty school	General information
Hospitalization on the day of surgery	Hospitalization 1 day before surgery
Prophylaxis of bleeding control (Tranexamic acid) (+)	No prophylactic bleeding control
COX-2 inhibitions and epidural analgesia for postoperative pain control	COX-2 inhibitions andopioids for postoperative pain control
Drain (–)	Drain (+)
Rehabilitation and mobilization starts at 6 hours postoperatively	Rehabilitation and mobilization starts at 1 day postoperatively
Accelerated postoperative rehabilitation	Standard postoperative rehabilitation

cedures for hospital admission and discharge, and the implant and surgical procedure to be applied to each patient undergoing TKA. They were specifically informed about the protocol and signed informed consent. Group 2 patients were not admitted to the Arthroplasty School. However, they were given appropriate and sufficient information on the basics of the treatment and they signed informed consent too.

Group 1 patients were admitted as inpatients on the morning of the operation, while Group 2 patients were admitted the night before.

Group 1 patients received 10-mg/kg tranexamic acid intravenously at 1 hour preoperatively.[6] No preoperative bleeding control modality was applied to Group 2 patients.

At 1 hour before transfer to the operating room, a single dose of 1-g cefazolin was administered intravenously as prophylactic antibiotic therapy to patients in both groups.

All patients were operated on by the same surgical team. After transfer to the operating table, combined spinal and epidural anesthesia was administered. Following standard cuts after a medial parapatellar incision, a Vanguard (Biomet Orthopedics Inc., Warsaw, IN, USA) knee prosthesis was used. Patelloplasty and patellar denervation was applied to all patients; no patient required a patellar implant.

Before suturing the surgical incision in Group 1 patients, 10-mg/kg tranexamic acid was administered intravenously, but not in Group 2 patients. A drain was used in Group 2 patients but not in Group 1 patients. Duration of surgery was not measured. We were able to use tranexamic acid in all Group 1 patients without any complications.

Group 1 patients were treated with COX-2 inhibitors in addition to epidural analgesia. For Group 2 patients, COX-2 inhibitors and opioid analgesia were used. At 4 hours postoperatively, 10-mg/kg tranexamic acid was administered intravenously to Group 1 patients. At 6 hours postoperatively, bandages were opened and strenuous knee ROM exercises as well as active and passive knee exercises in bed were initiated by a physiotherapist.[7,8] Group 1 patients without weight-bearing restrictions were mobilized in weight-bearing at 6 hours postoperatively. Our goal was to start physical therapy and mobilization for all patients after 6 hours. Most patients are able to tolerate early mobility, but occasionally treatment must be modified if mobilization is a problem. These modifications include attempts to repeat the same procedure every 2 hours after until they are successful.

All patients received a second and final intravenous dose of 1-g cefazolin at 12 hours as postoperative infection prophylaxis. Drains in Group 2 patients were removed after 24 hours. Group 2 patients then started mobilization and strenuous knee ROM exercises and active and passive knee exercises in the bed. Group 1 patients were expected to reach 120° knee flexion and self-mobilization without support on postoperative Day 1. Discharge criteria for acceptable discharge for both groups are defined in Table 3.

Data were analyzed with SPSS software version 15.0 for Windows. Categorical variables were presented as frequency and percentage. The χ^2 test and Fisher's exact test were used to compare categorical variables. The Kolmogorov–Smirnov test was used to assess the distribution of continuous variables. The Student's t-test was used for variables with normal distribution, and the values were presented as mean±SD. Continuous variables without normal distribution were analyzed using the Mann–Whitney U test, and values obtained were presented as median (50^{th} percentile) values and interquartile ranges (25^{th}–75^{th}). A two-tailed p-value of <0.05 was considered statistically significant.

Results

Data from 12 patients in Group 1 and 23 from Group 2 were missing; therefore, data of 169 patients in all were analyzed. Average postoperative length of hospital stay was 3.7±1.3 days for Group 1 and 6.3±2.5 days in Group 2 (p=0.021) (Table 4).

The mean total financial cost of care related to TKA was 4849±297 Turkish liras (TL) in Group 1 and 5970±342 TL in Group 2 (p=0.041) (Table 4).

Due to postoperative infection in the surgical area in 1 patient in Group 1, irrigation and debridement was applied, the polyethylene insert was changed, and the treatment was successfully concluded. In Group 2, infection at the surgical site developed in 5 patients. Two patients were successfully treated with irrigation, debridement, and change of the polyethylene insert. One patient re-

Table 3. Discharge criteria for patients.

