



Incidence and effectiveness of manipulation under anaesthesia for stiffness following primary total knee arthroplasty

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Background: There are various modalities of correction of stiffness following total knee arthroplasty. Manipulation under anaesthesia (MUA) is generally indicated for people who fail to achieve their pre operative range of motion at 12 weeks. The purpose of this study was to determine: (1) the effect of MUA on Flexion arc (2) the influence of timing of MUA from index procedure and of diabetes mellitus on final flexion achieved. **Methods:** We retrospectively evaluated patients who underwent manipulation following total knee arthroplasty at our institution between January 2016 to December 2018. For the purpose of analysis, we have divided the patients into two groups. Those who underwent manipulation within 12 weeks and later than 12 weeks. We have

also compared the effect of MUA between diabetic and non-diabetic patients. All were operated with posterior stabilised (PS) prosthesis by a single senior arthroplasty surgeon. The final flexion achieved during their last clinical follow-up were recorded and compared with the pre MUA flexion. **Results:** The incidence of MUA after TKA at our institute during this period is about 1.14 %. There was a significant statistical difference between the pre and post manipulation flexion, with p value <0.01. There was no significant statistical difference between those who were manipulated before 12 weeks and after 12 weeks in improving the Flexion of the operated knees. We have found that both the diabetic and non diabetic group had comparable flexion after the manipulation in our study. **Conclusion:** Manipulation after anaesthesia is a safe first intervention to

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improve post operative stiffness and gain additional range of motion following TKA in patients who develop stiffness. It can be done even after 12 weeks of surgery with reasonably good gain in range of motion.

Keywords: TKA, knee stiffness; manipulation under anaesthesia; diabetes.

INTRODUCTION

Total knee replacement is one of the most successful surgical procedures in modern day orthopaedics. The goals of total knee arthroplasty is to provide a stable knee with functional range of motion. Unfortunately about 5% of the patients who undergo total knee arthroplasty experience loss of motion and stiffness (1). Few of the patients develop restriction in motion following surgery without affecting their activities. A lesser number of those experience difficulty in activities like rising from the chair, climbing up and down the stairs. Such unhappy patients are said to have stiff knee. Therefore it is reasonable to define stiffness as the one that limits activities of daily living. The actual definition of what constitutes knee stiffness is variable in the literature. Kim et al described stiffness as flexion contracture of $> 15^\circ$ and/or $< 75^\circ$ of flexion of the knee (2), whereas Christensen et al (3) have defined it as an arc of knee motion $< 70^\circ$. According to us flexion arc ranging between 15 to 75 degree or those who gain $< 90\%$ of preop flexion arc and who are experiencing difficulties in performing the daily living activities are said to have stiff knee.

There are various modalities of correction of stiffness following total knee arthroplasty. Non-surgical interventions are- Use of continuous passive motion (CPM), physical therapy programmes, use of night splints, manipulation under Anaesthesia (MUA) in the early post operative period (within 3 months) and surgical interventions like arthroscopic arthrolysis, quadriceps pie-crusting and even revising the components if the conservative modalities fail. Manipulation under anaesthesia is generally indicated for people who

fail to achieve their pre operative range of motion at 12 weeks. Traditionally manipulation is done under short GA by applying pressure over proximal tibia with care till the scar tissues break up. An alternative gravity assisted procedure has also been described by Smith et al in 1999 (4).

In the literature there is no clear consensus regarding the timing of MUA. Some studies suggest patients manipulated within 90 days achieve greater increment in Flexion compared with patients at longer intervals after TKA, while in others manipulation was still beneficial in gaining adequate Flexion even after 12 weeks of surgery. Diabetes is one of the predisposing risk factor for stiffness following TKA. Bawa et al have noted diabetic patients gain lesser degree of improvement after MUA following TKA (5).

We present a retrospective study of 32 knees (23 patients) who underwent total knee arthroplasty requiring manipulation for post operative stiffness. We have used the traditional method of manipulation and found it very useful intervention to regain the range of motion in operated knees. The purpose of this study was to determine: (1) the effect of MUA on Flexion (2) the influence of timing of MUA from index procedure and of diabetes mellitus on final flexion achieved.

MATERIALS AND METHODS

We retrospectively evaluated patients who underwent manipulation following total knee arthroplasty at our institution between January 2016 to December 2018. A total of 2800 total knee arthroplasties (TKA) were done during this period. All were operated with posterior stabilised (PS) prosthesis by a single senior arthroplasty surgeon. For the purpose of the study we have included primary arthroplasties only. This study has been approved by the Institutional review board (IRB) of the authors affiliated with the institutions. Inclusion criteria includes 1) Patients of Both the sexes Primary Knee Osteoarthritis who undergone total knee arthroplasty 2) Patients with postoperative flexion range 15 to 75 degree only 3) Patients having difficulties in performing daily living activities due to stiffness. Exclusion criteria includes 1) Post traumatic OA knee 2) Patients

with constrained primary TKA & Revision TKA
 3) Patients with pre-op contracture due to severe defects, deformities, infection and who are wheel chair bound
 4) Patients who developed surgical site infection in postoperative period
 5) Neurological disorders like Parkinson's disease, CVA, Post Polio Limb, Rheumatoid arthritis. For the purpose of analysis, we have divided the patients into two groups. Those who underwent manipulation within 12 weeks and later than 12 weeks. We have also compared the effect of MUA between diabetic and non-diabetic patients. Total of 7 patients were identified as diabetic. 5 were manipulated within 12 weeks and 2 were in the other group manipulated after 12 weeks. 3 knees (2 Patients) who gained <50 % of their pre Op Flexion at 6 weeks follow up were taken up for early manipulation at 6 weeks. 21 knees (14 Patients) who gained >50% but less than 90% of the pre op Flexion were manipulated at 12 weeks. 8 knees (7 patients) who were lost to 12 week follow up were manipulated at a later period. Data was recorded from case sheets and operating room records. The final flexion was recorded in all patients at last clinical follow up. A total of 32 knees (23 patients) were enrolled to the present study. All the patients requiring MUA have been manipulated by the single senior operating surgeon.

Technique of manipulation

Pre-operative and pre manipulative range of motion recorded. In the operation theater (OT), under short general anaesthesia (GA) manipulation was done by placing the hip in 90 degrees of flexion. Leg was held with both hands close to the knee joint (tibia) and ankle held at the manipulating surgeon's axilla, careful progressive force applied to break the adhesions until desired amount of improvement was achieved or a firm end point reached. No force was applied beyond this point. Crackling sounds of the adhesions breaking were heard during the procedure. Any sudden jerky movements were avoided. The new ROM after the procedure was recorded using goniometer. Manipulation into extension: With the patient supine and the hip extended, a bolster is placed below the ankle of the patient. Surgeon's One hand held at distal thigh and

the other at the proximal leg, persistent firm force is applied to extend the knee. Any jerky movements were avoided. The improvement in flexion contracture gained after manipulation was recorded using a goniometer. In all the patients, ice packs were applied while 80 mg methylprednisolone I/A was given only in non diabetic patients (less risk of infection) to inhibit the inflammatory cascade response thus aids in rehabilitation. Patients were transferred to post operative care and placed on CPM exercises till discharge on the same day. Patients were provided with adequate intravenous analgesia following manipulation. All the patients were started on oral indomethacin 75mg twice a day for a week (to prevent post manipulation inflammatory mediators and heterotrophic ossification risk) with oral methylprednisolone 6mg twice a day for the first two weeks and tapered over 6 weeks. All patients received supervised physiotherapy that includes CPM, ROM (active and passive) exercises with ankle weights and squatting exercises following manipulation for 6 weeks. However we have excluded the patients who have had Flexion contracture of 100 or less. Hence the study contains mainly the patients who were manipulated for improvement in flexion only

Follow-up

The patients were kept under regular follow up every 2 weeks for first 6 weeks. After 6 weeks of intensive physiotherapy, they were weaned off the medications and physical therapy sessions and advised for follow-up every 3 months. The final flexion achieved during their last clinical follow-up were recorded and compared with the pre MUA flexion. Student t test (two tailed, independent) has been used to find the significance of study parameters on continuous scale between two groups (Inter group analysis) on metric parameters. Leven's test for homogeneity of variance has been performed to assess the homogeneity of variance. Student t test (two tailed, dependent) has been used to find the significance of study parameters on continuous scale with in each group.

RESULTS

The incidence of MUA after TKA at our institute during this period is about 1.14 %. Total of 23 patients were included who underwent MUA (Table I). Comorbidities were Diabetes mellitus (7 patients), Hypertension (7 Patients), coronary artery disease (1 patient). Mean age of patients in the study was 60.61 years (range 48-71 years). Mean follow up was 8 months (range 5-14months). There was a significant statistical difference between the pre and post manipulation flexion with p value <0.01. All the patients achieved functional range of motion following manipulation (Table I). We also recorded the influence of various posterior stabilized implants used in TKA over ROM in all the patients and found no significant inter-implant

Table I. — Demographic profile & Range of motion (ROM) Record

Variable	Value
Number of patients	23
Number of knees	32
Average age (years)	60.42
Sex	
Female	17 (69.57%)
Male	6 (30.43%)
Average ROM	
Pre-TKA Flexion	92.29±24.93
Pre-MUA Flexion	77.92±18.99
Final Flexion (at last follow up)	110.83±9.74*
*Significantly-Higher than pre-MUA Flexion with p value less than 0.001; Flexion= range of motion; MUA = manipulation under anesthesia.	

variation in terms of range of motion achieved postoperatively (Table II).

We have found that both the diabetic and non diabetic group had comparable flexion after the manipulation in our study. However the diabetic patients had higher pre TKA flexion in our study (Table III & Fig. 1).

16 patients were manipulated before 12 weeks and 7 after 12 weeks of TKA (Table IV). Patients who were manipulated within 12 weeks of surgery had a mean flexion 67.780±20.170 which improved to 108.890±10.540 after manipulation (mean gain was 41.10). Patients who were manipulated after 12 weeks had a mean flexion of 84.000±15.950 which improved to 112.000±9.410 (mean gain was 280). In our study group, there was no significant statistical difference between those who were manipulated before 12 weeks and after 12 weeks in improving the Flexion of the operated knees (Table V & Fig. 2).

9 of the 17 bilateral patients required manipulation of both knees only. 8 of the 17 bilateral patients required manipulation at one knee only. It was noted that the manipulated knee had a more severe restriction of motion pre-operatively than the knee that didn't require manipulation. All the patients had preserved their achieved Flexion during their final follow up.

Complications

There are many complications associated with the manipulation following TKA. Wound dehiscence, patellar ligament avulsion, hemarthrosis, heterotopic bone formation, supracondylar femoral peri-prosthetic fracture and pulmonary embolism etc are few of the major complications. However we did

Table II. — Type of the implant used and the respective mean flexion for each group

IMPLANT MAKE	Type of Implant	Number used (KNEES)	Pre -TKA Flexion	Pre MUA Flexion	Post MUA follow up Flexion
Smith and Nephew Oxinium	PS	10	81.26	77	104.03
Zimmer Gender	PS	14	98.2	77	112.31
Zimmer Legacy	PS	6	75	78	105.14
Zimmer persona	PS	2	115	79.68	121.81
Total		32	Mean 92.3	Mean 77.92	Mean 110.8

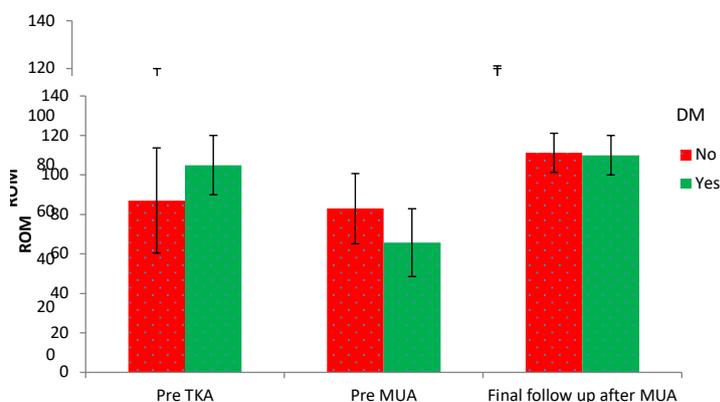


Figure 1. — Graphical representation of ROM (Flexion) in diabetic and non diabetic patients.

Table III. — Comparison of Pre operative Flexion, pre manipulation and post manipulation Flexion between diabetic and non diabetic patients. All measurements are in degrees

Flexion	Diabetes		Total patients in the study
	No	Yes	
Results			
• Pre TKA	87.06±26.64	105.00±15.00	92.29±24.93
• Pre MUA	82.94±17.77	65.71±17.18	77.92±18.99
• Final Follow up after MUA	111.18±9.93	110.00±10.00	110.83±9.74

not encounter any of the complications following MUA in the present study.

DISCUSSION

The literature varies about the requirement of MUA after TKA between 1-4%. Earlier it was about 20% in 1970s (6). Improvement in prosthetic design, surgical knowledge, timely surgeries have reduced the need for MUA in present times. Indications for TKA, pre-op Flexion, surgeon’s

Table IV. — Distribution of patients who were manipulated <12 weeks and > 12 weeks

Follow up weeks	No. of patients	Number of Knees
<12	16 (69.56%)	24(75%)
>12	7 (30.43%)	8(25%)

expertise, post op rehabilitation & comorbidities like Diabetes all determine the need for MUA after TKA. It is reasonable to expect the patient to return to their pre-op flexion after total knee arthroplasty. If the patients’ had stiffness before surgery, then the

Table V. — Comparison of the pre-operative Flexion, pre manipulation and post manipulation Flexion between patients who were manipulated < 12 weeks and > 12 weeks

Flexion	Duration of MUA		Total
	≤12weeks	>12 weeks	
Results			
• Pre TKA	90.00±32.79	93.67±20.04	92.29±24.93
• Pre MUA	67.78±20.17	84.00±15.95	77.92±18.99
• Final Follow up MUA	108.89±10.54	112.00±9.41	110.83±9.74

flexion under gravity after the closure of capsule on table should be considered as the new potential flexion the patient can achieve (7). Out of 2800 total knee arthroplasties done at our institute, 32 knees required manipulation following surgery. The incidence of manipulation at our institute is 1.14%.

In our study 16 patients were manipulated at or within 12 weeks post operatively while 7 patients were manipulated after 12 weeks. The farthest manipulated knee was at 36 weeks. The patient was lost to follow up and returned with stiffness after 36 weeks. He gained his pre operative range following manipulation. Improvement in Flexion after early MUA (<12 weeks) and late MUA (>12 weeks) is quite contradictory in the literature. Some studies suggest patients manipulated within 90 days achieve greater increment in Flexion compared with patients at longer intervals after TKA, while in others manipulation was still beneficial in gaining adequate Flexion even after 12 weeks of surgery provided there was adequate Flexion on table at the time of surgery (8, 9) while others show patients achieve similar final Flexion irrespective of the interval between surgery and MUA. In our study group, there was no significant statistical difference between those who were manipulated before 12 weeks and after 12 weeks in improving the Flexion of the operated knees (Table V & Fig. 2).

Since 1991, it can be noted that in the literature there is a gradual reduction in the percentage of people manipulated after total knee arthroplasty (Table VI). The incidence of manipulation at our institute is 1.14%. The follow up period is however

less than 1 year and further follow up is necessary to determine if the achieved flexion is retained over long term.

The degree of prosthesis constraint has some bearing on improvement in Flexion after anaesthesia. Studies indicate the mean Flexion was higher in posterior stabilised knees as compared to cruciate retaining knees after the anaesthesia (5, 16). We routinely use only posterior stabilised prosthesis and therefore the present study was unable to compare the outcomes of MUA between CR and PS knees. 10 patients had varus deformity before TKA. However there was no significant difference in the Flexion after MUA between those who had varus deformity and those who did not have varus deformity.

The mean preoperative flexion in nondiabetic patients before TKA was 87.06 ± 26 . The final flexion after manipulation in the present study nondiabetic patients was 111.18 ± 9.93 . However in diabetic population there was a pre operative flexion of 105.00 ± 15.00 and they achieved a mean flexion of 110.00 ± 10.00 after the manipulation. Diabetic patients had significant loss of motion during the follow up but after the manipulation they regained their lost flexion. We find in our study that diabetic patients are at greater risk of loss of Flexion following TKA compared to non-diabetic group significantly. However the final Flexion achieved between the diabetic and non diabetic patients in our study remains comparable. This might be attributed to the higher pre-operative flexion in diabetic patients and small number of diabetic patients in the study to give statistically significant and optimal

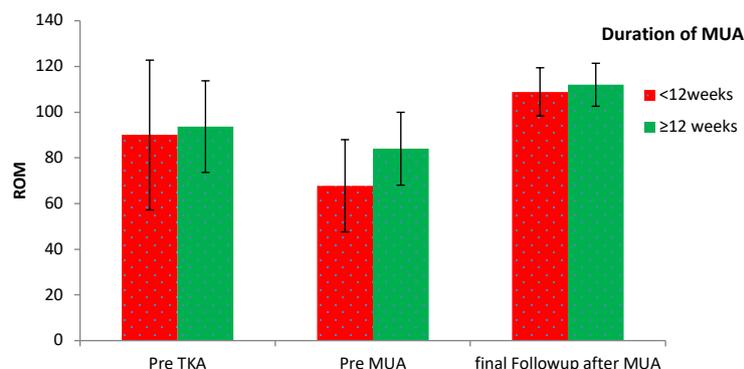


Figure 2. — Graphical representation of MUA before and after 12 weeks.

Table VI. — Comparison of previous studies of MUA after TKA

Study	Year	Numbe of knees	Number of patients	Type of prosthesis	MUA rate	Change in Flexion after MUA	Mean interval between TKA and MUA (days)	Mean Follow up (months)
Fox and Poss (10)	1981	76	–	CR, PS	23.0%	30°	14	12
Daluga et al. (7)	1991	94	60	PS	12.0%	42°	–	34.8
Esler et al. (9)	1999	47	42	CR	9.9%	35°	79	–
Scranton (13)	2001	19	19	PS	10.8%	42°	–	–
Maloney (12)	2002	24	–	PS	11.2%	47°	51	–
Yercan et al. (14)	2006	46	46	PS	4.0%	47°	30	31
Keating et al. (11)	2007	113	90	CR	1.8%	35°	–	55.2
Sekhar et al	2018	32	23	PS	1.1%	32.91°	82	8

results. Bawa et al have noted diabetic patients gain lesser degree of improvement after MUA following TKA (5).

There are no standard recommendations for the use of intra articular steroid in total knee arthroplasty. Gluco-corticoids are increasingly used in multimodal pain management in elective surgeries. Their mechanism of remains unclear. During surgery tissue injury results in the release of pro inflammatory cytokines and prostaglandins that cascade a pathway hypersensitizing the nociceptors generating pain. It is believed that steroids bind to specific receptors thereby inhibiting normal prostaglandin synthesis during surgery. Furthermore, steroid hormone receptors are found throughout the central and peripheral nervous systems allowing them to assist regulate the growth, maturation and differentiation of neurones. This suggests their role is pivotal in pain perception. We use I/A steroids for non diabetic patients the time of manipulation in the form of 80mg methylprednisolone mixed with bupivacaine. 10 patients received intra articular steroids at the time manipulation in our study. 7 patients were diabetic and hence were not given intra articular injections. Vineet Sharma et al in their study had noted injecting intra articular steroid at the time of manipulation had a significant influence on preserving the Flexion at the time of manipulation in long term follow up (17). In our study all patients following manipulation were put on oral deflazacort 6mg BD during the post manipulation protocol which was tapered over 6 weeks gradually. We

have noted that the achieved flexion was retained in all the patients during their follow ups. The mean follow up of patients in the study was 8 months and hence needs a longer time interval to assess the efficacy of steroids in preserving the Flexion achieved during manipulation and also the adverse effects associated with steroid use. Ritter et al reviewed 145 consecutive knees and found that post operative Flexion was determined by pre operative flexion particularly if the flexion was less than 75° (18). In the present study 8 of the 17 bilateral patients required MUA only on one side. The knee which required MUA after surgery had worse Flexion compared to the knee which did not require MUA after surgery. It is noted that pre operative Flexion and limitation might have an effect on the post operative recovery of the quadriceps muscle to achieve adequate Flexion.

Limitations of the study

The present study fails to recognize the effect of compliance to physiotherapy following total knee arthroplasty while determining the need for MUA. The study cannot adequately recognise the statistical significance of intra articular steroid use during MUA after total knee arthroplasty. The study has a mean follow up of 8 months after MUA, and hence it is inadequate to determine if the flexion gained after MUA is lost in the long term as stated by few authors. Due to small population size and monocentric study it is impossible to implement the

study's conclusion over entire population. In the last this study cannot adequately identify the influence of DM over MUA and final retained ROMs due to small number of diabetic patients.

CONCLUSION

Manipulation after anaesthesia is a safe first intervention to improve post operative stiffness and gain additional range of motion following TKA in patients who develop stiffness. It can be done even after 12 weeks of surgery with reasonably good gain in range of motion. Diabetic patients are at higher risk of stiffness and need for MUA after TKA while Pre-operative Flexion limits the outcomes of Manipulation after total knee arthroplasty.

List of Abbreviations:

CPM: Continuous Passive Movement
 CR: Cruciate Retaining
 CVA: Cerebrovascular Accident
 GA: General Anaesthesia
 MUA: Manipulation Under Anaesthesia
 OA: Osteoarthritis
 PS: Posterior Stabilized
 ROM: Range Of Motion
 TKA: Total Knee Arthroplasty

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