Rehabilitation after Total Hip and Knee Arthroplasty
A New Regimen Using Pilates Training

Brett Levine, M.S., M.D., Beth Kaplanek, R.N., Dina Scafura, and William L. Jaffe, M.D.

Abstract

Rehabilitation after total hip and knee arthroplasty is a rapidly expanding discipline. With the introduction of minimally invasive techniques and the pressure of insurance regulations, postoperative rehabilitation has been placed on an accelerated track. As surgeons turn to more aggressive postoperative protocols and early entry into outpatient therapies, we introduce a pre- and postoperative program involving the Pilates method. Renewed patient interest in the use of Pilates for postoperative rehabilitation has led to the development of safe and modified exercises for patients undergoing total hip or knee arthroplasty. While this technique appears safe and effective anecdotally, further controlled trials are necessary to prove its validity.

The prevalence of total hip and knee arthroplasty is rapidly increasing in the U.S. In a recent report, the number of primary total hip arthroplasties increased from 119,000 to 193,000 between 1990 and 2002.[1] Concomitantly, the number of total knee arthroplasties tripled from 129,000 to 381,000 between 1990 and 2002.[1] During this time, the health care environment and insurance regulations have changed dramatically, driving a push for shorter in-patient hospital stays for total joint arthroplasty patients. Concomitantly, the benefits of early rehabilitation and patient mobilization were also being realized. Ganz and colleagues reported on the nature of discharge and rehabilitation milestones in 11,000 total hip arthroplasties from 1990 to 2000.[2] They found a decrease in the average length of hospital stay from 9.7 days to 5.3 days over this decade. More recently, there has been an effort to limit inpatient stays to 72 hours. In addition, some surgeons are now performing total hip and knee replacements on an outpatient (or 23-hour stay) schedule.[3-5]

With the advent of minimally invasive total joint arthroplasty, an interest in rapid rehabilitation protocols and early enrollment in outpatient physical therapy has evolved. A contemporary report has shown early benefits of rapid rehabilitation after minimally invasive total hip arthroplasty.[4] The goals of early discharge, rapid mobilization, and expedited entry into outpatient physical therapy were realized by the majority of patients in the aforementioned study. While there have been no reports in the current literature, there is no reason that such an accelerated regimen could not be applied to all total joint replacements, including those with traditional incisions. It is also reasonable to infer that these patients also would respond well to this more aggressive approach to postoperative rehabilitation.

Indications for total joint arthroplasty have gradually expanded to encompass younger, more active patients who, themselves, are demanding a more rapid return to function. With this in mind, we have explored the concept of using the Pilates method for preoperative and postoperative rehabilitation in total joint arthroplasty patients. The advantages of using this method include maximizing preoperative function, developing a pathway for a swift return to outpatient exercise, and promoting a whole body approach to rehabilitation. It is the objective of this communication to introduce simple, modified preoperative and postoperative rehabilitative protocols for total hip and knee arthroplasty patients, applying

Brett Levine, MS, M.D., is an Adult Reconstructive Fellow, Rush University Medical Center, Chicago, Illinois. Beth Kaplanek, R.N., is a Certified Pilates Instructor, Pilates Center of Long Island, Huntington, New York. Dina Scafura is a Certified Pilates Instructor, Pilates Center of Long Island, Huntington, New York. William L. Jaffe, M.D. is Clinical Professor of Orthopaedic Surgery, New York University School of Medicine, and an Attending in the Adult Reconstructive Service, NYU Hospital for Joint Diseases, New York, New York.

Correspondence: Brett Levine, M.D., Midwest Orthopaedic Center, 6000 North Allen Road, Peoria, Illinois 61614.

the Pilates method.

History of Pilates

The Pilates method of exercise stems from Joseph Hubertus Pilates who operated an exercise studio in New York from the late 1920s to the 1960s.[6] Born near Dusseldorf, Germany, in 1880, Pilates, himself, suffered from childhood rickets, asthma, and rheumatic fever. These early ailments turned him toward a life of improving his health and well-being through exercise and fitness. In World War I, he developed mat exercises and a spring-resistance program that helped injured soldiers recover muscle tone more quickly.

Over time, Joseph Pilates developed a more regimented program as well as designed sophisticated machines during the period he worked with the boxer, Max Schmelling. Since the 1920s, little has been published on this method, with most of his teachings being passed down via apprenticeship. The Pilates method combines Joseph Pilates' experiences of strength and fitness training, gymnastics, boxing, self-defense instruction, and dance. At the time of his death, in 1967, a number of studios had opened that employed his techniques.

