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# Prognostic factors that predict failure of manipulation under anesthesia for the stiff total knee arthroplasty: A systematic review

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ABSTRACT

*Purpose:* Prognostic factors associated with Manipulation under anesthesia (MUA) failure remain unknown.
*Methods:* A systematic review of the literature was performed to identify studies that reported prognostic factors associated with MUA for postoperative stiffness.
*Results:* 7 studies analyzing prognostic factors associated with MUA outcomes were included. Several studies note pre-MUA ROM to be a significant prognostic factor affecting post-MUA ROM at final follow-up. Knees with < 70° of flexion pre-MUA had less final flexion arc than those with > 70°.
*Conclusions:* The strongest prognostic factor for decreased ROM after MUA is severe pre-MUA stiffness.

## 1. Introduction

Stiffness following total knee arthroplasty (TKA) remains a common challenge for healthcare professionals and patients.[1,2] Stiffness is characterized by limited range of motion (ROM), frequently associated with pain and knee dysfunction. Multiple definitions of post-operative stiffness have been presented. A recent International Consensus publication categorized knee stiffness as mild, moderate or severe according to the range of flexion (90°–100°, 70°–89°, < 70°) or extension deficit (5°–10°, 11°–20°, > 20°).[3]

Multiple patient-specific factors are thought to contribute to the risk for post-operative stiffness. These include poor preoperative range of motion, body habitus, preoperative diagnosis (i.e. post-traumatic), socio-economic status, ethnicity, poor pain tolerance, and lack of compliance with rehabilitation protocols.[4–10] In addition, technical errors related to the thickness of bony resections, flexion-extension gap mismatch, component sizing errors and component malrotation can all lead to stiffness after TKA. In a small subset of patients, arthrofibrosis may occur post-operatively. According to the International Consensus in 2016, post-operative arthrofibrosis is defined as a limited ROM in flexion and/or extension that is not attributable to an osseous or prosthetic block to movement, but due to soft-tissue fibrosis that was not present pre-operatively.[3]

The initial conservative treatment for knee stiffness after TKA include intensive physiotherapy and continuous passive motion devices, although the efficacy of the latter has recently been challenged.[11] If knee ROM does not improve with these treatments, a manipulation under anesthesia (MUA) is commonly performed to address suspected early post-operative arthrofibrosis. Several studies have evaluated the risk factors associated with an increased risk of requiring MUA post TKA; however, there is limited available evidence on the patient specific variables associate with inferior ROM gains after MUA. We therefore performed a systematic review of the literature to specifically evaluate the variables that negatively impact ROM outcomes after MUA. The purpose of the study was to determine whether there are prognostic factors that affect patient outcomes after MUA. We performed a systematic review of the literature and examined the following variables: Pre-MUA ROM, Pre-TKA ROM, prior history of knee surgery, BMI, age, DM status, gender, and smoking.

## 2. Methods

### 2.1. Search criteria

The US National Library of Medicine (PubMed/MEDLINE), SCOPUS, and the Cochrane Database of Systematic Reviews were queried for publications from January 1980 to December 2016 utilizing keywords pertinent to manipulation under anesthesia, stiffness, and total knee

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arthroplasty.

### 2.2. Search terms

1. ("Total Knee Arthroplasty" [All Fields])
2. AND Stiffness
3. AND Manipulation under Anesthesia

Only abstracts that evaluated the clinical outcomes of primary MUA were reviewed.

### 2.3. Inclusion and exclusion criteria

The inclusion criteria were: 1) Studies describing human subjects of any age and gender. 2) Studies that include a population of at least ten patients who underwent MUA for post-TKA stiffness. 3) Studies that follow patients for a minimum of 10 days after total knee arthroplasty. 4) Studies that analyze at least one prognostic factor in relation to pre- and post- MUA outcome. The exclusion criteria were: 1) Review articles. 2) Case studies. 3) Studies examining concomitant treatments of stiffness. 4) Studies stratifying patients based on perioperative management (anesthesia protocol, limitation of blood loss, surgical technique, prosthesis type, etc.) in which allocation of patients who previously underwent manipulation under anesthesia is not specified. 5) Studies in which no subjects underwent manipulation under anesthesia. 6) Non-English language publications. For articles that met these criteria, the reference lists were screened for additional studies not captured using the initial search terms.

### 2.4. Data collection

Two authors independently conducted the described search. Both authors compiled a list of papers not excluded after application of the inclusion and exclusion criteria. Discrepancies between the list compiled by two authors were resolved by discussion. During initial review of the data, the following information was collected for each study: title, author, study design, number of patients, number of knees, BMI, gender, ROM changes after MUA, pre-TKA flexion, pre-MUA flexion, prior knee surgeries, smoking status, diabetes, and complications.

