Analysis of Patient Outcomes When Applying the Mulligan Concept to Treat Recreational Dancers with Patellofemoral Pain Syndrome

Ryan Krzyzanowicz¹*, Frank Gargano², James May³, and Alan Nasypany³

¹Department of Exercise and Nutrition Sciences, University at Buffalo, USA
²Integrative Dry Needling Institute, USA
³Department of Movement Sciences, University of Idaho, USA

*Corresponding authors: Ryan Krzyzanowicz, Department of Exercise and Nutrition Sciences, University at Buffalo, 207 Kimball Tower, Buffalo, NY 14214, USA, Tel: +716.829.5439; Fax: +716.829.2428; E-mail: ryankrzy@buffalo.edu

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Abstract

Objective: The purpose of this a priori case series was to evaluate the treatment effects of the Mulligan Concept (MC) Mobilizations with Movement (MWM) as carried out by a novice practitioner of the MC, on dancers who were classified with PFPS.

Design: an a priori case series.

Setting: University Dance Medicine clinic.

Patients: Participants were recreational dancers. They were screened using the following inclusion criteria: ≥ 18 years of age, a member of the university dance company, and diagnosed with global patellar pressure syndrome or excessive lateral pressure syndrome by a certified athletic trainer. Exclusion criteria included acute fractures, joint instability, history of surgery (e.g., reconstruction of the anterior cruciate ligament), rheumatoid arthritis, corticosteroid injection within the last 30 days and the presence of open wounds. A total of 5 patients were included in this study.

Interventions: The Mulligan Concept in treating patellofemoral pain.

Outcome measures: pain on the numeric pain rating scale; function on both the Disability of Physical Active scale and Patient Specific Functional Scale; range of motion using a standard goniometer.

Results: At various points throughout the study, improvements in patient-oriented measures such as patient pain on the Numeric Pain Rating Scale (NPRS) and patient function on the Disability of the Physically Active (DPA) scale and Patient Specific Functional Scale (PSFS), were seen at levels consistent with minimal clinically important differences (MCIDs). Active range of motion, a disease-oriented measure, increased by an average of 5.8° in the five patients seen in this study.

Conclusion: The Mulligan Concept may improve patient-outcome measures when used by a novice clinician on a specific population.

Keywords: mulligan, patient outcome, patellofemoral
Introduction

Patellofemoral pain syndrome (PFPS) is often considered a “catchall” diagnosis for patients with patellofemoral knee pain. Individuals exhibiting patellofemoral dysfunction, iliotibial band (IT) pain and patellar pain are often classified as having PFPS. Clinical, the exact cause of PFPS may be difficult to isolate due to potential involvement from multiple joints and structures, combined with similar symptom presentation. Additionally, individuals often report pain (e.g., pain with prolonged sitting, pain going up and down stairs, pain with squatting) and abnormal sensations (e.g., grinding or locking) that mimic many knee pathologies [1]. Dancers commonly report these signs and symptoms, often due to the stresses inherent in the turnout position [2].

Turnout is often studied in performing arts medicine because this position is important to the aesthetics of dance and often alters the biomechanics of the lower extremity. Lack of turnout can cause a compensatory pattern, including stress on involved joints (e.g., tibiofemoral joint) [2]. Dysfunctional turnout can disrupt normal tibiofemoral joint dynamics by increasing the stresses placed on the medial collateral ligament and increasing stresses placed on medial structures [3]. Therefore, a patient with tight lateral structures (e.g., lateral retinaculum or IT band) may place an excessive load on the lateral patella, causing pain [3].

Patients presenting with excessive internal femoral rotation or excessive external tibiofemoral rotation may be predisposed to PFPS [4]. Patients diagnosed with PFPS display greater internal femoral rotation angles in weight-bearing than in non-weight bearing positions, supporting the theory that dysfunctional joint alignment, such as increased femoral rotation, could result in patellofemoral pain or even subluxation [4]. Evidence to support the link between increased femoral rotation and patellofemoral pain has been illustrated in the literature [5-7]. During internal femoral rotation, the lateral articular surface of the trochlea impinges upon the lateral articular facets of the patella, pushing the patella medially [8].