Philosophy and Principles

The exercise system that Joseph Pilates developed combined his personal philosophy with movements based on gymnastics, martial arts, yoga, and dance. One of the first principles of his method includes proper breathing technique and posture. "Contrology," is the complete coordination of body, mind, and spirit, and remains the backbone of Pilates' philosophy.[6] He focused on building motions and activities that helped to strengthen minor muscles, which, in turn, helps to strengthen major muscles. As this method of stretching and strengthening was further developed, Pilates' teachings were defined by six fundamental principles: concentration, control, centering, flowing movement, precision, and breathing.[7] There is an emphasis on stretching, maintaining a neutral spine during movements, and performing quality movements rather than on repetition exercises, where important focus on the body, the muscles, and the exercise can be lost.

The concept of centering is fundamental to the Pilates method and refers to the emphasis of strengthening and stretching the core of the body.[7] Pilates referred to this region as the "powerhouse," which has been broadly interpreted to anatomically include an area from the pelvic floor, inferiorly, to the rib cage, superiorly.[7,8] By creating a strong structural powerhouse, Pilates believed that one's ability to function during activities of daily living would be optimized. This concept of strengthening the core was recently reviewed by Willson and associates.[9] They found that decreased core stability may predispose one to injury of the lower extremities and suggested that stability of the core is crucial to the ability to establish a stable base for movement of the extremities.

Currently there are two styles of Pilates, the repertory approach (traditional) and modern Pilates.[10] There has been a renewed interest in this form of exercise in recent years, and many athletic centers, local gyms, and dance studios now offer Pilates training. Either method (traditional or modern) is recommended for the fit, unfit, and elderly who are looking to maintain or improve their health and fitness. More recent use of the Pilates method includes fine-tuning of performance for elite athletes and dancers.[6,11] There have been reports of using the Pilates method in rehabilitating postsurgical patients and for recuperation of musculoskeletal conditions (adhesive capsulitis and low back pain).[12-15] A typical mat workout that has been noted to maintain flexibility is depicted in Table 1.[16] A novel set of modified Pilates exercises is presented herein that are safe for use in patients after either total hip or knee arthroplasty.

Table 1 General Pilates Mat Regimen*

Beginner System	Intermediate	Advanced
Hundred	All previous exercises	All previous exercises
1/2 Roll Down	Double Straight Leg Stretch	Roll Over
Full Roll Up	Criss Cross	Adv Corkscrew
Single Leg Circles	Open Leg Rocker	Swan Dive
Rolling Like a Ball	Double Leg Kicks	Scissors
Single Leg Stretch	Neck Pull	Bicycle
Double Leg Stretch	Shoulder Bridge	Spine Twist
Single Straight Leg Stretch	Side Kicks--variations	Jack Knife
Spine Stretch Forward	Teasers 1	Teaser 2&3
Corkscrew	Hip Circles (Can Can)	Hip Circles
Saw	Swimming	Leg Pull Down
Swan Prep	Mermaid	Leg Pull Up
Single Leg Kick	Seal	Kneeling Side Kicks
Side Kick Variations	Push-ups	Boomerang
Teaser Prep 1&2		
Seal		

*The above table represents the average series of mat exercises performed at each level: beginner, intermediate, and advanced levels

Preoperative Regimen

The preoperative regimen depends on the patient's initial range of motion, pain level, and disease progression. The regimen concept follows the classical beginner mat work with individualized modifications. The benefit of applying Pilates presurgically is to establish muscle memory and improve strength, mobility, and range of motion of the involved and adjacent joints. It is also helpful in establishing a working relationship with a certified Pilates instructor for later continuity postoperatively.

Pilates mat exercises are designed to incorporate a whole body workout while following the six basic principles:

1. *Centering* is the foundation of all movements, requiring core muscle stabilization prior to initiating arm or leg movements.
2. *Control* refers to the ability to monitor movements, while performing them with the correct mindful intent, from the appropriate muscle groups.
3. *Precision* relates to the focus on completing an exercise using the proper form and execution.
4. *Concentration* places form and the mental fortitude to perform an exercise as the focal point.
5. *Breath* refers to maintaining proper breathing techniques crucial to performing these exercises (Inhalation is used to prepare for the movement and exhalation is used to execute the movement, activate core muscle support, and intensify the movement).
6. *Flow* is the connection of one movement to the next and is developed over time as the patient becomes familiar with the exercises.[17]

