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## Improve function before knee replacement surgery

by Robert Topp, RN, PhD and Phil Page, MS, PT; Ann M. Swank, PhD; Peter M. Quesada, PhD; John Nyland, EdD, PT and Arthur Malkani, MD

Osteoarthritis is a common chronic health condition. Among the estimated 27 million adults in the United States who had osteoarthritis in 2005, 33.6% were ages 65 and older (Lawrence, Felson, et al., 2008). One in 10 Canadians has osteoarthritis, and approximately 85% are ages 70 or older (Public Health Agency Canada).

Osteoarthritis (OA) is a wearing down of the cartilage surrounding the joints, which causes the bones to rub against one another. The result is typically pain, stiffness and functional impairment.

The knee is one of the joints most frequently affected by osteoarthritis. Characteristics of knee OA (Creamer, 2004) include:

- decreases in strength,
- limitations in the ability to complete functional tasks, and
- increases in joint pain.

Symptoms of osteoarthritis in the knee affect an estimated 13.6% of women and 10% of men 60 years and older—about 4.3 million people—in the United States (Dillon, Rasch, Gu, et al., 2006).

At first, knee OA is treated conservatively using medications, weight loss and exercise in an attempt to control joint pain and preserve the ability to complete functional tasks.



However, frequently the disease progresses to a point where total knee arthroplasty (TKA) surgery is indicated (Hawker, et al., 2006). During the surgery, the diseased knee joint is removed and replaced by a prosthetic device. After the surgery, there is typically a prolonged rehabilitation (DeFrances & Hall, 2004; Hawker, et al., 2006).

More than 381,000 TKA procedures are performed in the US annually (DeFrances & Hall, 2004) and this number is predicted to exceed 474,000 by 2030 (American Academy of Orthopedic Surgeons, 2003).

## Role of prehabilitation

Prehabilitation is broadly defined as improving the functional capacity of an individual through physical activity to withstand a stressful event (Ditmyer, Topp & Pifer, 2002; Topp, Ditmyer, et al., 2002).

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**Fast facts**

2 of 3 obese adults who will develop knee osteoarthritis

47% reduced risk of osteoarthritis disability from exercising 3 times/week

97% of all knee replacement surgeries are adults 50+ (Canada, 2000)

\$18 billion hospital costs for total knee replacement in US (2006)

SOURCES: CDC, Canadian Orthopaedic Assn

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Prior to surgery, individuals with OA of the knee commonly experience declines in the ability to complete functional tasks, such as ascending or descending stairs, arising from a chair or getting down to or up off of the floor. They also feel increasing levels of knee pain, which decreases levels of physical activity (Sharma, 1999; Topp, et al., 2002).

Following TKA surgery, the rehabilitation process involves reduced physical activity in order to allow the tissues to heal. This reduced physical activity contributes to further declines in functional ability. As a result of the low levels of physical activity prior to TKA surgery plus the restricted activity following TKA surgery, individuals commonly find themselves detrained compared to their healthy age-matched peers. This detraining contributes to low levels of functional ability following the TKA surgery.

These declines in functional ability prior to and following TKA surgery likely limit the progress of the rehabilitation process. If TKA patients could improve their ability

to complete functional tasks before surgery, then perhaps after the surgery they would retain a higher level of function. Logically, that could result in an accelerated progress of their rehabilitation. That model is shown in Figure 1.