According to Lee et al., external tibial rotation has been associated with a variety of patellofemoral dysfunctions, including compression syndromes. An increase in external tibial rotation has been shown to increase patellofemoral joint contact pressures at all knee flexion angles [9]. In non-weight bearing an increase of tibiofibular rotation coupled with excessive internal femoral rotation might not be evident [8].

To assist with proper classification of PFPS, Wilk et al. created a system that allows the clinician to apply treatment strategies and interventions for non-surgical management of PFPS according to the patient’s specific classification [3]. The patient is classified into one of eight major divisions following a thorough examination. Utilization of the classification system allows the clinician to more specifically treat the underlying cause of the pain or dysfunction.

A variety of treatments for PFPS are available. The two main goals of treatment are to unload abnormally stressed soft tissue around the patellofemoral joint by optimizing the patellar position and to improve lower limb mechanics [10]. However, no consensus on the preferred treatment of PFPS has been established [11]. A treatment option for patients diagnosed with PFPS is the Mulligan Concept (MC) Mobilizations with Movement (MWM). Mobilizations with movement are a manual therapy intervention developed by Brian Mulligan that couples accessory mobilizations with physiological motion to treat positional faults of joints [12]. Mulligan proposed that positional faults may result in subtle joint mal-alignment, which produces altered joint function, pain or decreased range of motion [12]. To date, the physiological process by which positional faults cause musculoskeletal pain or dysfunction has not been clearly identified [13].

The MC has been successfully utilized to reduce pain in patients diagnosed with osteoarthritis at the knee. Takasaki et al. [14] identified the MWM that effected the greatest decrease in pain for each osteoarthritic patient. The
most commonly used MWMs were tibial internal rotation and a lateral glide [14]. Overpressure, which Mulligan states is necessary at end-range of motion, was given once the patient was in full active range of motion [14].

The purpose of this a priori case series was to evaluate the treatment effects of the MC MWMs, as carried out by a novice practitioner of the MC, on dancers who were classified with PFPS. Patients with PFPS were classified according to the system described by Wilk et al. [3]. All patients were diagnosed with global patellar pressure syndrome or excessive lateral pressure syndrome and treated using a tibiofibular rotation MWM and a lateral glide for flexion MWM. Patient outcomes were assessed by measuring range of motion (specifically flexion) and assessing several patient-oriented measures, namely the Numerical Pain Rating Scale (NPRS), Disablement in the Physically Active (DPA) scale and the Patient-Specific Functional Scale (PSFS).

Materials and Methods

Participants

The study was conducted in the Dance Medicine Clinic of a small university. Individuals in this study were recreational dancers who reported to the clinical for evaluation and treatment of knee pain. Individuals were identified and screened using the following inclusion criteria: ≥ 18 years of age, a member of the university dance company, and diagnosed with global patellar pressure syndrome or excessive lateral pressure syndrome by a certified athletic trainer. Exclusion criteria included acute fractures, joint instability, history of surgery (e.g., reconstruction of the anterior cruciate ligament), rheumatoid arthritis, corticosteroid injection within the last 30 days and the presence of open wounds. The principle investigator (R.K.) qualified five of the six consecutive patients who met initial criteria to participate in the study (N=5 females, age 20.4 ± 1.52 years). As this was a clinical research study, no blinding was performed. Informed consent was obtained at initial physical examination and participants were instructed to continue normal recreational activities (e.g., dancing) without restrictions during the study period. Patients were discharged from care when their NPRS, DPA scale or PSFS score normalized and they had an increase in active range of motion. All study procedures were approved by the Institutional Review Board.

Evaluation

After consent was obtained, the principle investigator conducted a thorough evaluation. The evaluation consisted of palpation, manual muscle testing, ROM testing and special testing. Baseline measures on the NPRS, DPA scale and PSFS were also taken.

The NPRS, a patient-oriented measure that describes pain, is an eleven-point scale that has a ceiling of 10 (worse pain) and a floor of 0 (no pain). A minimally clinically important difference (MCID) is a decrease of 33% or 2 points [15]. Patient reported pain was recorded at initial examination, prior to each treatment session, following the completion of each treatment and at discharge.