Pilates and Total Hip and Knee Arthroplasty

The Pilates method is an integrative and comprehensive approach for a complete body workout, yet can also be individualized to meet specific postoperative rehabilitative needs (Tables 2 and 3).[17-19] Pilates exercises may be performed with modification, based upon individual limitations and surgeon-based restrictions (i.e., posterior approach hip precautions

Table 2 Recommended Postoperative THA Pilates Protocols*

Two Weeks to Three Months†‡	Three to Six Months‡§	Six Months and Beyond‡§
Hundred	All previous exercises	All previous exercises
1/2 Roll Down	Full Roll Up	Rolling Like a Ball
Single Leg Circles	Double Straight Leg Stretch	Open Leg Rocker
Single Leg Stretch	Criss Cross	Spine Twist
Double Leg Stretch	Double Leg Kicks	Side Kick Variations
Single Straight Leg Stretch	Corkscrew	Teaser 2
Spine Stretch Forward	Neck Pull	Hip Circles (modified)
Saw	Shoulder Bridge	Swimming
Swan Prep	Side Kicks--variations	Leg Pull Front (modified)
Single Leg Kick	Teaser 1	Serratus Push-ups
Side Kicks--variations	Can Can	Mermaid
Teaser Prep 1&2	Push-ups	Seal

*For a complete description of these exercises, see references 8,17,18.
†Two weeks to three months: The patient follows a very limited pre-Pilates warm up series staying within the guidelines for postoperative ROM.
‡All of the above exercises (or modifications thereof) are performed under the guidelines of the hip precautions recommended by the surgeon.
§Any individual performing these exercises only advances to the next level after demonstrating a strong sense of core stability and strength.

Table 3 Recommended Postoperative TKA Pilates Protocols*

Two Weeks to Three Months†‡	Three to Six Months‡§	Six Months and Beyond‡§
Hundred	All previous exercises	All previous exercises
1/2 Roll Down	Full Roll Up	Open Leg Rocker
Single Leg Circles	Rolling Like a Ball	Spine Twist
Single Leg Stretch	Double Straight Leg Stretch	Teaser2
Double Leg Stretch	Corkscrew	Hip Circles (modified)
Single Straight Leg Stretch	Criss Cross	Swimming
Spine Stretch Forward	Double Leg Kicks	Leg Pull Front (modified)
Saw	Neck Pull	Serratus Push-ups
Swan Prep	Shoulder Bridge	Mermaid (modified)
Single Leg Kick	Side Kicks Variations	Seal
Side Kicks--variations	Teaser 1	
Teaser Prep 1&2	Can Can	

*For a complete description of these exercises please see references 8,17,18.
†Two weeks to three months--The patient follows a very limited pre-Pilates warm up series staying within the guidelines for postoperative ROM.
‡All of the above exercises (or modifications there of) are performed under the guidelines of precautions recommended by the surgeon.
§Any individual performing these exercises only advances to the next level after demonstrating a strong sense of core stability and strength.

would limit hip flexion to 90°, avoid hip adduction across the midline and, as well, limit degrees of internal rotation). Such modifications can be easily made using pillows and padding in the appropriate locations and restricting hip or knee joint motion to fall within the surgeon's guidelines (Figs. 1 through 3).

The exercises listed in Tables 2 and 3 are specifically targeted toward the needs of total hip and knee arthroplasty patients. Each patient may progress in these regimens as directed by a certified Pilates instructor, keeping in mind postoperative restrictions. Early stages of movement may be quite limited but can be advanced to the more challenging stages with further integration of more difficult mat series as the rehabilitation process progresses.

Postoperative Regimen — Two Weeks to Three Months

Guided by the Pilates principle of initiating movements from a stable source, the goals for regimens of several weeks to several months include: the performance of active and active-assisted exercises to increase hip or knee range of motion (within postoperative guidelines) and early strengthening and development of muscle memory for the hip (flexors, extensors, adductors, abductors, and rotator) and knee (flexors and extensors). Slow and controlled performance of the listed exercises will help strengthen the core muscles, improve hip or knee range of motion, and enhance the stamina of adjacent muscles and joints.

