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## CHAPTER

# 18

# Total Ankle Arthroplasty Rehabilitation

## INTRODUCTION

Total joint replacement (TJR) surgery has seen an evolution over the last few decades highlighted by changes in implant design, a better understanding of biomechanics, and improved surgical technique. Over 750,000 Americans underwent total hip arthroplasty (THA)<sup>1</sup> and total knee arthroplasty (TKA) in 2008 and 2009.<sup>2</sup> This number is on track to expand to over 4 million by 2030.<sup>3</sup> Total ankle arthroplasty (TAA) has also seen a constant rise in implantation and success since the 1970s. Increasing evidence suggests that TAA, in the proper patient, is an equivalent, if not better, alternative to ankle arthrodesis.<sup>4</sup> As with THA and TKA, demand for TAA is expected to grow over the next few decades.<sup>5,6</sup>

Along with advances in technique and implant technology, we have seen an evolution in the perioperative protocols and rehabilitation practices after TJR surgery. Rehabilitation has progressed to include an increased awareness for preoperative planning and education along with postoperative rehabilitation.<sup>7</sup> Total hip and knee replacements performed 30 years ago had an average inpatient acute care stay of more than 9 days, with women staying slightly longer than men. By 2000, the average acute care stay was shortened to 5.3 days with the gender gap nearly closed.<sup>8</sup> Inpatient rehabilitation has focused on mobilization, pain management, transfer training, and range of motion, and has become condensed as the hospital length of stay has decreased, resulting in lower acute care hospital costs.<sup>9</sup> There has been increasing evidence that patients benefit from early progressive rehabilitation in THA and TKA with comparable functional results.<sup>10,11</sup>

## TAA: SIMILARITIES AND DIFFERENCES WITH THA OR TKA

Similar to THA and TKA, postoperative range of motion is a factor to success with TAA.<sup>12</sup> Multiple studies have showed that the kinematics of ankle range of motion does affect the gait postoperatively.<sup>13</sup> Queen et al.<sup>14</sup> showed that ankle range of motion could be maintained at 2 years postoperatively with high patient satisfaction. Stiffness following primary THA and,

more specifically, primary TKA is dealt with in the rehabilitation phase, with an incidence of 8% to 12%.<sup>15–17</sup> Stiffness can be defined as an inadequate range of motion that results in functional limitations in activities of daily living. To prevent adhesions and contractures, aggressive physical therapy (PT) in the first 6 weeks may be beneficial. Use of continuous passive motion (CPM) postoperatively is controversial and not routinely performed for THA and TKA.<sup>18–20</sup> Postoperative use of CPM after TAA has also not been well studied and remains questionable postoperatively.

The normal postoperative course for a primary total ankle replacement (TAR) varies from THA or TKA by virtue of its soft tissue envelope, blood supply, and weight-bearing status. Authors have defined the angiosomes and surgical anatomy of the distal one-third of the anterior leg.<sup>21,22</sup> This information has led to the common incisional approach for TAA in the interval between the tibialis anterior and extensor hallucis longus tendons, which lies just medial to the neurovascular bundle. The tendons should be maintained within their respective sheaths to decrease any skin tension postoperatively. This incision has long been a perceived source of wound care complications following TAA, with a rate less than 11%.<sup>23</sup> Farber and DeOrio<sup>24</sup> attempted to screen patients preoperatively by determining their operative extremity oxygen tensiometry. They found no significant difference with respect to transcutaneous oxygen tension between patients with and without wound healing problems.<sup>24</sup> The authors recommended a more judicious use of deep retraction and less superficial retraction. In addition to meticulous surgical technique, the timing, scope, and duration of PT and rehabilitation are important to optimize outcomes in TAA.

