

# Gravity-Assisted Manipulation (GAM) Technique for the Treatment of Knee Arthrofibrosis



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**Abstract:** Arthrofibrosis is a known complication after knee surgery, resulting in stiffness and decreased range of motion for patients. Manipulation under anesthesia is a commonly used technique to address postoperative arthrofibrosis after knee surgery. Often, direct pressure is applied to the knee during the manipulation. This can be difficult and can place undue stress above and below the joint. This Technical Note presents the technique for manipulation under anesthesia using gravity and the native knee motion alone to improve knee range of motion.

Arthrofibrosis has been recognized as a common and disabling complication after common knee surgeries including anterior cruciate ligament reconstruction and total knee arthroplasty. Rates have been reported between 4% and 38% for arthrofibrosis post-anterior cruciate ligament surgery and 1.3% to 12% after total knee arthroplasty.<sup>1,2</sup> Multiple definitions for arthrofibrosis have been proposed. Clinically, it is

understood as postoperative stiffness secondary to excessive collagen production and scar tissue adhesions manifesting as limited range of motion (ROM) in the operative knee.<sup>3,4</sup> Strategies used to address postoperative knee arthrofibrosis range from less invasive such as physical therapy and manipulation under anesthesia (MUA) to operative interventions including open/arthroscopic lysis of adhesions and revision knee surgery, or a combination of techniques.

MUA has been proposed as an option for patients who have yet to achieve 90° of knee flexion after initial knee surgery. Although there is no consensus as to when MUA should be performed, many recommendations suggest within the first 6 to 12 weeks.<sup>5,6</sup> Once adequate muscle relaxation is achieved under anesthetic sedation, a gentle force on the proximal tibia is applied during passive ranging of the knee to achieve maximum flexion and extension. This process is repeated multiple times with patellar mobilization to further lyse adhesive bands in the suprapatellar pouch. Although generally a safe procedure to perform, reported complications after MUA include supracondylar femur fractures, hemarthrosis, patellar tendon avulsion, wound dehiscence, heterotopic bone formation, pulmonary embolism, and recurrent loss of motion.<sup>2,7</sup>

The purpose of the following Technical Note is to detail the corresponding author's preferred technique for addressing postoperative stiffness/arthrofibrosis after knee surgery by primarily leveraging the force of gravity and the patient's natural knee motion to improve overall total knee ROM. We term this technique gravity-assisted manipulation (GAM) under anesthesia.

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## Surgical Technique (With Video Illustration)

### Patient Setup

Patients undergoing GAM are consented preoperatively. The patient is brought to the operating room and positioned supine on a standard table (Skytron, Grand Rapids, MI), where general anesthesia is induced.

### Initial Intraoperative Assessment

Once adequate sedation and pain control have been confirmed, the patient's initial ROM is assessed. The indicated knee is passively assessed for maximum premanipulation flexion (Fig 1) and extension (Fig 2). Measurements are recorded for postmanipulation comparison.

### Gravity-Assisted MUA (GAM Method)

The ipsilateral hip is brought to an approximate 90° of flexion. The primary surgeon will interlock or closely approximate their hands to support the thigh in such a way the knee is free to range under gravity (Fig 3). To perform the technique, the surgeon should begin alternating between flexion and extension at the hip joint in a rocking fashion (Video 1). This will allow the lower extremity distal to the knee to freely flex and extend under gravity. As the oscillating motion at the hip is increased, the motion from the knee towards the ankle likewise increases. The MUA should be performed for 25 to 30 cycles or approximately 15 to 20 seconds. The force required to lyse adhesions and improve motion in the leg primarily stems from the gravitational body weight of the leg itself. Modifications to the technique include the addition of manual pressure to the proximal tibia during flexion to achieve even more degrees of total knee flexion. The distal tibia and ankle should be left free without any applied force



**Fig 1.** Clinical image of a right knee demonstrating premanipulation limited knee flexion before gravity-assisted manipulation of the knee in the setting of knee arthrofibrosis.



**Fig 2.** Clinical image of a right knee demonstrating premanipulation knee extension before gravity-assisted manipulation of the knee in the setting of knee arthrofibrosis.

other than the influence of gravity to reduce the potential risk of fracture or injury. There should be caution to not place excess posterior pressure and internal rotation in patients with an ipsilateral total hip arthroplasty to avoid dislocation.

### Final Intraoperative Assessment

Once GAM is performed, the surgeon will reassess motion of the knee joint in flexion (Fig 4) and extension (Fig 5). Final ROM measurements are compared with premanipulation observations. Under the discretion of the surgeon and concordance of the anesthesia team, the GAM procedure may be performed a second time in an attempt to gain further motion.



**Fig 3.** Clinical image of a right knee demonstrating surgeon hand placement above the knee stabilizing the thigh (blue arrow) before gravity-assisted manipulation of the knee in the setting of knee arthrofibrosis. Red arrow indicates oscillation of knee.



**Fig 4.** Clinical image of a right knee demonstrating knee flexion post–gravity-assisted manipulation of the knee in the setting of knee arthrofibrosis.

### Postoperative Protocol/Rehabilitation

Postmanipulation anteroposterior and lateral radiographs are performed for all patients undergoing GAM to confirm the absence of acute complications from the procedure. Patients are allowed to weight bear as tolerated and are discharged home once able to ambulate with nursing staff. Outpatient physical therapy and clinic follow-up is arranged.

