



Original Research

Manipulation under Anesthesia for Stiffness of the Knee Joint after Total Knee Replacement

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ABSTRACT

Background: Stiffness of the knee joint is a feared complication after total knee replacement (TKR). An initial noninvasive treatment option is the manipulation of the knee under anesthesia (MUA). The purpose of this study is to evaluate the midterm result of the MUA for joint stiffness after primary TKR. **Methods:** Patients treated with the MUA for knee stiffness after primary TKR surgery performed at Akershus University Hospital during 2014–2018 were invited to a follow-up clinic. The range of motion (ROM) of the knee joint was measured using a goniometer, and the patients reported the Lysholm score, Knee injury and Osteoarthritis Outcome Score, and Tegner score. In addition, any complications or reoperation after the MUA was noted.

Results: A total of 24 patients were identified in the journal system at the hospital. Twenty-three of these (17 women and 6 men) attended the designated follow-up on average 26 months (range [r], 16–35) after the MUA. The total ROM was 97° (r, 84°–116°) at the time of follow-up, compared with 70° (r, 50°–80°) before the MUA ($P < .001$, the Mann-Whitney U-test). A regression analysis indicated that the ROM at follow-up was predicted by the time from the index TKR surgery to the MUA, with the early MUA improving results ($P = .02$). The median Lysholm score was 57.1 (r, 17.9–92.9).

Conclusions: There is a clinically and statistically significant increase of the total ROM of the knee joint after the MUA for knee stiffness after TKR. The earlier MUA yields a better total ROM. Despite improvement in the ROM, the patients did not achieve normal function of the knee joint.

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Introduction

An improved range of motion (ROM) predicts patient satisfaction after total knee replacement (TKR) [1]. However, a good ROM is not guaranteed after TKR, with some authors reporting that up to 20% of patients achieve less than 90° of flexion [2,3]. Reduced ROM will negatively impact activities of daily living. Up to 60° of flexion is needed for limple walking on level ground [4], at least 83° of flexion is needed to climb stairs, and 93° flexion is necessary to sit comfortably [5]. In addition, reduced ROM reduces the ability to rehabilitate knee function and quadriceps strength,

which is considered essential postoperative rehabilitation after TKR [6].

The successful treatment of knee stiffness is therefore of paramount importance. If the knee stiffness is not caused by malposition of the implant or soft-tissue limitations (eg, in morbidly obese patients), the initial treatment after failed focused physiotherapy is the closed manipulation of the knee joint under anesthesia (MUA).

The purpose of this study is to evaluate the clinical and patient-reported outcome measure (PROM) of the MUA for knee joint stiffness after primary TKR.

Material and methods

Patients undergoing the MUA at our institution during the years 2014–2018 were identified by electronic search of our computerized journal files, using both diagnostic codes and procedure codes.

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The medical charts were evaluated, and important clinical events were noted. The eligible patients were then invited to attend a designated follow-up clinic, where the ROM was measured using a goniometer. PROMs in the form of the Knee injury and Osteoarthritis Outcome Score (KOOS), Tegner score, Lysholm score, and a visual analogue Scale (VAS) score for pain when sitting and standing were provided by the patients.

All patients received a cruciate retaining, fixed bearing, cemented TKR (NextGen CR, Zimmer Biomet, Warsaw, IN). A tourniquet was used for all patients. The patella was not resurfaced.

After discharge from the hospital, all patients were referred to external physiotherapy. The patients are scheduled for an outpatient appointment with a departmental physiotherapist after 10-12 weeks. The physiotherapist assesses the ROM, and if there is any concern, the surgeon is consulted. If no mechanical reasons for the stiffness, such as implant malalignment or oversizing, are found on radiological evaluation, the stiffness is considered to be caused by soft tissue. Depending on the degree of knee stiffness, the patient is offered either focused physiotherapy or an MUA.

The indication to offer an MUA at our institution is a joint decision between the patient and surgeon. The patients need to feel restricted by the reduced ROM and dissatisfied with the function of daily activities. Normally this means that the total ROM is less than 90°. When the decision is made to perform an MUA, the patients are manipulated in theater under general anesthetic in combination with a femoral nerve block. The procedure normally takes between 10 and 20 minutes, using gentle, but firm force to mobilize the knee. The patients are kept in the hospital for 2-3 days on a continuous passive motion machine. Pain relief is achieved by a continuous femoral nerve catheter block. After discharge, the patients are referred to enhanced physiotherapy and home exercises.