Postoperative Regimen — Three to Six Months (Recommended for a Minimum of Three Times a Week)

As soft tissue healing occurs and postoperative precautions are eased, patients can advance to a more difficult level of exercise that requires a longer lever and increased core muscle stability to perform. In particular, additional versions of the side-kick series will afford an opportunity to increase the range of motion, flexibility, and strength and stamina of

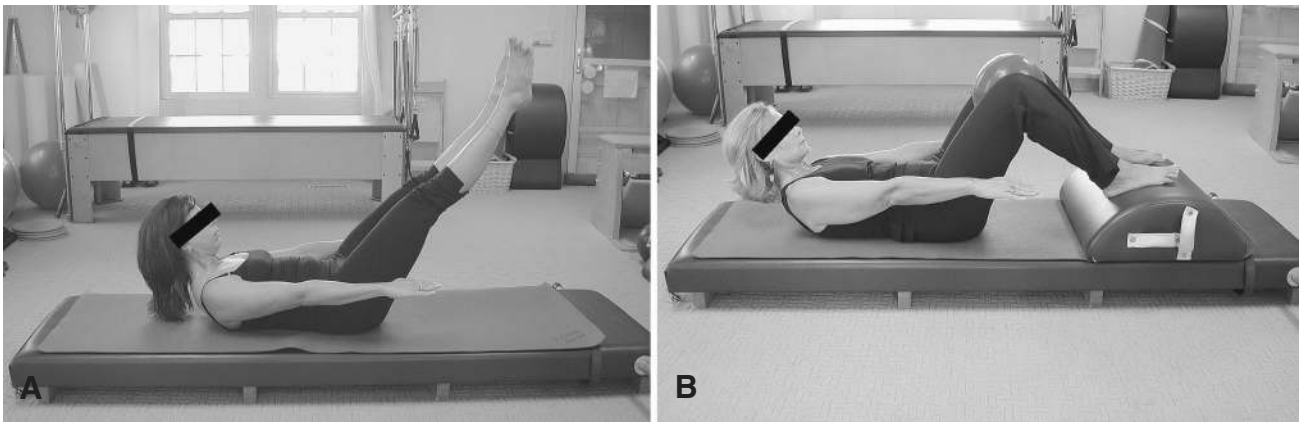

Figure 1 Idealized **(A)** and modified **(B)** versions of the Hundred. This is a warm-up exercise utilized to increase core temperature. The core muscles are engaged while actively moving the arms and legs up and down. This is coordinated with an appropriate breathing pattern to stimulate circulation during the warm-up period.

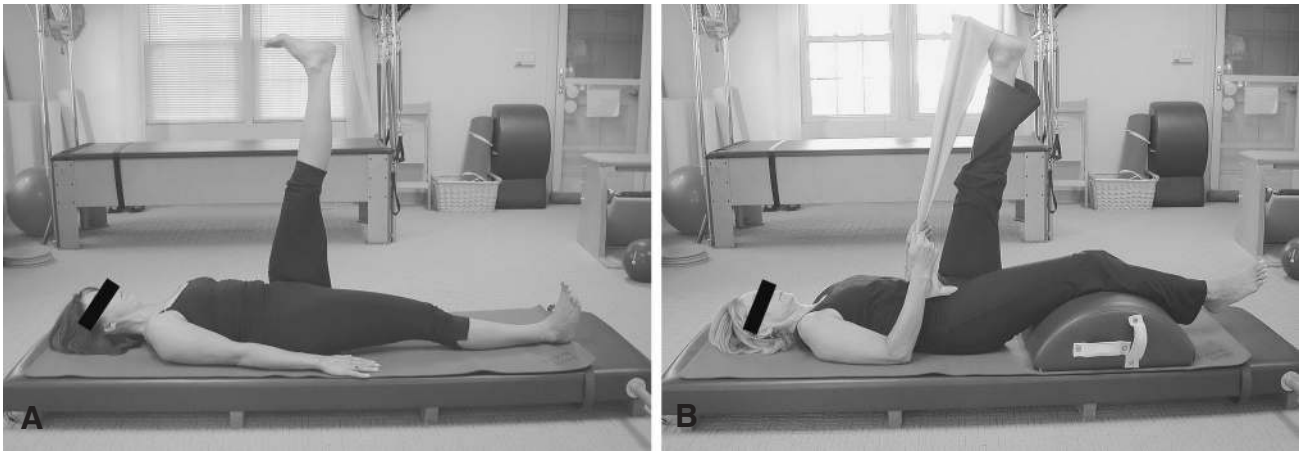

Figure 2 Single leg circles, ideal **(A)** and modified **(B)** positioning. This exercise focuses on hip range of motion and strengthening of the flexor and extensor muscles of the hip, while avoiding active abduction or adduction. Restrictions on flexion and extension can be controlled using the modified version of the exercise seen here.

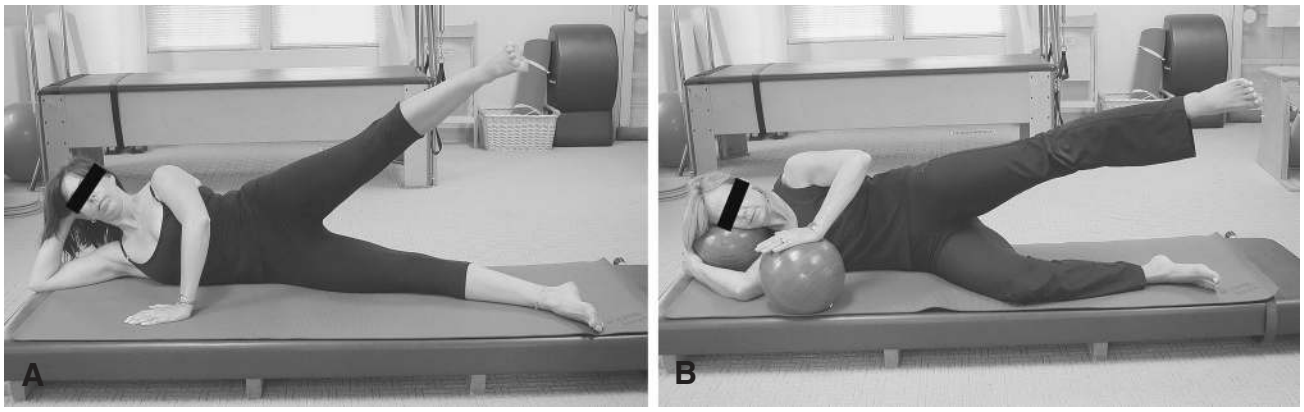

Figure 3 Ideal **(A)** and modified **(B)** side kick series (up and down version). This exercise isolates the abductor and adductor muscles of the hip, while engaging the core musculature to stabilize the pelvis and upper body. The benefit of this maneuver is found in enhancing hip range of motion and strengthening the abductor muscles, which can, in turn, improve ambulatory capacity, reduce postoperative limping, and increase hip stability. [The TRIADBALL™ (Zenirgy, LLC. Sun Valley, Arizona) can be useful in modifying these exercises for specific surgeon-based restrictions.]

the adjacent joints and muscles for hip and knee arthroplasty patients (Fig. 3). Benefits of these exercises may be seen with improved balance and gait.

Postoperative Regimen — Six Months and Beyond

At this time, patients are stronger and are nearing maximal range of motion for their respective joint arthroplasty. Postoperative precautions are further eased and patients may perform more intensive movements. As the patient's core musculature strengthens, they will be able to perform the exercises more efficiently and with enhanced stamina. A return to approved sports activities and full participation in the modified Pilates method can be expected during this time period.

Discussion

We present for the benefit of appropriate patients a novel and safe approach for rehabilitation after total hip or knee arthroplasty. While there have been no prospective randomized studies using the Pilates method, our experience applying this protocol has been promising. Several advantages of the approach described include the use of preoperative exercises to maximize function and flexibility prior to surgery, the formation of a relationship with a certified instructor that can be maintained after surgery, the relative ease in implementing some of these basic exercises at home, and the adaptability of the Pilates method to accommodate various joint precautions and range of motion restrictions.

In recent years, there has been a resurgence in the teachings of the Pilates method. The number of Pilates studios and fitness centers offering Pilates training has been increasing. In a survey of the Hip Society's members, Pilates was rated as a sports activity that patients are allowed to participate in after a total hip arthroplasty (64% of respondents allowed participation for patients who had no prior Pilates experience, and an additional 15% recommended participation for patients with Pilates experience).[20] There are several levels of difficulty and the individual exercises can be easily modified for joint precautions or motion limitations. Patients can safely progress from the early stages in the protocol to the latter stages on an individual and surgeon-defined basis. The goal after surgery would be to resume training with the patient's preoperative instructor, starting at two weeks postoperatively or when the patient would typically start outpatient physical therapy. This type of mind-body approach to rehabilitation is becoming more popular in the U.S. and this article represents the introduction of this form of exercise for postoperative rehabilitation in total hip and knee arthroplasty patients.

The above protocols have been developed in conjunction with certified Pilates instructors and are safe for postoperative total joint patients. In the future, we hope to be able to evaluate the clinical benefits of this accelerated Pilates approach in treating our total hip and knee replacement patients. For now, the use of such a program should be considered on a case-by-case basis, and its implementation and coordination should be limited to include only certified Pilates instructors.

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