## TAA REHABILITATION

Our current approach to rehabilitation in TAA is based on the concept of integrated, multidisciplinary care across a time line that ranges from the preoperative evaluation and surgical decision-making process through the formal postoperative rehabilitation protocol. With this in mind, “rehabilitation” for our patients begins before surgery. The concept of preoperative physical therapy (POPT), or “prehabilitation/prehab,” is

described in the literature, but the precise definition and effectiveness of prehabilitation remain controversial. Studies have demonstrated a need for “prehab” as intense preoperative exercise training to increase hip and knee strength, range of motion, and, ultimately, function postoperatively.<sup>25–30</sup> Alternatively, prehabilitation can be seen as a single PT session preoperatively with the goals of reviewing basic postoperative activities of daily living and discussing expectations for surgery and recovery. This also allows for a preoperative assessment of patient needs and leads to planning for the appropriate type and intensity of postacute care rehabilitation services.

A case report by Brown et al.<sup>31</sup> analyzed the functional recovery of a patient who underwent staged bilateral TKA. The initial TKA did not incorporate POPT and the second TKA was preceded by a 4-week home-based prehabilitation that consisted of resistance training, flexibility, and step-training. The outcomes of interest were knee strength, functional ability, and pain. The addition of POPT led to decreased pain and increased knee strength and functional ability prior to surgery. The strength gain was maintained in the nonoperative leg postoperatively, and the authors suggest that POPT was effective in facilitating the recovery after TKA. A similar case study by Jaggars et al.<sup>32</sup> reported favorable functional results after a 4-week prehabilitation program.

Other studies in TJR have reported unfavorable or equivocal results with prehabilitation. In a prospective randomized trial, Gocen et al.<sup>26</sup> studied 60 patients with osteoarthritis of the hip, randomized into two groups with and without POPT and education. Their primary outcomes of interest were the Harris Hip Score, visual analog scale, and hip range of motion. No significant differences were found between the groups and the time of discharge. In a randomized controlled trial of 160 patients, Mitchell et al.<sup>33</sup> evaluated the cost and effectiveness of prehabilitation in TKA patients. Their primary outcome of interest was patient-perceived health outcomes, which was not improved by preoperative home-based PT, as compared to hospital outpatient PT. The POPT group was also noted to be more expensive. McKay et al.<sup>34</sup> examined the effects of a 6-week preoperative training program on outcomes in 22 TKA patients. The primary outcome of interest was quadriceps strength, with secondary outcomes related to pain, function, and quality of life. They concluded that the program resulted in clinically meaning increases in quadriceps strength, walking speed, and mental health before TKA, but did not result in lasting benefits to patients in the first 12 weeks after surgery.

In a national survey of health care leaders across Canada, Landry et al.<sup>35</sup> evaluated the factors that affect the demand for rehabilitation services after TJR. The results of the study indicated that the demand for rehabilitation services after TJR is increasing and that new, innovative approaches to care are needed to align the increasing demand with supply. Prehabilitation was noted in their paper as a promising area for more research.

## CURRENT TAA REHABILITATION PROTOCOL

Our PT protocols were developed as a joint effort between surgeons and physical therapists, with a goal of maintaining consistency of care before and after surgery. Protocols help

to generalize knowledge from centers of large volume to the therapist with less specific experience. A protocol will assist the therapist in knowing not only when and which interventions to use, but also which milestones to look for and what signs and symptoms to watch out for. This ultimately guides the quality and level of recovery for the patients. TAA has gained acceptance in the foot and ankle community worldwide, but many PT clinics, depending on their location, will not treat this surgery on a consistent basis.

As we look at the general layout of the protocol, it is designed in this way to be read and utilized by the physical therapist and patient at the same time. By including the patient into the medical team, it is hoped that they acknowledge that a certain level of contribution and commitment is expected of them in their recovery. The physical therapist and patient will not only discuss the importance of homework, but also talk about goals and milestones they are working toward, as well as what the physician expectations are at the end of each 2-week phase of the protocol.