The study protocol was reviewed and approved by the Regional Committee for Medical and Health Research Ethics of South Eastern Norway (REK 2018/2339) and by the data protection officer of Akershus University Hospital (study no 44-2018). Written informed consent was obtained from all patients participating in the study.

Statistical analysis

Nonparametric variables were compared using the Mann-Whitney U-Test, whereas normally distributed variables were compared using student's T-test. Linear regression analysis was performed with adjustment for age and gender. Statistical analysis was performed using Statistical Package for Social Sciences (SPSS), version 25 (IBM Corp., Armonk, NY). *P*-values less than .05 were considered statistically significant. All tests were 2-sided.

Results

During the years 2014-2018, 1071 patients underwent primary TKR at Akershus University Hospital. Of these, 24 patients underwent the MUA because of knee joint stiffness (Fig. 1). Twenty-three patients (17 [73.9%] women) volunteered to participate in the study and were examined on average 2.5 (range [r], 1.3-2.9) years after the manipulation. The median age of patients at TKR surgery was 61 (r, 46-80) years, and the median time from TKR surgery to the MUA was 127 (r, 42-260) days (Table 1).

The median total ROM was 97° (r, 84°-116°) at the time of follow-up, compared with 70° (r, 50°-80°) before the MUA (*P* < .001) (Table 2, Fig. 2). The average improvement in the total ROM was 35° (standard deviation, 28°). Flexion ≥90° was achieved by 20 of 23 (87%) patients. Two patients had reduced ROM at follow-up compared with previous MUA.

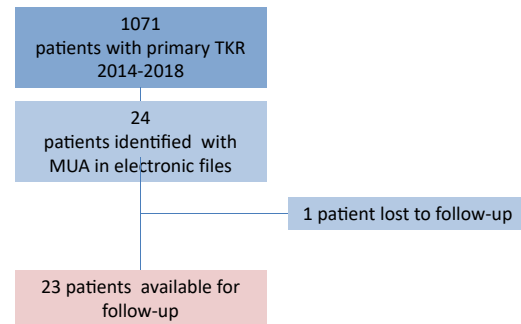


Figure 1. Flowchart of patients included in the study.

A multiple regression analysis was performed to predict what effect time to the MUA had on the change in the total ROM at follow-up. A statistically significant regression coefficient of -0.3 (95% confidence interval, -0.5 to -0.04) was found (*P* = .02), indicating that the ROM at follow-up decreased with an average of 0.3 degrees for each additional day between the index TKR and the MUA. The improvement in the ROM at follow-up tended to decrease if the MUA was performed after 10 weeks (Fig. 3). However, only 3 knees were manipulated before 10 weeks.

The median Lysholm score was 57.1 (r, 17.9-92.9) at follow-up, indicating that despite improvement in ROM, the patients did not achieve normal function of the knee joint (Table 3). Similarly, the KOOSs reported by the patients in our study were inferior to the KOOSs by patients who underwent TKR reporting to the Norwegian Arthroplasty Registry 2 years after surgery (Fig. 4) [7].

Two patients had a repeat MUA performed because of persistent joint stiffness after the initial MUA. One of these patients suffered a tuberositas tibia fracture at the second MUA that required surgical fixation, which ultimately led to poor results (Lysholm score of 39) and a total ROM of 50°. Two patients had their TKR revised after the MUA because of persistent extension deficit over 15° after the MUA.

Discussion

The main finding in this study is that the ROM after the MUA for knee joint stiffness after TKR remains clinically and statistically improved on average 2.5 years after the joint manipulation. Furthermore, the data suggest that earlier mobilization yields better results. We also find that despite the improvement in the ROM, the patient-reported results as measured by KOOSs 2.5 years after the MUA remain substantially inferior compared with those in the general arthroplasty population.

Table 1

Patient characteristics of 23 patients treated with the manipulation under anesthesia for knee stiffness after TKR at Akershus University Hospital 2014-2018.

