The Journal of Arthroplasty Vol. 22 No. 6 Suppl. 2 2007

Early and Late Manipulation Improve Flexion After Total Knee Arthroplasty

Robert S. Namba, MD,* and Maria Inacio, MS†

Abstract: Manipulations have been considered effective only in the early postoperative period. From a total joint registry containing 9640 primary total knee arthroplasties (TKAs), 195 patients who underwent manipulation under anesthesia (MUA) were identified. A total of 102 had MUA within 90 days (early), and 93 more than 90 days (late) after TKA. Average pain (10-point scale), satisfaction (10-point scale), flexion (degrees), and extension (degrees) were recorded before and after MUA. Flexion was significantly improved after MUA for both groups: early MUA from 68.4° (±17.2°) to 101.4° (±16.15°), $P < .001$; late MUA from 81.0° (±13.3°) to 98.0° (±18.0°), $P = .001$. Pain decreased significantly with early MUA from 4.92 (±2.25) to 3.34 (±2.67) and with late MUA from 4.51 (±2.62) to 3.44 (±2.78), $P = .048$. Extension improved only in the early MUA group from 7.15 (±10.1) to 2.50 (±4.98). Satisfaction scores were not improved. Both early and late manipulation can improve TKA pain and flexion. **Key words:** manipulation, total knee arthroplasty, early and late.
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Total knee arthroplasty (TKA) is a highly effective treatment for the management of arthritic knee pain. Despite modern implant designs, contemporary surgical techniques, and aggressive physiotherapy, postoperative stiffness still occurs, mitigating optimal TKA function. Management of stiffness includes manipulation under anesthesia (MUA), surgical debridement, and revision of implants.

Manipulation under anesthesia has been recommended from as early as 2 weeks to up to 3 months after TKA [1-3]. After 3 months, maturation of scar tissue is assumed, leading many authors to recommend surgical intervention. The current report was undertaken to determine the effectiveness of MUA performed both in the early (≤3 months) and late (>3 months) postoperative periods.

*From the *Department of Orthopedic Surgery, Kaiser Permanente, Orange County, Anaheim, California; and †Department of Orthopedic Surgery, Kaiser Permanente, San Diego, El Cajon, California.*
Submitted December 14, 2006; accepted February 23, 2007.
No benefits or funds were received in support of the study.
Reprint requests: Robert S. Namba, MD, Department of Orthopedic Surgery, Kaiser Permanente, 411 N. Lakeview, Anaheim, CA 92807.
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0883-5403/07/1906-004$32.00/0
doi:10.1016/j.arth.2007.02.010

Methods

A retrospective analysis of patients who underwent an MUA procedure after a primary TKA was performed and entered into a community-based total joint registry. The inclusion period was between April 1, 2001, and September 30, 2005. Data from the registry were matched with those from an administrative database for analysis. Manipulations were performed in the operating room as a quick (≤5 minutes), closed procedure, with patients in the supine position. The end point for manipulation was firm resistance after the initial gain in motion with moderate but not excessive force. Self-reported patient pain and satisfaction ratings were recorded before and after MUA procedures. Flexion and extension measurements made with pocket-sized goniometers were recorded by the treating surgeons.

Statistical Analysis

Pearson χ^2 and Fisher exact tests were used to compare the demographic categorical variables operative site, sex, and American Society of Anesthesiologists scores. A Mann-Whitney test was used to compare age means, height, and weight. A Mann-Whitney test was also

applied to compare the means of the pain, satisfaction, flexion, and extension between early and late MUA groups and magnitude of change in variables. Wilcoxon signed rank test was used to compare mean satisfaction, pain, extension, and flexion before and after MUA surgery. SPSS 14.0 (Chicago, IL) was used to analyze the data.