## 3. Results

### 3.1. Study selection

The search resulted in 727 abstracts that were examined to determine the efficacy of MUA for post-TKA stiffness (Fig. 1). Following elimination of duplicate articles, predetermined inclusion and exclusion criteria were applied. In total, 9 articles met the inclusion criteria. Two articles were excluded as they only reviewed revision TKA. Overall, 7 articles were included in this analysis (Table 1). Each study included analyzed at least one prognostic factor for ROM response post-MUA. Indications for MUA in each study are described in Table 2. Additional anesthesia protocols are described in Table 3. Consensus on which articles would be analyzed in the present study was achieved by discussion between the reviewers based on the predetermined inclusion and exclusion criteria described above.

### 3.2. Prognostic factors evaluated

#### 3.2.1. Pre-TKA stiffness and MUA outcome

Four studies[14–17] analyzed whether ROM before primary TKA predicts response to MUA. Among patients who required MUA after TKA, Keating et al. found that those with pre-TKA flexion less than 90° had significantly less absolute flexion gain following MUA ($p = 0.001$) at five-year follow-up than those with greater pre-TKA flexion requiring MUA.[15] Rubenstein et al. found that, for knees requiring MUA after TKA, those with less than 115° of flexion before TKA had less total flexion ($p = 0.004$) at long-term follow-up than those with greater than 115° of flexion before TKA.[14] In contrast, Yeoh et al. used a cutoff of 90° to delineate MUA study groups and found that pre-TKA ROM did not significantly affect absolute flexion at one-year follow-up after MUA ($p = 0.06$).[17] Similarly, Choi et al. found that pre-TKA ROM was not associated with achieving a satisfactory outcome (> 90° ROM) after MUA ($p = 0.42$).[16] Based on the available evidence, it is unclear if pre-TKA absolute flexion has any impact on MUA outcome.

#### 3.2.2. Pre-MUA stiffness and MUA outcome

Two studies[12,13] analyzed the prognostic value of ROM prior to MUA. Ipach et al. found that knees with a pre-MUA flexion of less than 70° had significantly less absolute flexion ($p = 0.04$) at six-week follow-up than those with pre-MUA flexion of greater than 70°.[13] Cates et al. found no difference in absolute flexion ($p = 0.35$) at one-year follow-up between knees with a pre-MUA flexion of less than 90° compared to those with greater than 90°.[12] Ipach et al. reported a significantly greater gain in total flexion if pre-MUA flexion was less than 70° compared to those with pre-MUA flexion of greater than 70°.[13] Similarly, Cates et al. reported that pre-MUA flexion of less than 90° had a significantly greater gain in total flexion compared to those with flexion of greater than 90°.[12] Combining the result of these two studies suggests that patients with severe post-operative stiffness (ROM < 70°) achieve significant gains in ROM gains but fail to achieve similar absolute flexion as patients with mild or moderate stiffness (ROM 70–90°) undergoing MUA.

#### 3.2.3. BMI and risk of MUA failure

Association between BMI and development of post-operative stiffness was evaluated in three studies.[12,13,16] Ipach et al. found no difference in final ROM when stratifying post-MUA patients into 18.5–25, 25–30, and 30 + BMI groups ($p = 0.33$).[13] Choi et al. found that BMI did not affect the likelihood of achieving final ROM of greater than or less than 90° ($p = 0.58$).[16] Cates et al. found no difference in flexion or extension gains when comparing a post-MUA group with a BMI less than 30 to a group with a BMI greater than 30.[12] In general, BMI is not shown to be a risk factor for worse outcomes after MUA.

#### 3.2.4. Age

Association between age and stiffness post-TKA was evaluated in three studies.[12,15,16] Choi et al. found that age, using a cutoff of 65 years to stratify groups, was not significantly different between patients achieving post-MUA ROM greater than 90 and patients failing to achieve post-MUA ROM greater than 90 [$p = 0.87$; 16]. Cates et al. found no difference in MUA outcome for those less than or greater than 60 years old.[12] However, Keating et al. observed that patients requiring MUA (average age of 65) were significantly younger than patients not requiring MUA (average age of 71; $p < 0.0001$).[15] Overall, age is not associated with success or failure after MUA.

#### 3.2.5. Gender

Gender was analyzed in two studies.[12,16] Choi et al. found no difference in gender prevalence when analyzing a cohort with greater than 90° of ROM at final follow-up compared to a cohort with less than 90° of ROM at final follow-up [$p = 0.8$; 16]. Cates et al. found no significant difference between men and women in flexion ($p = 0.2$) or extension gain ($p = 0.4$) at one year following MUA.[12] Based on this evidence is does not appear that gender is a risk factor for poor outcomes after MUA.

#### 3.2.6. Diabetes mellitus

Current literature regarding the effect of diabetes mellitus on MUA outcome is inconclusive.[16,18] While Bawa et al. reported that subjects with diabetes achieve less ROM after MUA than non-diabetics,[18] this may not be functionally significant as another study found no