The DPA scale, a patient-oriented evidence measure, has sixteen Likert-scale questions with a ceiling of 64 (worst) and a floor of 0 (best). An MCID is a nine-point change for acute injuries and a six-point change for persistent injuries [16]. Healthy patients have a normative range from 0 to 34 [16]. The DPA scale was given to the patient during initial examination, at the end of each week of treatment regardless number of treatments in that week and at discharge.

The PSFS is a patient-oriented evidence measure that describes a set of functional activities selected by the clinician and patient. The PSFS is an 11-point scale that has a ceiling of 10 (able to perform the activities at the same level as prior to injury or problem) and a floor of 0 (unable to perform the activities). An MCID is a change of 2 points [17]. The composite is scored by the sum of activity scores divided by the number of activities. Patient-rated outcomes using the PSFS were assessed during the initial examination, following the completion of each treatment and at discharge.
Range of Motion (ROM) is a commonly used disease-oriented evidence measure that describes a joint’s function. Active flexion was the sole joint movement assessed in this study. Active ROM was measured as described in Measurement of Joint Motion: A Guide to Goniometry [18]. Goniometric measurements were recorded using a standard goniometer, marked to 1° increments, during initial examination, prior to each treatment, following the completion of each treatment and at discharge. To ensure reliable data, the same clinician, using the same goniometer completed all pre- and post-treatment goniometric measurements [19]. Active ROM was recorded at initial examination, prior to each treatment session, following the completion of each treatment and at discharge.

Classification

Following clinical evaluation, a classification was made using the classification system of Wilk et al. [3]. The classification was made using information gained during the clinical evaluation including observation, palpation and special testing. Refer to Table 1 for the Classification System.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Definition</th>
<th>Clinical Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excessive lateral pressure syndrome</td>
<td>Unilateral compression of patella or an over constrained patella, usually with tilting of the patella</td>
<td>Lateral retinaculum pain, pain near distal IT band and insertion at Gerdy’s tubercle. Pain with stair climbing, squating or stooping down.</td>
</tr>
<tr>
<td>Global patellar pressure syndrome</td>
<td>Both medial and lateral retinaculum are excessively tight. Can develop secondary to direct trauma or immobilization.</td>
<td>Diffuse anterior knee pain, globally around the patella. Restricted movement of the patella and atrophy of the quadriceps.</td>
</tr>
<tr>
<td>Patellar instability</td>
<td>Excessive movement, usually laterally, that can cause subluxation or dislocation of the patella.</td>
<td>Pain and/or instability of the patella, significant lateral tracking of the patella.</td>
</tr>
<tr>
<td>Biomechanical dysfunction</td>
<td>Biomechanical imbalances at other joints such as the foot and ankle, or limb length deficiency.</td>
<td>Complaints of general tightness in the lower extremity, and toe-out and/or pronation of the foot.</td>
</tr>
<tr>
<td>Direct trauma</td>
<td>Direct blow to the patella.</td>
<td>Pain with movement, possible dislocation or fracture.</td>
</tr>
<tr>
<td>Soft tissue lesions</td>
<td>Injury to soft tissue such as plica, infrapatellar fat pad or bursa.</td>
<td>Pain as a result of inflammation and loss of range of motion.</td>
</tr>
<tr>
<td>Overuse syndromes</td>
<td>Inflammatory reaction involving the tendon sheath.</td>
<td>Pain over the tendon and pain with activity, specifically jumping.</td>
</tr>
</tbody>
</table>

Treatment Intervention

Each patient received care two to three days per week until discharge. Once classified, the internal tibiofemoral rotation MWM was performed as both a treatment strategy and as an evaluative tool. According to Mulligan, patients should experience pain-free, immediate and long-lasting relief, also known as the P.I.L.L. effect, if the MWM is indicated [12]. In patients that had a P.I.L.L. effect, three sets of ten repetitions were performed as described by Mulligan [12].