The TAA postoperative protocol has three 2-week phases of time (Appendix A). The phases are not labeled in postoperative weeks of time as most protocols. Instead they are labeled as to which week of PT the patient is in. For example, phase 1 is labeled as “Initial 2 Weeks of Physical Therapy.” This allows more flexibility on the physician’s part and less confusion on the physical therapist’s part. From the physician’s perspective, patients can be referred to therapy when they are ready, whether ahead, on, or behind schedule, without causing confusion on the therapist’s part as to whether or not they should start therapy. Each subsequent phase of the protocol is labeled accordingly.

The protocol phases are divided into six different sections to include goals, common frustrations with recommendations, physician expectations, and three separate interventional focus areas. Phase 1 includes an additional description of the surgery.

The three interventional focus areas include motion, strength, and proprioception. Each of the focus areas has a Physical Therapist column and an accompanying Patient column. The Physical Therapist column includes the key interventions to be performed in the clinic (and/or by the therapist), while the Patient column includes the key home exercises the patient is asked to perform. For example, in phase 1 of the protocol under the focus area of motion, the therapist is asked to perform joint mobilizations, while the patient will need to do general active range of motion (AROM) exercise in non-weight bearing (Fig. 18.1A, B). The patient will do this as part of his/her home exercise program (HEP). In this way, the physical therapist guides patient care, while the patient understands the importance of doing the activity, to promote improved motion.

In phase 1 under the focus area of proprioception, there is a box set aside to touch on the use of modalities. Modalities are beneficial in decreasing pain and inflammation; however, they should not substitute the use of manual therapy and/or exercise to accomplish the same goals.

In phases 2 and 3 of the protocol, the specific interventions are progressed accordingly as to weight bearing and intensity. The specific PT interventions in these sections are in no way all-encompassing. They are merely the key interventions that we have found to promote the desired goal. As stated before, the protocol is merely a guideline to promote consistency in level of



**Figure 18.1.** A, B: Expected AROM DF and PF at the first PT treatment.

care and outcomes. Additions to the interventions are welcome within sound clinical judgment based on patient needs.

The Goals section of the protocol includes specific and general milestones to be reached at the end of each 2-week phase. It is expected that the patient progresses with decreased pain and edema as well as improves with AROM, plantar flexion (PF) strength, and symmetry of gait mechanics. It can also be helpful to identify which type of prosthesis is utilized in the surgery. The Scandinavian total ankle replacement (STAR TAA, SBi, Morrisville, NJ) can demonstrate slightly more AROM dorsiflexion (DF) earlier on at  $5^{\circ}$  to  $8^{\circ}$  as compared to the INBONE (Wright-Medical, Arlington, TN), which can take longer to achieve the same degree of motion. As a result, the STAR can have slightly more total passive range of motion (PROM) at  $30^{\circ}$  to  $35^{\circ}$  compared to the INBONE at  $25^{\circ}$  to  $30^{\circ}$  of total PROM.

## COMMON FRUSTRATIONS AND RECOMMENDATIONS

The Common Frustrations and Recommendations section is in place to assist the therapist and patient in working past slow-downs and/or problems that might arise during the



**Figure 18.2.** Manual therapy technique to improve DF and PF. Grade 3 mobilization pressure can be placed on the calcaneus and talus in opposition to each other to promote PROM DF. Using the same position, slight traction can be utilized as the ankle is gently stretched into PF.

recovery process. For example, if patients have difficulty with their AROM not progressing as expected, the therapist should continue to utilize controlled manual therapy techniques during each visit (Figs. 18.2 and 18.3). The manual therapy can be progressed to controlled weight-bearing mobilizations with movement (MWMs) for DF to progress the patient. Some patients might have difficulty transitioning from their boot to a regular shoe. The patient should be instructed to follow more of a structured boot weaning process, including a tiered schedule of taking the boot off 1 to 2 hours the first day, 2 to 3 hours the second day, 3 to 4 hours the third day, and so on. If acute pain initializes, the patient should stay at the same number of hours they are out of their boot for 2 to 3 days, then progress back toward increasing the non-boot wearing time. Another limitation could be that the patient demonstrates greater than expected limping. The therapist should continue to focus on AROM/PROM of ankle as well as PF strength. Ipsilateral knee extension and hip extension should also be focused on to improve the symmetry of gait. Foot and/or ankle symptoms that



**Figure 18.3.** Manual therapy technique to improve DF. Grade 3 mobilization pressure is maintained posteriorly at the talus while the patient bends his/her knee to promote posterior talar glide and thus improves ROM DF. The clinician maintains steady A-P pressure as the patient repeatedly bends and straightens the knee more than approximately 10 to 15 repetitions.