Variable	
Female gender, n (%)	17 (73.9)
Age in years at TKR, median (range)	61 (46-80)
Side, the right knee, n (%)	14 (60.9)
BMI, kg/m ² , median (range)	28.1 (21.2-42.3)
Active smokers, n (%)	9 (39.1)
Knee surgery before TKR, n (%)	11 (47.8)
Days in hospital, index surgery, median (range)	3 (2-10)
Days from TKR to the MUA, median (range)	127 (42-260)
Years from the MUA to follow-up, median (range)	2.5 (1.3-2.9)

BMI, body mass index.

Table 2

ROM in 23 patients treated with the MUA for knee stiffness after primary TKR at Akershus University Hospital during 2014–2018.

Range of motion	The ROM before the MUA (degrees)		The ROM during the MUA (degrees)		The ROM at follow-up (degrees)		P-value ^a
	Median (range)	Quartiles (25,75) %	Median (range)	Quartiles (25,75) %	Median (range)	Quartiles (25,75) %	
Flexion	80 (20–105)	60–85	120 (100–150)	120–130	107 (50 to 127)	91–116	<i>P</i> < .001
Extention	5 (0–30)	0–15	0 (0–10)	0–2	0 (–10 to 70)	0–2	<i>P</i> = .006
Total ROM	70 (10–90)	50–80	120 (100–150)	115–130	97 (28 to 125)	84–116	<i>P</i> < .001

Quartiles are presented as 25th and 75th percentiles.

^a The Mann-Whitney U test comparing the ROM at follow-up with the ROM before the MUA.

The MUA for stiff knee joint after TKR is an established treatment, and there is a general consensus that the MUA leads to a better ROM both in the short and long term [2,3,8,9]. We found a clinical and statistically significant improvement in the total ROM of 35° at a mean follow-up of 26.4 months. Choi et al found that 95% of patients improve their ROM after the MUA and 74% achieve a flexion over 90° [8]. This is similar to our results of 87% of patients achieving more than 90° of flexion.

The timing of the MUA is hotly debated in the literature. Our study suggests that the MUA should be performed earlier than about 10 weeks after the index surgery, which is in line with reports that support the MUA to be performed at least before 3 months [10–13]. Newman et al examined 62 patients who underwent the MUA for knee joint stiffness after TKR. They found that patients who had MUA performed before 6 weeks after the index surgery obtained a similar ROM to patients without the need for MUA [9]. Issa et al found that patients who had the MUA performed before 12 weeks obtained an ROM of 119° compared with 95° in patients with the MUA performed later than 12 weeks [13]. A recent systematic review of 22 studies, including 1488

patients, concluded that the MUA should be performed between 4 and 12 weeks after surgery [14]. To identify patients in need for an MUA, we recommend a follow-up appointment at 6–8 weeks. Although most authors recommend an early MUA if possible, a recent study by Colacchio et al indicate that the MUA beyond 3 months, or even beyond 1 year, may still yield meaningful improvement in the ROM [15].

Some authors recommend a hyperearly MUA (within 3 weeks) [11,16]. However, the lack of randomization or proper control groups makes it difficult to recommend the MUA this early after TKR surgery. At that stage, the wound has not healed yet and the knee joint manipulation might introduce a risk of wound problems or infection. If more time and proper rehabilitation are allowed instead of the hyperearly MUA, an acceptable ROM might still be achieved. In short, the good results for the hyperearly MUA might be explained by the fact that some of these patients did not need the procedure in the first place.

The most commonly mentioned risk factors for knee stiffness after TKR are previous surgery to the knee, a reduced ROM before TKR, smoking, and diabetes [3,9,10]. There is also compelling