Results

A total of 9640 primary TKAs were entered into a community total joint registry for the southern California region between April 1, 2001, and September 30, 2005. From this pool of primary TKAs, 195 patients subsequently underwent an MUA under an inpatient setting under the care of 36 different surgeons. The MUAs performed within 90 days of TKA were designated as early manipulations. Early MUAs were performed in 102 patients at a mean of 56.7 days (±19.8 days) after TKA (range, 19-90 days) (Fig. 1). The MUAs performed more than 90 days after TKA were considered late. Late MUAs were performed in 93 patients at a mean of 164.7 days (±96.6 days) after TKA (range, 91-729 days) (Fig. 2). The patient demographics of the early and late MUA groups were similar (Table 1). The MUAs were performed under the following anesthetic settings: 128 general, 33 spinal, 18 epidural, and 17 local. The average length of stay was 1.31 days in the early MUA group and 1.15 in the late group.

Average pain (10-point scale), satisfaction (10-point scale), flexion (degrees), and extension (degrees) were recorded 90 days before MUA and at final follow-up after MUA. Table 2 shows results for the comparison of outcomes between the 2 MUA groups. Premanipulation flexion was significantly less in the early MUA group than in the late MUA group. Before MUA, the average flexion of the late MUA group was 81.0° (±13.3°) compared with

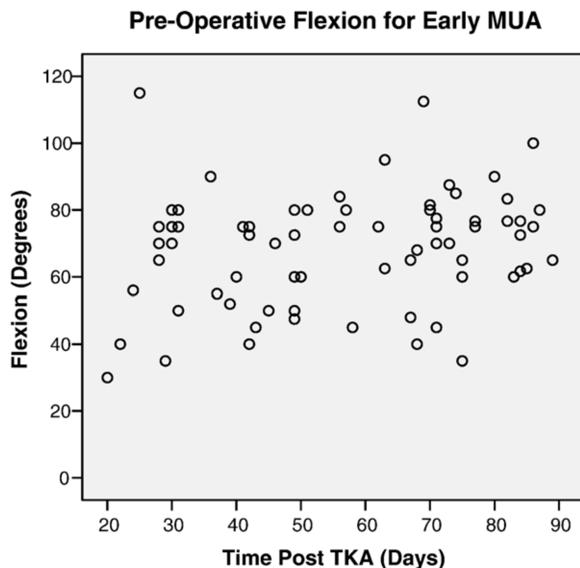

Fig. 1. Distribution of patients undergoing early MUA.

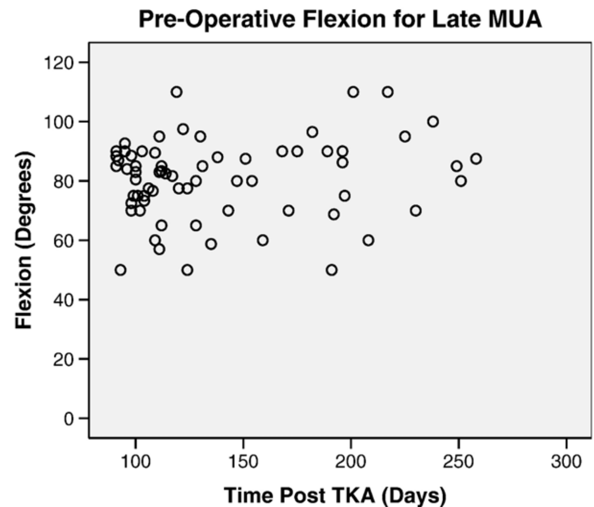

Fig. 2. Distribution of patients undergoing late MUA.

68.4° (±17.2°) for the early group, $P < .001$. Extension was also significantly different with the early MUA group having higher flexion contractures, 7.15° (±10.1°), than the late MUA group, 3.99° (±6.19°), $P = .034$. No other differences were observed between the groups.