A prone lateral glide MWM was performed on all patients after the internal tibiofemoral rotation MWM was performed. The patient was prone on a table with a mobilization belt wrapped around their lower leg and the clinician’s pelvis. The mobilization belt was positioned so that the proximal edge was on the tibial joint margin, a gentle lateral glide was applied by the clinician while the patient actively flexed the knee. Overpressure was given once the patient was in full active flexion ROM. Patients were told to inform the clinician if the MWM or overpressure was not pain-free. Only one patient (Patient 1) experienced discomfort. Since that discomfort was specifically due to the pressure from the belt, padding was utilized by the clinician along the medial tibial joint margin. The patient subsequently reported no pain with the MWM and overpressure.
Results

Patient Descriptions

Table 2: Patient Examination Descriptions

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (Years) and Sex</th>
<th># of Treatments</th>
<th>Examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>19 F</td>
<td>20</td>
<td>Patient 1, a novice female dancer (i.e., no history of organized dance instruction) presented to the clinic with complaints of left lateral knee pain, near the insertion of the iliotibial band, which was exacerbated by squatting and going up stairs. Patient reported pain had been consistent over the previous three months, but the patient had not sought treatment. Patient was participating in a ballet piece when she felt the most pain during dance. The patient reported using cryotherapy and ibuprofen as self-treatments as needed during the summer, but with minimal improvement. During observation, it was noted that she had bilateral genu valgum. The patient also displayed positive signs (i.e., pain and decreased motion) during the lateral tilt, lateral patellar glide and Ober's test on her left side only. The remainder of the physical examination was unremarkable. Based upon her physical examination and positive special tests, using the Wilk et al (1998) classification system, she was classified as having excessive lateral pressure syndrome.</td>
</tr>
<tr>
<td>2</td>
<td>22 F</td>
<td>3</td>
<td>Patient 2, an experienced female dancer, presented to the clinic with complaints of left knee pain inferior to the patella over the patellar tendon, with the pain present for about two weeks prior to examination. The patient had taken ibuprofen for pain but denied any other self-treatment. The remainder of the physical examination was unremarkable. Based upon her physical examination and positive special tests, using the Wilk et al (1998) classification system, she was classified as having excessive lateral pressure syndrome.</td>
</tr>
<tr>
<td>3</td>
<td>22 F</td>
<td>6</td>
<td>Patient 3, a novice female dancer (i.e., no history of organized dance instruction) presented to the clinic with complaints of right knee pain by the distal iliotibial band bear Gerdy's tubercle and inferior to the patella, lateral to the patellar tendon. The patient complained of pain while performing a move on the floor in which she had to go from a supine position to a rotation. During evaluation it was noted that going from a supine position to a standing position caused valgus collapse. The patient also worked as a waitress and complained of knee pain while on her feet for long shifts (i.e., six hours or more) and pain while going up stairs. The patient reported no self-treatment and experienced pain for three weeks prior to presenting to the clinic. The patient also displayed positive signs (i.e., pain and decreased motion) for her right knee during the lateral tilt, lateral patellar glide and Ober's tests. The remainder of the physical examination was unremarkable. Based upon her physical examination and positive special tests, using the Wilk et al (1998) classification system, she was classified as having excessive lateral pressure syndrome.</td>
</tr>
<tr>
<td>4</td>
<td>19 F</td>
<td>4</td>
<td>Patient 4, an expert female dancer (i.e., formally trained in ballet for 16 years), presented to the clinic with complaints of left lateral knee pain while squatting and going up stairs. Patient reported a sensation of pressure directly on the patellar tendon, with the pain present for about two weeks prior to examination. The patient’s pain had increased during the increased dancing time required during show week. She also reported a history of chronic left ankle sprains. The patient also displayed positive signs (i.e., pain and decreased motion) bilaterally during the lateral tilt and lateral patellar glide tests. Uniquely, this patient had no pain with her right knee, even though special tests and observation revealed dysfunction. The remainder of the physical examination was unremarkable. Based upon her physical examination and positive special tests, using the Wilk et al (1998) classification system, she was classified as having excessive lateral pressure syndrome.</td>
</tr>
<tr>
<td>5</td>
<td>20 F</td>
<td>4</td>
<td>Patient 5, a novice female dancer (i.e., no history of organized dance instruction), presented to the clinic with complaints of left knee pain inferior to the patella at the patellar tendon for a month prior to seeking care. Patient reported pain while performing a squat during a hip-hop piece, as well as going up the stairs. The patient had taken ibuprofen for pain but denied any other self-treatment. The remainder of the physical examination was unremarkable. Based upon her physical examination and positive special tests, using the Wilk et al (1998) classification system, she was classified as having excessive lateral pressure syndrome.</td>
</tr>
</tbody>
</table>
Mulligan Mobilizations with Movement