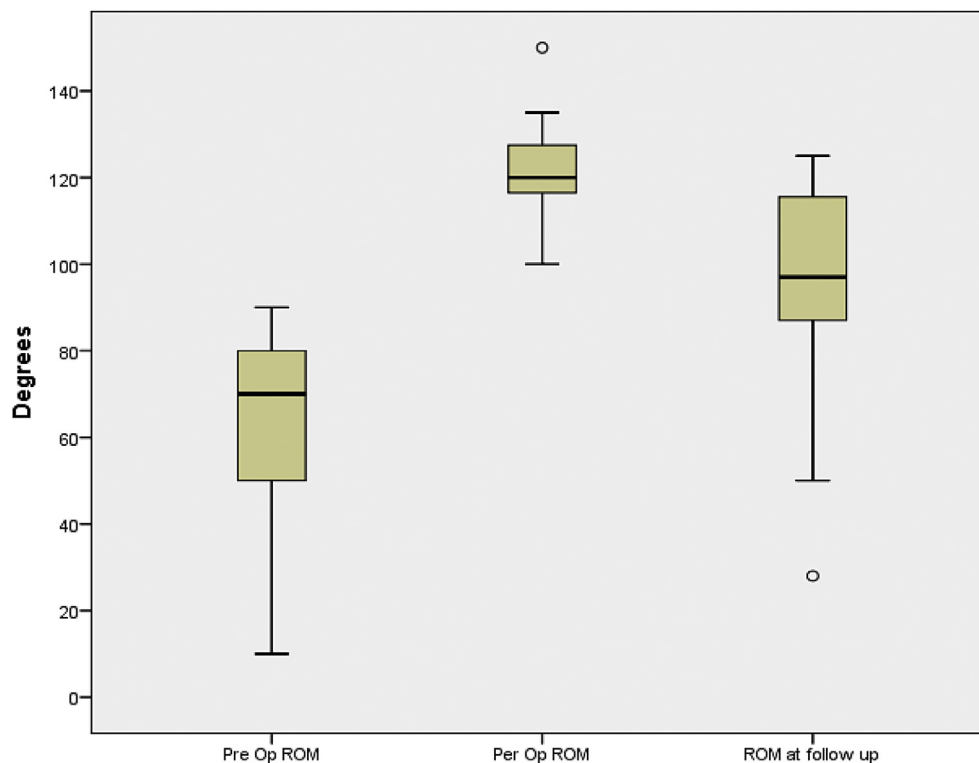


Figure 2. Boxplot demonstrating change in the total range of motion (ROM) in 23 patients treated with the manipulation under anesthesia (MUA) for knee stiffness after TKR at Akershus University Hospital 2014–2018.

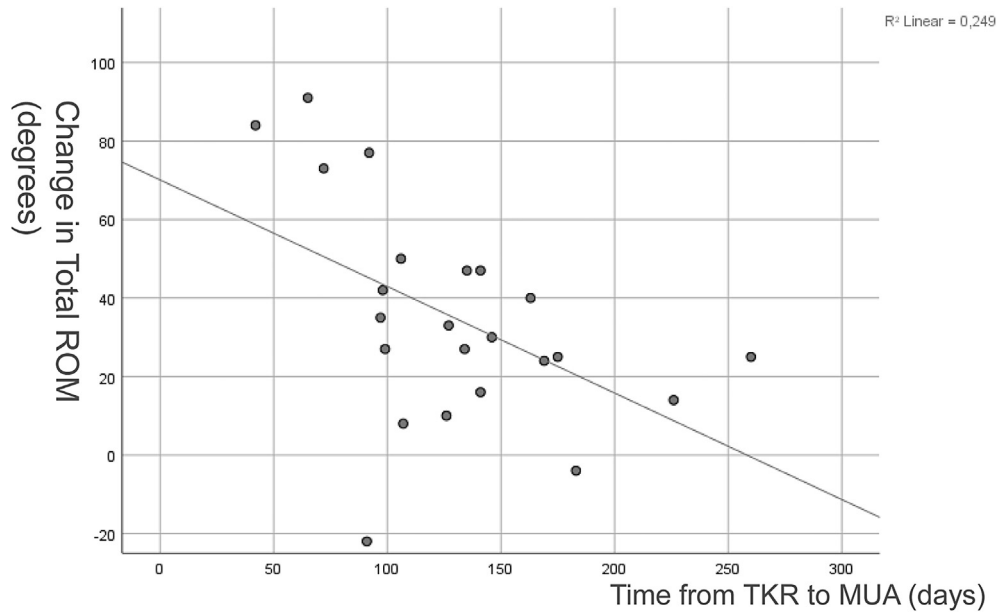


Figure 3. Scatterplot showing the relationship between the time from the index surgery (TKR) to the MUA and the change in the total ROM at follow-up.

evidence that younger age increases the risk of needing an MUA after TKR. The average age of the patients in our study was about 10 years less than the average age of the patients who underwent TKR who reported to the Norwegian Arthroplasty Register [17]. Newman et al also observed that patients undergoing the MUA were about 10 years younger than patients who underwent TKR who did not end up with an MUA (55.2 vs 65.3 years) [9]. Dzaja et. al. observed an average age of 59.8 years in their cohort of patients who underwent the MUA, which is similar to our findings [18]. Younger patients considered for a TKR should be made aware of the increase risk of stiffness and possible need for the MUA.