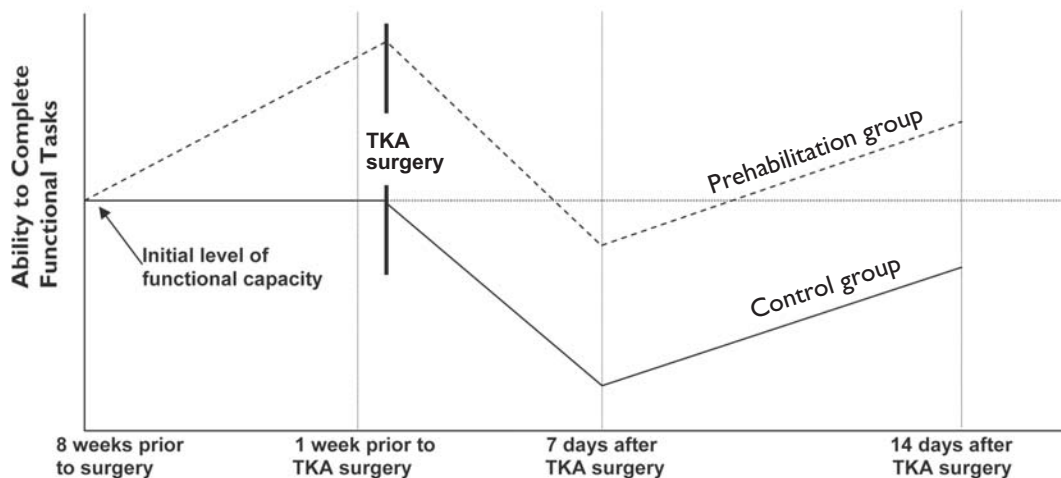
**Research on the effect of prehabilitation**

Few studies have attempted to examine the effect of a presurgical exercise program designed to improve strength, performance of functional tasks and reduce pain on postsurgical recovery among TKA patients.

To examine the potential of prehabilitation, our research team conducted a study with 54 patients scheduled for total knee arthroplasty (Topp, Swank, Quesada, Nyland & Malkani, 2009). These individuals were randomly assigned to a usual care group (N = 28) or to a prehabilitation group (N = 26) and followed for five months. The participants ranged in age between 50-95 years old.

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**Figure 1. Theoretical model of the effect of prehabilitation on functional capacity among TKA patients**



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They were assessed at eight weeks and one week before surgery, and again at four and 14 weeks after TKA surgery. The assessment recorded their performance on four functional tasks:

- distance covered in a 6-minute walk,
- number of sit-to-stand repetitions in 30 seconds,
- time required to ascend two flights of stairs, and
- time required to descend two flights of stairs.

Patients assigned to the control group were asked to continue their normal activities until their TKA. People assigned to the prehabilitation group were asked to participate in a minimum of three exercise sessions per week. One weekly session was supervised by the research personnel, while the other two weekly sessions were completed by individuals in their homes. They recorded the results of the session in an exercise log.

### Exercise program

The intervention emphasized three exercise components: resistance training, step training and flexibility training. A session was structured as follows:

**Warm-up:** 5 minutes of slow walking.

**Resistance training:** 9 lower body resistance training exercises incorporating various intensity levels using a Thera-Band.

**Step training:** series of forward and lateral steps up and down on a standard 8-inch step.

**Static stretching:** moderate-intensity static stretching: gluteal, hip, hamstring, calf, torso, upper back, lower back and triceps.

**Cool-down:** 5 minutes of “light” walking.

The exercises and progression of the exercise volume during the weeks prior to surgery are shown on page 4. The prehab intervention group exercised for 4-8 weeks prior to their TKA surgery, and averaged approximately 13 prehabilitation sessions per person.

**Before surgery.** Between baseline and just prior to surgery, participants in the prehabilitation exercise group significantly increased their ability to complete sit-to-stand repetitions in 30 seconds and increased the distance they covered during the 6-minute walk. Although not statistically significant, they also demonstrated a trend toward reducing their time to ascend and descend both the first and second flights of stairs. These findings demonstrate the effectiveness of the prehabilitation protocol to improve performance of functional tasks prior to TKA surgery.

Those in the control group did not change their ability to complete any of the functional tasks. However, they did demonstrate a trend toward decreased distance covered during the 6-minute walk, and an increased time required to negotiate ascending and descending both flights of stairs.

**One month after surgery.** At one month following their TKA, participants in the prehabilitation group were able to maintain the gains in sit-to-stand that they had achieved prior to the surgery. But, they were unable to maintain the improvements in their performance of the 6-minute walk. Their ability to ascend or descend stairs did not change.

**Three months after surgery.** The prehabilitation group continued to improve in the ability to complete the sit-to-stand assessment over their baseline measures. They also demonstrated increases in the distance they covered in 6 minutes and significantly reduced the time to ascend

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## Content and progression of prehabilitation intervention

Exercises are shown on pages 7 and 8.