Four of the five patients reported immediate improvements on the NPRS after initial repetitions. Patient 1 did not have a pain-free and immediate relief effect during both the internal tibiofibular MWM and the lateral glide into flexion MWM. A simple shift of hand placement for internal tibiofibular rotation and padding for the mobilization belt was all that was needed to create a pain-free and immediate relief effect. All five patients received the internal tibiofibular and lateral glide into flexion MWMs.

Global Patellar Pressure Syndrome

Only one patient (Patient 2) was classified with global patellar pressure syndrome. Following the first week of treatment, this patient exhibited an MCID of 2 points on the NPRS for pain during activity (Figure 1). Her functional activities on the PSFS are in Table 3. Patient 2 also exhibited an MCID on the DPA scale, from 21 at initial examination to 11 at discharge (Figure 2). Active ROM increased from 135° to 139° (Table 4). The patient was discharged once her NPRS score reached 0 and had an increase in function, as shown on the PSFS.

![Figure 1: NPRS scores during physical activity decreased with treatment. * Minimal clinically important differences compared to the previous time point.](image)

<table>
<thead>
<tr>
<th>Patient</th>
<th>Activity</th>
<th>Level of Function at Initial Examination</th>
<th>Level of Function at Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Going up stairs</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Squatting</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>Going up stairs</td>
<td>7</td>
<td>9*</td>
</tr>
<tr>
<td></td>
<td>Turnout</td>
<td>7</td>
<td>9*</td>
</tr>
<tr>
<td>3</td>
<td>Going up stairs</td>
<td>6</td>
<td>9*</td>
</tr>
<tr>
<td></td>
<td>Waitressing</td>
<td>5</td>
<td>8*</td>
</tr>
<tr>
<td>4</td>
<td>Going up stairs</td>
<td>7</td>
<td>9*</td>
</tr>
<tr>
<td></td>
<td>Squatting</td>
<td>6</td>
<td>9*</td>
</tr>
<tr>
<td>5</td>
<td>Going up stairs</td>
<td>7</td>
<td>10*</td>
</tr>
<tr>
<td></td>
<td>Squatting</td>
<td>7</td>
<td>9*</td>
</tr>
</tbody>
</table>

*Indicates a minimal clinically important difference.
DPA scale scores decreased with treatment. * Minimal clinically important differences compared to the previous time point.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Initial Evaluation (affected limb)</th>
<th>Discharge</th>
<th>Change</th>
<th>Initial Evaluation (unaffected limb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient 1</td>
<td>119°</td>
<td>123°</td>
<td>+4°</td>
<td>113°</td>
</tr>
<tr>
<td>Patient 2</td>
<td>135°</td>
<td>139°</td>
<td>+4°</td>
<td>139°</td>
</tr>
<tr>
<td>Patient 3</td>
<td>128°</td>
<td>135°</td>
<td>+7°</td>
<td>137°</td>
</tr>
<tr>
<td>Patient 4</td>
<td>117°</td>
<td>125°</td>
<td>+8°</td>
<td>124°</td>
</tr>
<tr>
<td>Patient 5</td>
<td>124°</td>
<td>130°</td>
<td>+6°</td>
<td>130°</td>
</tr>
</tbody>
</table>

**Excessive Lateral Pressure Syndrome**

Patients 1, 3, 4 and 5 were all classified as having excessive lateral pressure syndrome using the Wilk et al., classification system [3]. After the first week of treatment, Patients 3, 4 and 5 exhibited an MCID on the NPRS for pain (Figure 1) during activity and an MCID on the DPA scale score (Figure 2). These three patients also exhibited an MCID on the PSFS (Table 3) and an increase in AROM of at least 6° (Table 4) at the time of discharge. Patients 4 and 5 were treated for one week; Patient 3 was treated for two weeks.