Previous studies of the MUA have largely focused on the improvement in the ROM, which naturally is the main focus of the procedure. However, the optimal goal for the patients is to regain knee function and become pain free. We therefore included the PROM scores, KOOSs, Lysholm scores, and VAS scores for pain. The results indicate that despite improvement in the ROM after the MUA, the patients do not achieve PROMs scores

comparable with those recorded by the National Arthroplasty Register. This is useful prognostic information that can be used in patient expectation management. The MUA is a noninvasive procedure and is therefore often considered to have little risk of complications, but there is a substantial risk of complications after the MUA that should not be undercommunicated to the patients. We had one periprosthetic fracture during the MUA that needed surgical fixation, which ultimately led to a total ROM of only 50° at follow-up. Patients should be made aware of the risk of complications such as periprosthetic fracture, hemarthrosis, pain and swelling, and the need for a repeat MUA or ultimately revision knee arthroplasty.

This study has some limitations. The number of patients is too low to conduct any further risk assessments, and the results were not compared with those of a matched cohort, but rather historical norms that were not stratified or matched. Only 3 knees were manipulated before 10 weeks. The retrospective nature of the study, depending on medical journal notes for the measurement of the preoperative and perioperative ROM, is also a limitation. We did not have preoperative PROMs, so the changes in Lysholm scores and KOOSs for the individual patient were not available. Furthermore, the study is conducted in a single institution, which limits the external validity of the findings.

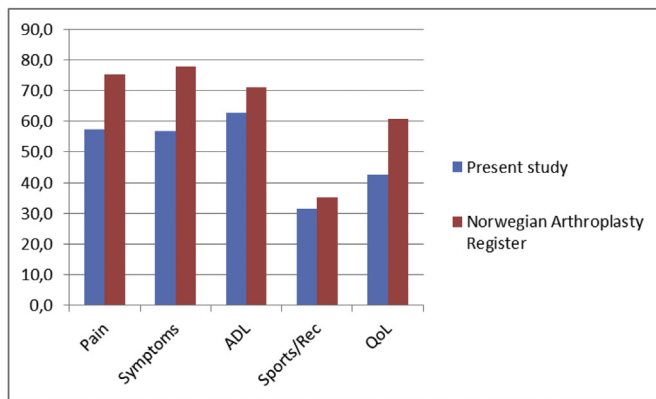


Figure 4. KOOSs in 23 patients treated with the MUA for stiff knee joint after TKR compared with the KOOSs reported to the Norwegian Arthroplasty Register 2 y after TKR surgery.

Table 3
PROM scores reported by 23 patients 2.5 y after the MUA for knee stiffness after primary TKR, treated at Akershus University Hospital during 2014–2018.

PROM	Median (range)	95% CI
Lysholm score	57.1 (17.9–92.9)	47.1–66.3
Tegner score	2.0 (0–7)	1.2–2.9
VAS score sitting	1.5 (0–6)	1.2–2.9
VAS score standing	2.25 (0–8)	1.9–4.4
KOOS symptoms	57.1 (17.9–92.9)	47.1–66.3
KOOS pain	58.3 (0–94.4)	46.3–68.5
KOOS adl	66.2 (0–100)	50.0–75.9
KOOS sports&rec	25.0 (0–100)	18.2–44.9
KOOS QoL	43.8 (0–81.3)	32.6–52.7

VAS, Visual Analogue Scale for pain; adl, activity of daily living; sports&rec, sports and recreational activity; QoL, quality of life.

Conclusions

This study supports previous findings that the MUA for knee joint stiffness after TKR improves the ROM also in the long term. An earlier MUA yields a better total ROM. However, the patients report worse pain and functional scores than patients who underwent uneventful TKR surgeries.

Conflict of interest

The authors declare there are no conflicts of interest.

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The data sets used and/or analyzed during the present study are available from the corresponding author on reasonable request.

Authors' contributions: P.H.R. designed the study, performed statistical analysis, and drafted manuscript. J.T. and H.N. collected data, examined patients, and performed data analysis and revision of the manuscript. J.H.R. performed data analysis and revision of the manuscript. All authors read and approved the final manuscript.

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