Exercise	Week 1-2	Week 3-4	Week 5-6	Week 7-8
Warm-up	5 minutes of slow walking	5 minutes of slow walking	5 minutes of slow walking	5 minutes of slow walking
Squat	1 set × 10 reps @ low resistance	2 sets × 10 reps @ low resistance	1 set × 10 reps @ moderate resistance	2 sets × 10 reps @ moderate resistance
Knee curl	1 set × 10 reps @ low resistance	2 sets × 10 reps @ low resistance	1 set × 10 reps @ moderate resistance	2 sets × 10 reps @ moderate resistance
Hip abduction	1 set × 10 reps @ low resistance	2 sets × 10 reps @ low resistance	1 set × 10 reps @ moderate resistance	2 sets × 10 reps @ moderate resistance
Hip adduction	1 set × 10 reps @ low resistance	2 sets × 10 reps @ low resistance	1 set × 10 reps @ moderate resistance	2 sets × 10 reps @ moderate resistance
Hip flexion	1 set × 10 reps @ low resistance	2 sets × 10 reps @ low resistance	1 set × 10 reps @ moderate resistance	2 sets × 10 reps @ moderate resistance
Hip extension	1 set × 10 reps @ low resistance	2 sets × 10 reps @ low resistance	1 set × 10 reps @ moderate resistance	2 sets × 10 reps @ moderate resistance
Ankle plantarflexion (calf raise)	1 set × 10 reps @ low resistance	2 sets × 10 reps @ low resistance	1 set × 10 reps @ moderate resistance	2 sets × 10 reps @ moderate resistance
Ankle dorsiflexion	1 set × 10 reps @ low resistance	2 sets × 10 reps @ low resistance	1 set × 10 reps @ moderate resistance	2 sets × 10 reps @ moderate resistance
Step-ups (forward and lateral)	8 steps each direction 3 in. step height	12 steps each direction 5 in. step height	16 steps each direction 5 in. step height	20 steps each direction 7 in. step height
Cool-down	Stretch: 2 sets × 20 seconds 5 minutes light walking	Stretch: 2 sets × 20 seconds 5 minutes light walking	Stretch: 2 sets × 20 seconds 5 minutes light walking	Stretch: 2 sets × 20 seconds 5 minutes light walking

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and descend the first and second flights of stairs compared to their baseline measures.

The control group also demonstrated significant improvements in sit-to-stand and distance covered during the 6-minute walk compared to their baseline measures. They did not demonstrate any improved performance to ascend or descend stairs at compared to their measures at baseline.

Thus, at three months after the surgery, individuals who had engaged in the prehabilitation intervention improved their performance on all four of the functional tasks. This finding is in contrast to the control group who improved their performance on only two of the four functional tasks that were assessed.

### Lessons learned

These findings appear to support the efficacy of prehabilitation to improve the performance of functional tasks prior to and following TKA surgery. Further supporting the efficacy of prehabilitation is the finding that individuals who participated in this intervention were able to maintain their preoperative gains in the ability to complete sit-to-stand repetitions at one month following their TKA and then demonstrated gains in their performance of all of the functional tasks at three months following their TKA compared to their pre-surgery baseline levels.

The individuals who did not participate in prehabilitation did not improve their ability to perform any functional task until the final data collection point and then only improved on two of the four functional tasks. These findings demonstrate the need for further study and tentatively indicate that practitioners should prescribe prehabilitation to their patients scheduled for TKA in order to facilitate their recovery following the surgery.

### Applying the findings

It seems appropriate to provide prehabilitation exercise to enhance an individual's ability to complete functional tasks prior to encountering the stressor of TKA. Even before scheduling a TKA surgery, individuals may want to try exercise because previous research indicates that components of the prehabilitation training reduce pain and increase functioning. As a result, the training might delay TKA surgery among knee OA patients.

People who have been cleared for a TKA surgery are usually healthy enough to engage in the prehabilitation training program. However, they should consult their physician before starting to exercise. Of course, any increase in pain or swelling signals a decrease in exercise.

A benefit of informing the surgeon and the postoperative physical therapy staff that a person is engaging in prehabilitation is a potential effect on how quickly the health care staff progress the person through the rehabilitation process, including the length of the hospital stay.

Beginning prehabilitation early before a TKA will also maximize the benefits of the exercise training, including gains in strength and functioning and reductions in pain prior to and possibly following the TKA surgery.

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*Photography courtesy of the Hygenic Corporation, Akron, Ohio. The photos are part of the resources available at the Thera-Band Academy, [www.thera-bandacademy.com](http://www.thera-bandacademy.com).*

### Resources

American Academy of Orthopaedic Surgeons  
Information on osteoarthritis, arthritis of the knee and joint replacement  
<http://orthoinfo.aaos.org/main.cfm>

Knee Rehab CARES  
Consumer brochure with exercises  
Thera-Band Academy  
[www.thera-bandacademy.com](http://www.thera-bandacademy.com)

OPTP  
(Orthopedic Physical Therapy Products)  
[ICAA Preferred Vendor]  
Resistance bands and tubing  
[www.optp.com/Default.aspx](http://www.optp.com/Default.aspx)

Spri  
[ICAA Preferred Vendor]  
Resistance bands and tubing  
[www.spri.com/](http://www.spri.com/)

Thera-Band®  
[ICAA Preferred Vendor]  
Resistance bands and tubing  
[www.thera-band.com/](http://www.thera-band.com/)

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## Glossary

### Abduction

Move a limb away from the center of body

### Adduction

Move a limb toward the center of the body

### Detraining

Loss of fitness when training stops; deconditioning

### Extension

Moving away from the body; straightening a limb

### Flexion

Moving toward the body; bending a limb

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### Chair squat

Begin with center of band under feet. With hands at sides, grasp ends of bands. Keeping your elbows straight, slowly bend your knees while leaning forward slightly at the hips. Maintain tension in the band. Slowly return to starting position.

*Tip:* Keep your back straight.

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### Knee curl, standing

Begin by looping the center of the band around the ankle of the exercising leg. Bring the ends of the band underneath the foot of the opposite leg to stabilize, and hold onto the ends near the knee. Slowly bend the knee, pulling upward against the band. Hold and slowly return.

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### Hip abduction (kick outs), standing

Begin by looping the middle of the band around the ankle of the exercising leg. Place the ends of the band under the opposite foot to stabilize the band and hold onto the ends. Keeping the knee straight, kick the leg outward against the band. Hold and slowly return.

*Tip:* Keep your back straight; don't lean over.

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### Hip adduction

Securely attach one end of the band to a sturdy object, loop the band above the exercising ankle, then fasten the remaining end securely. Keeping the knee straight, bring the exercising leg inward toward the opposite leg. Hold and slowly return. Use a sturdy object nearby for balance if needed.

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### Hip flexion, sitting

Sit in a sturdy chair. Begin by looping the center of the band around the top of the knee of the exercising leg. Bring the ends of the band underneath the foot of the opposite leg to stabilize and hold onto the ends near the knee. Slowly flex the hip against the band, pulling upward. Hold and slowly return.

*Tip:* Keep your back straight; don't lean forward.

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### Hip extension (kick backs), standing

Begin by looping the middle of the band around the ankle of the exercising leg. Place the ends of the band under the opposite foot to stabilize the band and hold onto the ends. Keeping the knee straight, extend the leg backwards against the band. Hold and slowly return.

*Tip:* Keep your back straight; don't lean over.

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### Ankle calf raise, standing

Place the middle of the band under the balls of both feet. Hold onto the ends of the band near the hips. Keeping the elbows straight, raise your heels off the floor. Hold and slowly return.

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### Ankle dorsiflexion (foot raises), sitting

Begin by wrapping the middle of the band around the foot of the ankle that will exercise. Place the ends of the band under the opposite foot to stabilize the band. Hold onto the ends of the band near the knee. Lift your foot upward against the band. Hold and slowly return.



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### Step-up

Step up onto stairs or steps facing forward. Use the railing or other sturdy object for balance if needed.



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### Lateral step-up

Step up onto stairs or steps facing the side. Use the railing or other sturdy object for balance if needed.