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appear to be coming from the use of the brace can also occur. If the therapist has concerns about this issue, he/she should contact the surgeon to potentially present the patient with an alternative brace. Persistent lack of PF strength can also occur. It is important that the therapist emphasize the consistent performance of HEP and educate the patient on the fact that it can take up to 1 year after surgery to achieve their maximum attainable strength in the ankle. Ultimately, rehab clinicians can contact the listed PT resource in this section in phase 1 to discuss solutions or to ask questions.

Phase 1 of the protocol also includes a surgery description section. This section is included to give the rehab clinician a general understanding of the surgery performed. This section further describes how the prosthesis moves to include the majority loss of inversion (IV) and loss of eversion (EV). The focus of therapy should be in the sagittal plane of movement, allowing natural IV and EV to occur but never forcing frontal plane motion. Lateral stepping, lateral stepping-up, and lateral stepping-down, while in the frontal plane, are all normal motions performed during day-to-day activities and therefore can be performed as part of therapy, as long as predominantly pain-free.

The primary indication for the surgery is also listed, namely pain relief. It is important for the physical therapist to understand and guide the patient's expectations toward outcome. Although studies show that TAA patients have significantly improved function and time-distance gait parameters over arthritic ankles, they do not typically have the same combined average range of motion (ROM) and strength as age-matched healthy ankles at 12-month follow-up. Nor do the patients typically reach the same strength and ROM of the contralateral healthy leg at 12 months. Although the TAA patients will enjoy a return to significantly improved day-to-day function and minimal-to-abolished pain, it is important they understand that their "new" ankle will not tolerate the same level of activity that their much younger or healthier ankle once did.<sup>36-40</sup>

One of the most helpful sections of the protocol is the Physician Expectation section. These are the general expectations attained at the end of each 2-week phase. This can be a nice reference point related to how the patient is progressing in his/her recovery. This section complements the Goals section and gives progress from the physician's perspective. At the end of the first 2 weeks, it is expected that the patient will be walking in regular shoes with moderate difficulty without an assistive device. Their pain and swelling should be stable and predictable, such that the more activity they perform, the more soreness and/or edema they could potentially have. The patient's pain and edema should not unexpectedly increase, fluctuate significantly, or become increased when at rest. After 4 weeks of therapy, it is expected that the patient will demonstrate increasing velocity of gait and continue to have some stable swelling and pain. Patients are not expected to be able to do a partial single-leg heel raise; however, this can sometimes be seen. The therapist should continue to emphasize the consistent performance of HEP, and some patients can be discharged at this time as long as they have progressed well with their strength, pain, and gait, and are consistent with their HEP. At the end of 6 weeks of PT, it is generally expected that the majority of patients will be walking in regular shoes, without an assistive device, with good velocity and minimal to no pain with their normal day-to-day activities.

## SUMMARY

In summary, our concept of TAA rehabilitation begins in the preoperative period and is based on a multidisciplinary team-based approach to recovery. A standardized postoperative protocol is important to facilitate communication between the surgeon, therapist, and patient. Our goal is to engage the patient as a member of the medical team and give the physical therapist an improved understanding of the expected recovery process. Although the layout of the protocol is atypical, it has been our experience that patients respond favorably when they are an integral part of the medical team.



There are limited evidence-based rehabilitation guidelines for optimizing outcomes after TAA. As the delivery of health care continues to change, health care providers must aim to provide cost-effective care over a defined episode of care. In TAA and TJR in general, it is important to strive toward integrated and coordinated care from the preoperative period through postoperative recovery and rehabilitation. Developing a standardized rehabilitation protocol is an important step toward developing care pathways that improve the overall quality of care and experience for patients.