Patient 1 was seen over 35 days (20 visits) prior to discharge. As indicated by her NPRS scores, her pain fluctuated throughout treatment (Figure 1). Her DPA scale scores decreased after two weeks of treatment and continued to decrease until discharge (Figure 2). Her PSFS improved, but not by clinically meaningful levels (Table 3). Her AROM increased by 4° (Table 4).

**Discussion**

In this a priori case series, the Mulligan Concept internal tibiofemoral rotation MWM and lateral glide into flexion MWM decreased pain, increased AROM and increased function in the individuals studied (recreational dancers) classified with global patellar pressure syndrome and excessive lateral pressure syndrome. The weight-bearing internal rotation MWM was performed on all patients, as all patients complained of pain with weight-bearing activity. Takasaki
et al. [14] found that the weight-bearing internal rotation MWM resulted in an immediate reduction of pain during functional tasks (i.e., ascending stairs) in patients with osteoarthritis of the knee. Mulligan [12] suggested that the internal rotation MWM can be performed non-weight-bearing, but this modification is primarily designed for patients with osteoarthritis and was not used in this study. Interestingly, a valgus collapse was seen in all five patients while in weight-bearing performing a double-leg squat. Valgus collapse can be correlated to lateral tibial rotation (externally rotated tibia) and lateral patellar alignment [20]. Results from the PSFS (e.g., ascending stairs) were also like those reported by Takasaki et al. [14] for osteoarthritic patients. The average increase in active knee flexion in our study (5.8°) was greater than that observed by Takasaki et al. (3.9°).

Regarding patient classification, only one patient, patient 2, was classified as having global patellar compression syndrome as her evaluation met the criteria for this syndrome. Global patellar pressure syndrome is thought to occur when both the lateral and medial retinacula are excessively tight [3]. While most patients develop global patellar pressure syndrome after a traumatic blow to the patella, Patient 2 did not report a mechanism of trauma. She did, however, display diffuse anterior knee pain globally around the patella, a cardinal symptom of global patellar pressure syndrome. Patient 2 also had positive medial and lateral glide tests, indicating that her patella was hypomobile in both directions [3,21]. Based upon MCIDs on the NPRS, the DPA scale, the PSFS and increased AROM, Patient 2 had a positive outcome following MWM interventions.

Patients 1, 3, 4 and 5 were all classified with excessive lateral pressure syndrome. Variations in patient characteristics can explain the wide range of days treated in this group (average of 15.75 days). Patient 1, who was treated for 35 days, was also diagnosed with osteoarthritis on day 30 of treatment. Patient 3 was also waitressing at the time of treatment (14 days) and Patients 4 and 5 were discharged after 7 days from initial evaluation. Excessive lateral pressure syndrome can be a result of dysfunction of the tibiofibular joint, which is commonly seen in dancers during the turnout phase of dance.

Limitations

Several limitations were identified in this study. The core limitation was lack of a comparison group of patients with similar clinical presentation; this was an a-priori designed case series rather than a randomized trial and the number of patients (N=5) was insufficient for a comparison study. With this study being a true, a-priori clinical design, everyone received the same evaluation and treatment decisions were based upon that evaluation rather than each patient receiving the exact same treatment. A larger sample size would be of benefit. It is unclear if the observed results will apply to the general population of dancers with PFPS, or to individuals with PFPS participating in other activities. Due to time restrictions, no long-term follow-up was performed to assess patient status following the intervention (e.g., at 6-months, 9-months and 1 year).

Conclusion

For this a priori case series, the use of the MC MWM internal rotation of the tibiofemoral joint and a lateral glide into knee flexion was associated with clinically significant improvements in patient- and disease-oriented measures. At various points throughout the study, improvements in patient-oriented measures such as patient pain on the NPRS and patient function on the DPA scale and PSFS, were seen at levels consistent with MCIDs. Active range of motion, a disease-oriented measure, increased by an average of 5.8° in the five patients seen in this study. The lead investigator, although at the time considered a novice in the Mulligan Concept, was able to effectively treat the individuals within this study. This could show that the Mulligan Concept skills are transferrable for even novice clinicians to the concept. Further study is needed to validate the findings of the current study to validate the clinical efficacy of the Mulligan Concept MWMs.
Conflict of Interest

The authors declare that there are no conflicting interests with respect to the research, authorship, and/or publication of this article.

References