Adequate pain control
Able to fully participate in the rehabilitation program
Adequately equipped home to continue the treatment process
Safe mobilization with or without support
Able to meet their own personal needs
No wound site problems

Table 4. Comparison of the group results.

	Group 1	Group 2	p
Duration of hospitalization (days)[1]	3.7±1.3	6.3±2.5	0.021
Total cost (TL)[1]	4849±297	5970±342	0.041
Postoperative infection[2]	1	4	0.034
AKSS function score[1,3]	52.4±6.8	50.1±7.6	0.67
AKSS function score[1,4]	87.5±5.6	81.3±3.4	0.032
Knee flexion[1,3]	105.6°±8.4°	103.4°±6.3°	0.56
Knee flexion[1,4]	120.7°±5.3°	114.2°±4.6°	0.04
Knee extension[1,3]	−5.1°±3.1°	−4.9°±2.7°	0.87
Knee extension[1,4]	−2.2°±1.9°	−2.8°±1.8°	0.048

[1]Values are presented as mean; [2]Number of patients; [3]Preoperative values; [4]6-month postoperative values.

quired implant removal, and 2 patients were treated with antibiotics for superficial infections. Including cases with superficial infections that responded to antibiotic therapy, a statistically significant difference was determined in infection rates between the groups (p=0.034) (Table 4).

At 6 months postoperatively, the mean AKSS function score was 87.5±5.6 for Group 1 and 81.3±3.4 for Group 2 (p=0.032). Mean knee flexion and mean knee extension was 120.7°±5.3° was −2.2°±1.9°, respectively, for Group 1 and 114.2°±4.6° and −2.8°±1.8°, respectively, for Group 2; the differences were significant (p=0.04 and p=0.48, respectively) (Table 4). There was no significant differences between preoperative knee flexion ROM (p=0.56), knee extension ROM (p=0.87), and preoperative AKSS scores (p=0.67) between the two groups.

Discussion

The principal finding of this study is that the application of rapid recovery protocol in patients undergoing TKA had reduced costs and infection rates, increased patient satisfaction, and improved functional results. To the best of our knowledge; this is the first study in Turkey to include these results.

It is important to provide high-quality healthcare services with efficient and productive use of limited resources based on scientific evidence.[9] Larsen et al. reported that the rapid recovery protocol not only helped to significantly reduce costs but also helped to achieve successful clinical results in TKA cases.[10] Our results are in agreement and demonstrated significantly lower costs associated with the rapid recovery protocol. In addition, increased patient satisfaction and reduced in infection rates may result in a reduction in various future treatment expenses or potential revision surgeries, which can be unseen but nonetheless important. Berend et al concluded that rapid recovery program has led to significantly decreased hospital length of stays and significantly lower hospital readmission rates in patients who underwent total hip and knee arthroplasties.[11] As seen in the current study, a significantly shorter length of hospital stay was achieved when compared to the standard protocol. At this point, the relation between the length of hospital stay and infection rates should be reviewed. There can be potential focus points of contagion in the hospital environment between visitors, patients, and caregivers. Therefore, in the postoperative period, the patient should be kept in isolation. If this is not possible, the patient should be discharged in the shortest possible time.

Functional result is one of the most important indicators in the evaluation of the surgery performed and the perioperative protocol. Larsen et al reported better quality of life scores from rapid recovery protocol patients.[12] Furthermore, Husted et al. reported better functional results from rapid recovery patients.[13] In the current study, improved AKSS function scores and knee ROM was demonstrated in patients who received the rapid recovery protocol. Moreover, patient education received in the Arthroplasty School resulted in better preparedness for immediate postoperative life and better idea of expected recovery and duration of recovery. The importance of patient education was similarly emphasized in a study by McDonald et al.[14] When our results are taken with existing literature, we can conclude that effective analgesia together with an appropriately applied rehabilitation program result in effective, rapid, and more patient-focused treatment.[15]

There were two major limitations of our study: limited number of patients and retrospective study design. A prospective, randomized study design and evaluation with clinical results with a longer follow-up period are warranted.

Our study results indicate that a rapid recovery pro-

tocol is beneficial for both patients undergoing TKA and healthcare providers. We recommend adopting a rapid recovery protocol for TKA patients as the routine program.

Conflics of Interest: No conflicts declared.

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