CHAPTER **13**

TENODESIS FOR CHRONIC LATERAL ANKLE INSTABILITY

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It has been reported that 10 to 30% of acute ankle injuries result in chronic symptoms. Ankle instability is one of the most common long-term sequela of acute ankle injuries.[1-3] Chronic ankle instability can be classified as either mechanical or functional. Mechanical instability can be objectively measured and quantified. The anterior, talofibular ligament (ATFL) is the primary ligament that resists ankle inversion during plantarflexion. The calcaneal fibular ligament (CFL) is the primary ligament that resists ankle inversion during dorsiflexion. The ATFL and CFL function synergistically: when one is relaxed, the other is tense.[4,5] Damage to the ATFL with or without damage to the CFL, can result in lateral ankle joint instability. Various biomechanical problems and structural deformities, including fixed calcaneal varus, tibial varum, rigidly plantarflexed first ray, overactivity of the tendinous structures and other miscellaneous abnormalities may contribute to lateral ankle instability.[2,3]

Functional instability is indicated by the patient's subjective complaints of weakness or of the ankle joint giving way. Potential causes include proprioceptive disorders, muscle weakness, and subtalar joint instability. Freeman has described de-afferentiation as the primary cause of functional instability. Afferent nerve fibers within the capsule and ligaments of the ankle subserve reflexes which help stabilize the foot during locomotion. When the foot or ankle is sprained, partial de-afferentiation of the injured joint occurs, so that reflex stabilization of the foot is impaired and the foot tends to give way.[6]

EVALUATION

Evaluation of chronic instability should include history, physical examination, standard radiographs and stress radiographs. A thorough patient history may reveal complaints of pain, swelling, a feel of giving way, frequent ankle sprains and difficulty walking on uneven surfaces.

Physical examination should include evaluation of peroneal muscle strength and proprioception and manual stress testing. Manual stress testing requires anterior drawer and talar tilt maneuvers. The anterior draw can be performed by placing the patient's heel in the palm of the physician's hand with the ankle at 90 degrees to the leg. The examiner then attempts to move the heel and foot gently but firmly forward. This maneuver is considered positive when there is a palpable and visible anterior displacement of the foot. Examination of the talar tilt is performed by firmly adducting the heel and assessing for increased laxity or instability relative to the contralateral ankle. Although stress testing is a somewhat controversial tool for diagnosing instability, manual stress testing has been utilized for many years and is quick, simple, and requires no cost to perform.

Radiographic assessment should include standard views to rule out osseous pathologic conditions such as osteochondral lesions, occult fractures and so forth. Radiographic assessment of the foot and ankle will also reveal any underlying structural deformities (i.e. varus of the heel) that may contribute to lateral ankle instability.

Diagnostic tests including stress testing, arthrograms, tenograms, computed tomographic (CT) scans, scintigraphy, and MRI imagining may be considered for preoperative evaluation. Quantitative stress testing has been recommended for patients with complaints of pain and instability who have not responded to nonoperative care. These stress tests are performed with an anterior drawer and inversion stress maneuver. The anterior drawer maneuver is performed with the patient positioned on the affected side. The ankle is maintained in a plantarflexed position and a pressure bar is positioned 2 cm above the ankle joint anteriorly. A predetermined 15 kilopound force is applied. A measurement of anterior displacement of the talus within the ankle mortise is often taken and compared with the measurement on the contralateral ankle (Figure 1). The inversion maneuver is performed

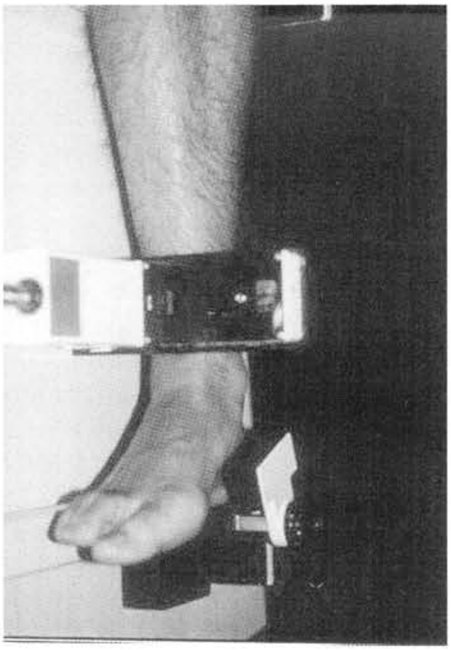

Figure 1A. Quantitative stress testing demonstrating anterior drawer maneuver.