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## TAA Rehabilitation Protocol

BELIEVE IN W/ 						Phase 1: Initial 2 Weeks of Physical Therapy		
TAR Protocol						Focus area: proprioception		
Focus area: motion			Focus area: strength			Focus area: proprioception		
PT	Patient homework	PT	Patient homework	PT	Patient homework	PT	Patient homework	PT
Joint mobilizations no greater than grade 3 and mild talocrural distraction can be utilized to improve AROM DF/PF. No IV or EV	General AROM in non-weight bearing (focus on DF > PF)	Toe curls and toe extensions for foot intrinsics (start seated and progress to standing)	Toe curls or extension for foot intrinsics (start seated and progress to standing)	Toe curls and toe extensions for foot intrinsics (start seated and progress to standing)	Toe curls or extension for foot intrinsics (start seated and progress to standing)	Pain-free single-leg stance while supporting w/ bilateral upper extremities (initially performed for 5 s only; progressing to 10 s each rep)	Pain-free single-leg stance while supporting w/ bilateral upper extremities (initially performed for 5 s only; progressing to 10 s each rep)	Pain-free single-leg stance, initially performed for 5 s only; progressing to 10 s each rep
Stationary bike with minimal to no resistance (pain-free)		Pain-free total gym or leg press	Forward step-ups on regular 8-in step	Pain-free total gym or leg press	Forward step-ups on regular 8-in step	A-P Wobble Board, bilateral stance. DF limited to patient's tolerance	A-P Wobble Board, bilateral stance. DF limited to patient's tolerance	
Gentle calf stretch (gastroc and soleus). Seated with towel stretch initially progressing to standing runners stretch with medial arch support	Calf stretch as directed by PT	Pain-free resisted stepping with tubing (limit single-leg balance by having patient step back or have them reach, touch, and return)	Resisted T-band stepping, X4 directions, band on nonoperated ankle	Pain-free resisted stepping with tubing (limit single-leg balance by having patient step back or have them reach, touch, and return)	Resisted T-band stepping, X4 directions, band on nonoperated ankle			
General lower extremity stretching (hip and knee) as indicated		General trunk and hip strengthening (bridging, abdominals, etc.)	Physical therapist-directed core and hip strengthening	General trunk and hip strengthening (bridging, abdominals, etc.)	Physical therapist-directed core and hip strengthening			
		Seated heel-toe rocking progressing to standing heel-toe rocking with leaning on table/countertop, etc.	Seated heel-toe rocking progressing to standing heel-toe rocking with some hand support on wall or table	Seated heel-toe rocking progressing to standing heel-toe rocking with leaning on table/countertop, etc.	Seated heel-toe rocking progressing to standing heel-toe rocking with some hand support on wall or table	**PT note: Electrical stimulation, Game Ready ice compression, and/or ice is to be utilized for pain and swelling	**PT note: Electrical stimulation, Game Ready ice compression, and/or ice is to be utilized for pain and swelling	
Goals of phase 1 interventions			Common frustrations	Recommendations	Physician expectations			
1. Improve gait to full Wbing in regular shoes without assistive devices	4. Increase strength and proprioception	AROM DF/PF not progressing as expected	Continue with manual therapy each visit. Consider progressing to Easy Mulligan MWMs in Wbing for DF	Continue with manual therapy each visit. Consider progressing to Easy Mulligan MWMs in Wbing for DF	Walking in regular shoes, with moderate difficulty, without an assistive device Stable and controlled pain and edema levels			