Flexion was significantly improved after MUA for both groups (Table 2). The early MUA group improved from a mean maximal flexion of 68.4° (±17.2°) before MUA to 101.4° (±16.15°) after manipulation, $P < .001$. The late MUA group improved from a mean maximal flexion of 81.0° (±13.3°) before MUA to 98.03° (±18.02°) after MUA, $P < .001$. Pain scores for early MUA decreased from 4.92 (±2.25) to 3.34 (±2.67), $P = .005$. For late MUA, the pain score decreased from 4.51 (±2.62) to 3.44 (±2.78), $P =$

Table 1. Demographics of Patients who Underwent MUA

	Early MUA	Late MUA	*P*
MUA group definition (d)	0-90	>90	–
n (%)	102 (52.3)	93 (47.7)	–
Days to MUA (mean ± SD)	56.7 ± 19.8	164.7 ± 93.6	<.001
Age (mean ± SD)	60.8 ± 9.44	62.5 ± 9.65	.175
Sex (n [%])			.915
Female	72 (70.6)	65 (69.9)	–
Male	30 (29.4)	28 (30.1)	–
Operative site (n [%])			.534
Right	55 (53.9)	46 (49.5)	–
Left	47 (46.1)	47 (50.5)	–
Bilateral primary TKA (n [%])	5 (4.9)	7 (7.5)	.446
ASA score at primary TKA (n [%])			.137
1	7 (7.4)	4 (4.3)	–
2	63 (67.0)	1 (65.6)	–
3	24 (25.5)	26 (28.0)	–
4	0 (0)	1 (1.10)	–
Missing	8 (7.80)	1 (1.10)	
Weight, lbs (mean ± SD)	192.1 ± 36.6	191.1 ± 35.7	.983
Height, in (mean ± SD)	65.4 ± 3.38	64.9 ± 3.66	.550

ASA indicates American Society of Anesthesiologists.

Table 2. Comparison of Outcomes Between Early MUA and Late MUA

	Early MUA			Late MUA		
	Pre-MUA	Post-MUA	*P*	Pre-MUA	Post-MUA	*P*
Days post-MUA (mean ± SD)	–	291.8 ± 247.6 (range, 10-1206)	–	–	313.8 ± 281.1 (range, 16-1205)	–
Pain (mean ± SD)	4.92 ± 2.25	3.34 ± 2.67	.005	4.51 ± 2.62	3.44 ± 2.78	.001
Satisfaction (mean ± SD)	7.20 ± 2.90	7.90 ± 2.80	.349	7.38 ± 2.63	7.22 ± 3.40	.961
Flexion (mean ± SD)	68.4 ± 17.2	101.4 ± 16.15	<.001	81.0 ± 13.3	98.0 ± 18.0	<.001
Extension (mean ± SD)	7.15 ± 10.1	2.50 ± 4.98	.001	3.99 ± 6.19	2.32 ± 5.31	.057

.001. Extension decreased significantly in the early MUA group from 7.15° (±10.1°) before MUA to 2.50° (±4.98°) after MUA, *P* = .001. Extension did not change in the late MUA group. Satisfaction scores did not significantly change after MUA for either group.

Despite improvements in pain and range of motion, the outcomes of both early and late MUA groups were inferior when compared with those of patients who did not require MUA (Table 3). There were no significant differences in preoperative flexion or extension between patients who underwent MUA and those TKA patients who did not have an MUA.

No complications occurred with any of the 195 MUA procedures. After MUA, 13 patients (6.7%) went on to have revision surgery: 9 (8.8%) in the early MUA group and 4 (4.3%) in the late MUA group (*P* = .206). Reoperations included revision of implants for persistent stiffness in 7 cases, treatment of infection in 3 cases, and failure of tibial fixation in 2 cases. A lateral release was performed in 1 patient for patellar maltracking.

Discussion

Total knee arthroplasty is an effective medical intervention for relief of arthritic pain and restoring function for activities of daily living. Some patients may have residual pain and stiffness after TKA due to the development of motion-limiting fibrous scar tissue and adhesions. An acceptable range of knee motion depends on the patient, but in general 70° of flexion has been reported as necessary for the swing phase of gait, 90° to descend stairs, and 105° to get up from a low chair [4].