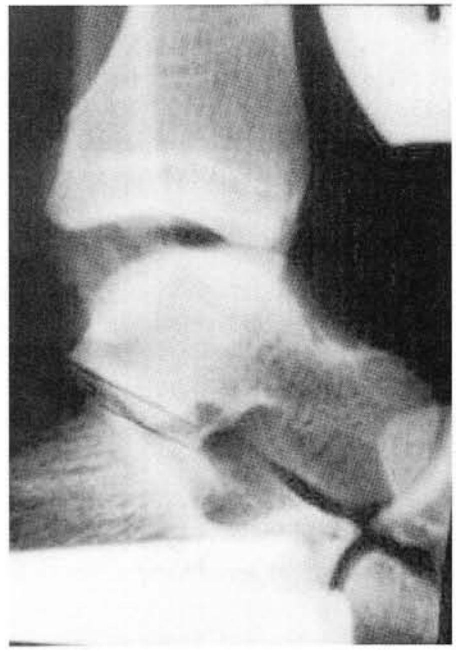

Figure 1B. Lateral radiograph of the ankle demonstrating anterior translation of the talus relative to the tibia.

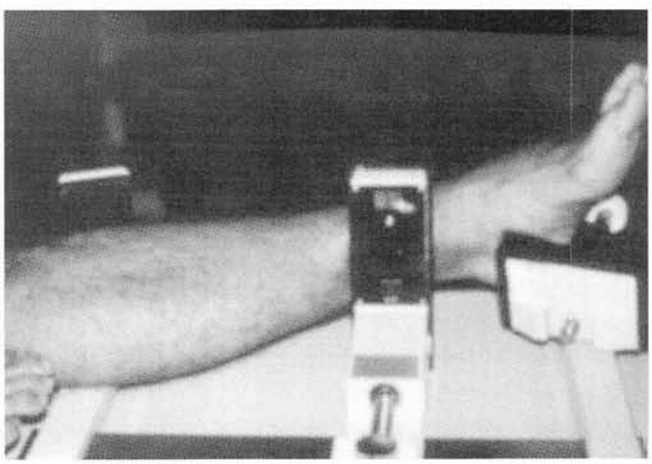

Figure 2A. Quantitative stress testing following the inversion maneuver.

Figure 2B. Anteroposterior (AP) radiograph of the ankle demonstrating talar tilt.

with the patient in a supine position. The leg is internally rotated 18 degrees and the knee is maintained in flexion. The ankle is placed in neutral position, and the pressure bar positioned 2m above the ankle medially. A predetermined 15 kilopound force if applied and a measurement of talar tilt within the ankle mortise is compared with the contralateral ankle (Figure 2). The use of quantified stress testing to assess lateral ankle instability remains controversial. The authors prefer to use the measurements recommended by Karlsson. A stress test is considered positive when the anterior drawer is greater than 10 mm and the talar tilt is greater than 90.[7]

INDICATIONS

Indications for surgical intervention include lack of response to nonoperative care, continued pain and giving way despite bracing. Patients presenting with mechanical instability indicated by a positive tress test are also candidates for surgical intervention. Various options are available for surgical reconstruction of the lateral collateral ligaments. The decision as to whether an anatomic reconstruction will suffice or a tenodesis procedure is necessary must be based on the patient's specific needs. The authors have found that anatomic reconstruction using regional tissue is usually sufficient. A tenodesis procedure should be considered for individuals weighing more than 225 pounds, when there is objective evidence of combined ATFL and CFL incompetence, or when previous anatomic reconstruction has failed.

Figure 3. Three-incisional approach to lateral ankle stabilization using the peroneus brevis tendon graft.

The possibility of subtalar joint instability must be assessed preoperatively to ensure that ankle joint ligament reconstruction or tenodesis will address the patient's symptoms and instability. