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Case Series

Assessment of the role of manipulation under anaesthesia in knee stiffness following total knee arthroplasty

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ABSTRACT

About 3-4% of all total knee arthroplasty (TKA) patients develop unfortunately develop stiff knee. There is inadequate understanding of risk factors and a lack of consensus regarding its management protocol. This study aims to assess the risk factors and outcome of manipulation under anaesthesia to treat stiff knee following TKA. 18 knees with stiffness following primary TKA were enrolled in this study who underwent manipulation under anesthesia (MUA) between January 2023 and April 2024. Patient demographics, type of surgery (conventional or robotic), contributing factors and knee motion before and after manipulation were assessed from hospital records. Final FFD and arc of motion was recorded in a follow-up clinic. Female patients were significantly more affected than male. Delayed physiotherapy due to comorbidities was associated with stiffness. 72.22% stiff knee patients had conventional surgery while rest had robotic assisted surgery. Manipulation under anaesthesia led to mean 31.11degree improvement in arc of motion immediate post manipulation and 26.39 degree in final follow-up. There was no complication during MUA. MUA is safe, effective and noninvasive and can be considered as a first line treatment for stiff knee following TKA.

Keywords: Stiff knee, Manipulation under anesthesia, Total knee arthroplasty, Arthrofibrosis, Physiotherapy, Continuous passive motion

INTRODUCTION

Total knee replacement significantly improves knee pain, mobility and quality of life in patients with arthritis.[1] Stiffness following total knee arthroplasty (TKA) is uncommon, occurring in 3 to 4% patients undergoing total knee replacement.[2] Normal knee range of motion is 0–140 degree and an estimated arc of motion of 90 degree is required to perform activities of daily living.[3] About 65-degree flexion is required to walk on an even surface, 70 degrees to get up from chair and 90 degrees to climb downstairs.[4] Although stiff knee following TKR can be described as limited range of motion often associated with persistent pain, there is a lack of consensus regarding its definition.[5] Yercan et al defines it as range of motion less than 10–90 degree while Scranton defines it as flexion less than 85 degree.[6,7] Pathogenesis is complex in terms of cellular and molecular changes and is associated with pre operative risk factors including pre operative stiffness, obesity, surgical errors including incorrect component sizing, component malposition and errors in soft tissue balancing and post operative factors including infection and delayed rehabilitation.[2,8,9] There is no universally accepted protocol for management of knee stiffness after total knee replacement. Treatment modalities include physiotherapy, manipulation under anaesthesia, arthroscopic arthrolysis and revision arthroplasty.[10] The objective of this study is to identify risk factors and assess outcome of manipulation under anesthesia in knee stiffness following TKA.

CASE SERIES

The study was conducted in Calcutta Medical Research Institute, West Bengal, India with prior approval from ethical committee and written consent from every patient.

This was a hospital based, prospective and retrospective, descriptive study. Out of 542 knees operated for primary TKA between January 2023 and April 2024, 19 knees developed knee stiffness and required manipulation under anaesthesia. Knee stiffness was defined as flexion deformity of more than or equal to 10 degrees or flexion range less than 90 degrees at 6 weeks post-operatively.

These patients were identified from hospital records and contacted for further follow-up. 1 patient refused participation, hence 18 knees of patients age ranging from 44 to 72 years were included in the study.

Revision TKA, patients with patellar tendon rupture and secondary TKA following HTO were excluded from this study. All of these patients were started on physiotherapy from post-operative day1 post TKA following standard hospital protocol (Table 1). On discharge, they were assigned departmental physiotherapists from the hospital for 6 weeks. Patients were routinely followed up at 6 weeks and 3months and assessed for fixed flexion deformity and range of motion using goniometer. The decision for manipulation under anesthesia (MUA) was taken when flexion was less than 90 degree or FFD of more than 10 degree and patient was dissatisfied with activities of daily living.

Manipulation was done in operation theatre under spinal anaesthesia. Gentle firm pressure was applied for 5 to 10 minutes (Figure 1). Patients were started on continuous passive motion after procedure and discharged after 1 day. Continuous passive motion was continued at home for 1 hour daily for at least 2 weeks. Physiotherapy was continued at home for 6 weeks by physiotherapists assigned from the hospital.

Computerized hospital records were used to obtain information regarding important clinical events in the hospital, type of implant, duration between primary surgery and MUA, fixed flexion deformity and arc of motion before and after MUA. Patients were also followed up in a special clinic where final fixed flexion deformity and range of motion was recorded using goniometer. Patient satisfaction was also recorded in an ordinal scale.

Statistical analysis was done using IBM SPSS Statistics 27.0.1. Continuous variables were expressed as mean and standard deviation and categorical variables summarized as count and percentage. Pearson's Chi Square Test for independence of attributes was used for comparison of categorical variables. Confidence interval of 95% was chosen with $p<0.05$ taken to be statistically significant.

A total of 19 knees out of the 542 primary total knee replacements done during the study period, that is 3.5% of the patients developed knee stiffness. 1 patient refused participation, rest 18 knees were included in the analysis.

Mean age of the patients was 62.17 years (SD±8.45) (Figure 2) with 15 female (83.33%) and 3 male (16.67%), p=0.008 (Figure 3). Left knee was involved in 10 patients (55.56%) and right knee in 8 patients (44.44%). Out of these patients, 9 patients had osteoarthritis (50%) and 9 patients had inflammatory arthritis (50%). 13 patients (72.22%) with knee stiffness had conventional TKA while 5 patients (27.78%) had robotic assisted TKA, p=0.096 (Figure 4).

Figure 1: Technique of manipulation under anesthesia.

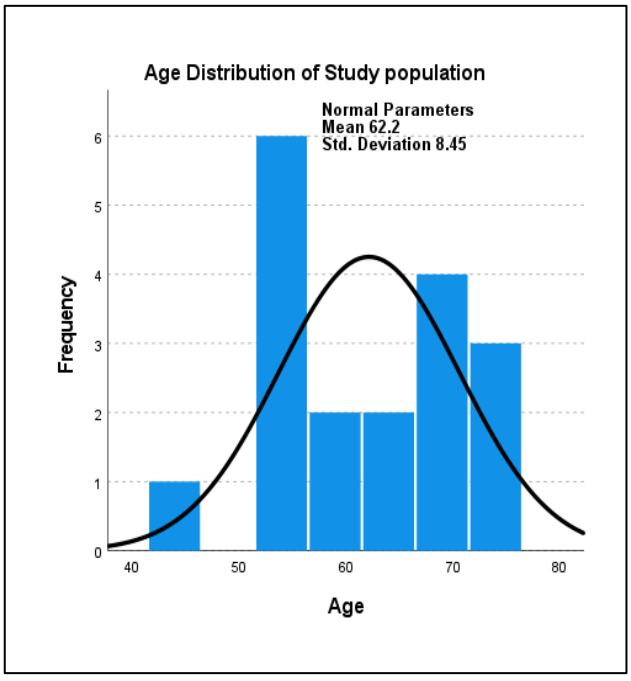

Figure 2: Histogram of age distribution of study population.

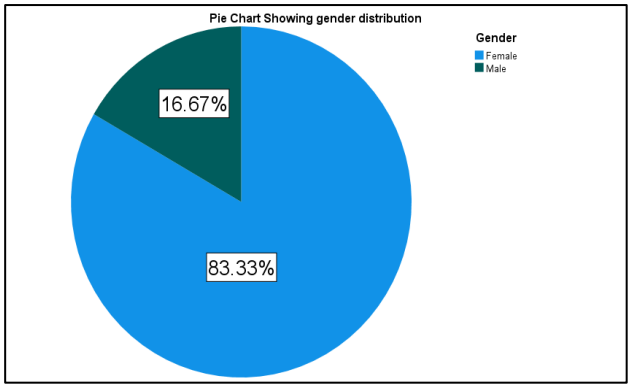

Figure 3: Gender distribution of study population.

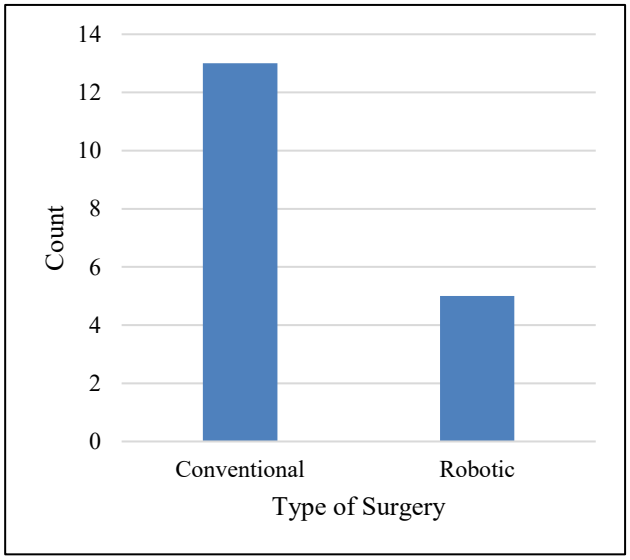

Figure 4: The type of surgery associated with stiff knee- whether conventional or robotic assisted.

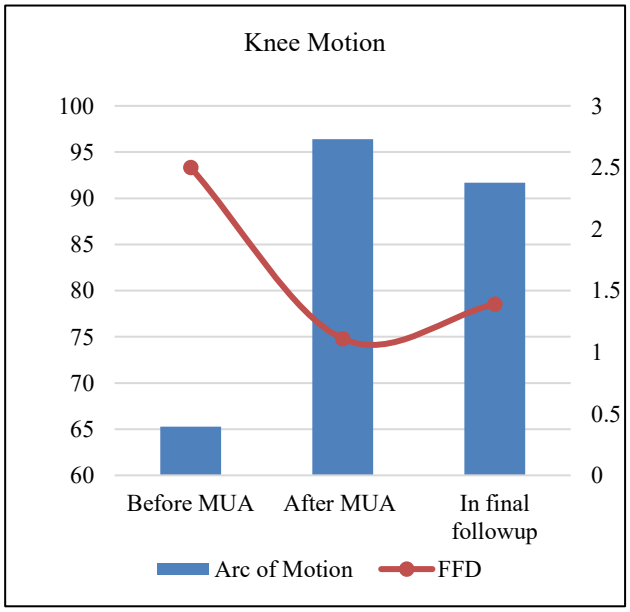

Figure 5: FFD and arc of motion in stiff knee before and after manipulation.

Figure 6: Pressure ulcer in heel due to improper padding in CPM machine.

Among these patients, 5 patients (27.78%) had prolonged ICU stay and 2 patients (11.11%) had readmission due to medical comorbidities within the first month post TKR, which might have contributed to development of stiffness. No contributing factors were identified in remaining 11 patients (61.11%).

Pre-manipulation, there was a mean fixed flexion deformity of 2.50 degree (SD±3.93) with further mean arc of motion of 65.28 degree (SD±22.91). Immediately following manipulation, the mean flexion deformity and arc of motion as measured under anaesthesia were 1.11degree (SD±2.14) and 96.39 degree (SD±14.83) respectively. Mean final FFD recorded in subsequent follow up visit was 1.39 degree (SD±2.87) and further mean arc of motion of 91.67 degrees (SD±15.05) (Figure 5).

Mean duration of follow up was 6.89 month (SD±4.19). Patient satisfaction was recorded in a 3-point ordinal scale at final follow-up. 4 patients (22.22%) were 'Very Satisfied', 8 (44.44%) patients were 'Satisfied' and 6 patients (33.33%) were 'Not Satisfied' with the outcome.

There was no complication during manipulation under anesthesia. However, 1 patient developed pressure sore in heel while using continuous passive motion machine which healed uneventfully (Figure 6).

Buechel-Pappas™ Gold (primary knee system TiN coated with ultra coat and mobile bearing platform) was used in 13 patients (72.22%) and Smith&Nephew™ Oxonium (Oxidized Zirconium) was used in 5 patients (27.78%), p=0.096. (Table 2).

Table 1: Institutional rehabilitation protocol after TKA upto 6 weeks.

Day	Rehabilitation protocol
Day 0	Static quadriceps and hamstring exercises, straight leg raising
Day 1	Straight leg raising, knee range of motion exercises 30 to 45 degree as tolerated, static and dynamic quadriceps and hamstring exercises, full weight bearing
Day 2	Knee range of motion exercises 45 to 60 degree as tolerated, ambulation with walker, continue static and dynamic quadriceps and hamstring exercises
Day3	Knee range of motion 60 to 75 degree as tolerated, ambulation with walker
Day 4	Knee bending upto 90 degree, continue ambulation and muscle strengthening exercises
Upto 2 weeks	Home based physiotherapy, transfer from bed to chair safely, knee range of motion upto 100 degrees
Upto 4 weeks	Independent ambulation, independent ascending and descending stairs
Upto 6 weeks	Independent exercise program, progress walking and increase walking endurance, increase knee range of motion

Table 2: Demographics and study parameters of the study population.

		Mean	Standard deviation	Count	Percentage
Age (in years)		62.17	8.45		
Type of arthritis	OA			9.00	50.00
	RA			9.00	50.00
Type of surgery	Conventional			13.00	72.22
	Robotic			5.00	27.78
Implant	BP Gold			13.00	72.22
	S and N Oxonium			5.00	27.78
Pre-MUA FFD (degrees)		2.50	3.93		
Pre-MUA arc-of motion (degrees)		65.28	22.91		
Post-MUA FFD (degrees)		1.11	2.14		
Post-MUA arc of motion (degrees)		96.39	14.83		
Final FFD (degrees)		1.39	2.87		
Final arc of motion (degrees)		91.67	15.05		
Contributing factor	None			11.00	61.11
	Prolonged ICU Stay			5.00	27.78
	Readmission for medical comorbidity			2.00	11.11
Patient Satisfaction	Not Satisfied			6.00	33.33
	Satisfied			8.00	44.44
	Very Satisfied			4.00	22.22
Duration of follow-up (months)		6.89	4.19		

DISCUSSION

Stiffness following knee replacement is infrequent but not rare. Incidence in reported literature varies vastly, ranging from 1.3% by Yercan et al, 3-4% by Freeman et al, 3.7% by Gandhi et al and upto 16% according to Rodríguez-Merchán et al.[2,6,11,12] This is probably the result of a lack of consensus regarding the definition of stiffness.[5-7] In our study, 3.5% of primary TKA patients developed stiffness. Although indication and timing of manipulation under anesthesia as a management is debated, most surgeons including Maloney et al, Pariente et al and Scranton et al agree that knee motion less than 90 degree 6 weeks after surgery should be taken up for manipulation.[13-16] We considered manipulation under anesthesia 6 weeks after surgery if the patient had flexion deformity more than 10 degree or range of motion less than 90 degree.