## Appendix A




2. Wean from walking boot, utilizing the boot only when symptoms increase	5. Educate patient on injury and rehabilitation process	Difficulty transitioning out of walking boot	Progress out of boot 1–2 h per day as tolerated by the patient. OK to use cane to assist with decreased pain	The TAR is the removal of the talocrural joint and its replacement with a metal and plastic prosthetic joint. The end of the tibia and the majority of the dome of the talus are replaced. The primary indication of the surgery is pain relief. The majority of AROM is in the sagittal plane with DF and PF. Limited to abolished IV and EV AROM remains
3. Stabilize pain and joint effusion	6. Increase ankle joint ROM	Minimal to no improvement with limping	Continue to work AROM PF/DF. Focus more on PF strength and push-off of lower extremity	
			Consult Jim Wilgus PT, DPT (ph: 614-533-3219) for any questions regarding the protocol or patient progress	

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 				Phase 2: Third and Fourth Weeks of Physical Therapy
TAR Protocol				
Focus area: motion		Focus area: strength		Focus area: proprioception
PT	Patient homework	PT	Patient homework	Patient homework
Continue joint mobilizations if limited AROM DF/PF limiting gait cycle (grade 3)	Standing calf stretches (knee extended; knee flexed)	Pain-free wall squats (can progress to wall squats w/stability ball)	Wall squats at home	Progress pain-free single-leg stance time per repetition and/or stance time on minimally unstable surfaces
Gastroc and soleus stretching in standing and continue general lower extremity stretching		Seated heel raises with resistance, 5 s up and 5 s down		Repeated tubing in standing with increased reps or increased time
Initiate pain-free retro-treadmill		Initiate anterior step-ups and step-downs (2-in step → 8-in step; DF needs to be neutral)	Step-ups and step-downs as indicated by your physical therapist	Progress bilateral stance Rocker Board in sagittal plane only
		Progress standing bilateral heel raise to 3 × 10 without pain (leaning on table or counter progressing to no leaning)	Standing heel raises leaning on countertop/wall to less leaning as strength progresses	Pain-free repeated tubing in standing

Goals of phase 2 interventions	Common frustrations	Recommendations	Physician expectations
1. Increase AROM DF to 5° DF and PF to ~20°	Decreased lower extremity push-off	Continue to progress PF strength	Walking with increased velocity with some difficulty
2. Progress single-limb stance to within 10 s of uninjured limb	Lateral foot pain with walking	Continue with modalities and joint mobilizations. Try posterior fibular taping	Potential discharge for clients who have progressed well
3. Minimal gait deviations with focus on midstance and toe-off phase	Heel pain with walking—this is normal!	Continue with modalities and joint mobilizations	Single-leg heel raise not expected at this point
4. Patient to be progressing toward use of regular shoe 100% of day (no heel lift)	Foot symptoms with use of brace	Contact physician office	Some swelling and discomfort is expected
5. Decreasing and stable pain with gait and weight bearing		Use of modalities as needed for pain management and joint edema	Continue to place emphasis on independent HEP

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  		Phase 3: Fifth and Sixth Weeks of Physical Therapy	
TAR Protocol			
Focus area: motion		Focus area: proprioception	
PT	Patient homework	PT	Patient homework
Joint mobilizations as needed for restricted ROM in any plane at foot and ankle	Lower extremity flexibility as needed with stretches learned in phases 1 and 2	Alternate anterior mini lunges	Alternate anterior mini lunges
Treadmill and/or elliptical trainer as warm-up activities	Treadmill and elliptical trainer as warm-up/ cardio activities	Progression of calf strengthening with focus on single-leg heel raises standing/ sitting	Standing single-leg heel raises leaning on countertop/ table
		Dynamic balance activities on minimally unstable surfaces with trunk and arm movement (pain-free)	



Goals of phase 3 interventions	Common frustrations	Recommendations	Physician expectations
1. Minimal to no pain with normal day-to-day gait and standing	Gastrocnemius/ PF weakness	Continue with HEP. Educate patient as to potential 1 y recovery of normal strength	Patient to be walking in regular shoes, without an assistive device, with good velocity and minimal to no pain with normal day-to-day activities
2. >50% symmetric gait mechanics of lower extremities	Continued edema	Stable and predictable edema can be present up to 1 y or more after surgery	

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