Surgical debridement has been recommended for stiffness persisting for more than 3 months after TKA [5]. Improvements in range of motion have been described with arthroscopic lysis of adhesions in conjunction with manipulation [6-8]. For severe stiffness with an arc of motion of less than 70°, open debridement of adhesions with and without revision of implants has been described. Isolated tibial liner downsizing with lysis of scar tissue was reported to produce poor results [9]. Revision of implants for stiff TKA was demonstrated to have modest improvement in range of motion and flexion [10,11].

For less severe forms of stiffness, MUA has been recommended historically within 90 days of TKA. The indications for MUA are unclear, but early reports of knee manipulation in a series of predominantly rheumatoid patients [3] included failure to achieve 90° of flexion 2 weeks after surgery. These series included early designs of TKA implants with a conservative postoperative rehabilitation protocol. In a contemporary series of prospectively studied press-fit condylar knees, Esler et al [2] reported a series of manipulations performed for flexion of less than 80° after intensive therapy, performed for a mean of 11.3 weeks postoperatively (range, 2-41 weeks). Our report includes a series of contemporary TKA implants with aggressive inpatient physical therapy limited to 3 to 4 days, followed by home exercises with or without outpatient therapy. There was no clear indication for recommendation of MUA in our series, but early MUA (<3 months postoperatively) was performed on knees averaging to 68° of flexion and late MUA on knees with maximal flexion averaging to 81°.

The efficacy of manipulations for improving knee flexion has been previously reported [1,2]. Our report confirms significant improvement of knee flexion with MUA, with a mean increase of 31.6° for MUA performed within 90 days of TKA. Pain scores were improved after MUA, but satisfaction scores were not changed. Despite some improvement, all measured outcomes of patients in our series were inferior to those of TKA patients who did not undergo MUA. Maintenance of the gains in motion after MUA will be studied in future analyses of these patient cohorts.

A unique finding in our report is that late MUA also significantly improved flexion, with a mean increase of 19.5° for late MUA. The early postoperative period after TKA is characterized by extensive inflammation from surgery and exercises directed at breaking adhesions. Aggressive physiotherapy may perpetuate persistent

Table 3. Comparison of Change of Outcomes Among Early MUA, Late MUA, and TKA Patients who did not Undergo MUA

	Early MUA	Late MUA	TKA Without MUA (n = 7211)
Pain (mean ± SD)	3.34 ± 2.67	3.44 ± 2.78	2.31 ± 2.48
Satisfaction (mean ± SD)	7.90 ± 2.80	7.22 ± 3.399	9.22 ± 1.70
Flexion (mean ± SD)	101.4 ± 16.15	98.03 ± 18.02	111.1 ± 12.4
Extension (mean ± SD)	2.50 ± 4.98	2.32 ± 5.31	1.43 ± 4.17

swelling in some patients. After 6 months, most patients have dramatically reduced knee swelling and warmth. Manipulation under anesthesia performed in this milieu of reduced inflammation may achieve gains in motion that may not be obtained with protracted physical therapy. For patients with limited flexion 6 to 12 months after TKA, a late MUA may provide a safe and effective opportunity to improve knee motion and function. For some patients, even a modest increase in knee flexion could make an activity such as descending stairs possible.

Flexion contractures were not significantly improved with late MUA in our series; however, improved knee extension was observed with early MUA. Prior reports of MUA have reported only improvements in flexion. Significant improvement in flexion contractures has been reported up to 2 years after TKA without MUA but with prolonged physiotherapy [12].

The rates of reported complications after MUA are low but have included supracondylar femur fractures, heterotopic bone formation, wound dehiscence, patellar tendon ruptures, and fatal pulmonary embolism [3,13-16]. These anecdotal occurrences should be described to patients who are contemplating MUA, but these can be minimized by careful technique. In this series of 195 manipulations, there were no significant complications.

Advances in surgical technique, implant designs, rehabilitative exercises, and pain management provide most TKA patients with comfortable knees with a functional arc of motion. Some patients develop stiffness after TKA, however, and may benefit from MUA. The efficacy of late MUA to improve flexion permits both the surgeon and patient ample time to consider this intervention several months after surgery.

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