On a cellular level, hypoxia associated oxidative stress resulting from surgical trauma is thought to accelerate fibroblast proliferation creating fibrous bands which later undergo metaplastic transformation to fibrocartilage.[2,17,18] Manipulation under anesthesia breaks these fibrous bands and frees the adhesions, particularly in suprapatellar pouch.[10.13] Arthrofibrosis has been shown to be more prevalent in high BMI, younger age and female patients.[19,20] 83.33% patients were female in this study (Figure 3) and mean age was 62.17 years (SD±8.45) with a peak between 50-60 years of age (Figure 2) which in agreement with studies done by Fisher et al, Serkan Erkan et al and others.[19,20] While some studies note that rheumatoid arthritis is associated with more chance of perioperative infection, prolonged hospital stay and increased pain score in short term followup others found that type of arthritis did not seem to affect knee stiffness.

This study had 50% patients with RA and 50% with OA.[21,22]

Intraoperative factors including accurate component sizing, inadequate tibial/femoral resection, tibial slope and component malalignment has been frequently associated with stiffness.[10,11,13] Incorrect balancing of Tight PCL in PCL retaining prosthesis and type of polyethene insert also contributes to stiffness, although Fisher et al concluded that type of tibial bearing (fixed or mobile) had no effect on pain or stiffness.[13,19] Robotic TKA allows superior component sizing and alignment accuracy, precise cuts and balancing and can reduce post TKA stiffness by correcting these modifiable causes.[23] In this study, 72.22% of patients with knee stiffness had conventional surgery while 27.78% patients had robotic assisted surgery (Figure 4). Implant used was Buechel-Pappas™ Gold in 13 patients and Smith&Nephew™ Oxinium in 5 patients but the difference was not statistically significant (p=0.096).

The most important post operative factor to prevent stiffness post operatively is early physiotherapy.[4,8,11] In this study, 5 patients had prolonged ICU stay and 2 patients had readmission due to medical comorbidities, and delayed physiotherapy in these patients (total 38.89%) contributed to knee stiffness.

Improvement following manipulation under anesthesia was reported to be 33 degree by Esler et al, 37 degree by Fox et al, 42 degrees by Pariente et al and 47 degree by Maloney et al.[14,15,24,25] In our patients, mean arc of motion improved from pre manipulation 65.28 degree to 96.39 degree immediately after manipulation (mean 31.11 degree improvement) and 91.67 degrees at final follow-up (mean 26.39 degree improvement) (Figure 5). No patient required a second MUA or arthrolysis.

Complications with MUA is rare in experienced hands. Reported complications in literature include hemarthrosis, wound dehiscence, pulmonary embolism and supracondylar fracture.[15,25,26] There was no complication during manipulation under anesthesia in this study, however one patient developed a rare complication of pressure sore in heel while on continuous passive motion post manipulation which healed with dressing and postural care (Figure 6). Patient satisfaction is dependent on multiple factors including age, activity level and pre operative range of motion. Various studies note about 60% patients to be satisfied or very satisfied with the procedure.[27] In our study, 66.66% were satisfied or very satisfied with the procedure while rest were not satisfied.

The limitation of this study includes the accuracy of the retrospective data, the quality of which is dependent on how well it was originally recorded. Contributing factors needs to be further studied against control groups. Another shortcoming was the relatively short follow-up period which cannot account for long term recurrence and patient satisfaction.

CONCLUSION

Female gender is strongly correlated with stiff knee. Early physiotherapy is imperative to limit the occurrence of stiffness. Medical comorbidities delaying post operative physiotherapy is frequently associated with stiffness. Robotic assisted surgery by allowing precise sizing, balancing and implant placement can reduce the occurrence of knee stiffness.

Findings of this study reaffirms favourable results of Manipulation under anesthesia as a management in patients who develop stiffness following knee arthroplasty. It is noninvasive and improves flexion deformity and arc of motion significantly. Complications with manipulation of knee are rare. We recommend manipulation under anesthesia as a first line treatment for patients with knee stiffness 6 weeks following TKA.

Further studies to identify the intrinsic, extrinsic, implant related and intraoperative causes of stiffness can help predict the results of TKR and limit the occurrence of stiffness.

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Ethical approval: Not required

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