### Discussion

Arthrofibrosis can be a devastating complication in patients who undergo knee surgery, with the goal of regaining mobility and function. Risk factors have been described, including diabetes, rheumatoid arthritis, smoking, and obesity.<sup>8</sup> Younger age and preoperative stiffness are also well documented risk factors in the



**Fig 5.** Clinical image of a right knee demonstrating knee extension post–gravity-assisted manipulation of the knee in the setting of knee arthrofibrosis.

literature, as well as a greater propensity in Black versus White individuals.<sup>9</sup>

Although arthrofibrosis can compromise the outcome of knee surgery, there are data to suggest good outcomes can be achieved either early (less than 3 months from index surgery) or late (greater than 3 months). In a study that retrospectively examined outcomes between patients treated with MUA or arthroscopic lysis of adhesions (ALA), the group who underwent manipulation had greater gains in flexion; however, they had poorer postoperative motion after the index surgery than the ALA group. Both groups achieved an average of 117° of flexion, but the MUA group started at 72.7° of flexion versus 89.3°. The motion gain achieved in the MUA group was the same whether performed early (less than 3 months) or late (greater than 3 months).<sup>8</sup> This is in keeping with literature from Namba and Inacio,<sup>10</sup> who showed not only that flexion gains were equivalent in their early and late MUA group but also that pain scores improved in both groups. However, satisfaction scores were unchanged and extension only improved in the early group from 7.15° to 2.5°.

In terms of complications, Thomas et al.<sup>8</sup> showed a markedly greater risk of complications with ALA than with MUA (18% vs 9.8%); however, other studies have shown that MUA after primary total knee arthroplasty is also associated with greater complications and revision rates than patients in whom it is not required.<sup>9,11</sup> At 2 years from index surgery, Werner et al.<sup>11</sup> found a 2.4 times risk of needing revision surgery, whereas Parkulo et al.<sup>9</sup> found a 6.39% revision rate at the same time point. However, other literature looking at a matched cohort of patients who required MUA versus those who did not reported no difference in complication rates at a mean follow-up of 36.4 months, and, furthermore, demonstrated no significant difference in clinical outcome scores (Western Ontario and McMaster Universities Arthritis Index, Short-Form Health Survey, and Knee Society Clinical Rating System) at 3 months, 1 year, and 2 years.<sup>12</sup>

A study by Baum, et al.<sup>7</sup> described a technique for MUA similar to GAM. The technique was used in 78 patients at an average time to manipulation of 60 days' postoperatively. Flexion improved from an average of 80 to 115°, and improvements were maintained at 1-year postoperative. They found a 6.4% complication rate, all related to continued stiffness, with no reported fractures or extensor mechanism disruptions.<sup>7</sup> Other studies have shown similar outcomes after MUA, with 9.9% of knees requiring revision surgery with continued stiffness as the most common reason.<sup>13</sup>

The GAM technique is especially useful in cases with patients with larger body mass indexes or when the surgeon may not have the strength to manipulate the knee using conventional techniques of manual

**Table 1.** Pearls and Pitfalls of Gravity-Assisted Manipulation of the Knee

Pearls	Pitfalls
Use the force of gravity and weight of leg itself to manipulate the knee, rather than surgeon's own body weight	Avoid excess posterior pressure and internal rotation in patients with ipsilateral total hip arthroplasty to prevent dislocation
Slowly move the leg back and forth to use gravity assist the manipulation; repeat as necessary to gain additional motion	Discuss expectations of manipulation preoperatively with patient, as not all manipulations result in improved overall outcomes
Take photos of preoperative and postoperative motion to share with patients and demonstrate their progress	Outcomes dependent on time to manipulation, with best results within first 12 weeks
Ensure appropriate pain medication postoperatively to allow for aggressive physical therapy to maintain motion	
Can consider corticosteroid injection at time of manipulation to decrease inflammation	

**Table 2.** Advantages and Disadvantages of Gravity-Assisted Manipulation of the Knee

Advantages	Disadvantages
Lower risk of fracture, tendon avulsion(s) than standard forced knee flexion techniques	More difficult to manipulate extension
Good alternative for patients with larger BMI or poor bone quality	Patient motivation to maintain motion postoperatively required
Only requires one surgeon/person to hold the leg	Patients with obesity/larger legs may be more difficult to hold up in the flexed position
Less invasive than arthroscopic lysis of adhesions	

BMI, body mass index.

pressure. It can be fatiguing using conventional MUA techniques when the arthrofibrosis is extensive and the patient is robust. This technique is particularly helpful for cases with flexion contractures. In those with extension contractures, it may be helpful to perform GAM first, then address residual ROM limitation in extension. Further pearls and pitfalls as well as advantages and disadvantages of this technique are detailed in [Tables 1 and 2](#).

To treat stiffness after knee surgery, the authors demonstrate GAM to be a useful and effective treatment method. Although the literature supports effective MUA after 3 months, the deconditioning and disuse osteopenia that can arise with a poorly functional knee may increase complication rates, which include femur fractures and patellar tendon ruptures, both of which are devastating consequences.<sup>14</sup> The GAM technique is a safe, reliable, and effective method to improve knee ROM in the setting of arthrofibrosis.

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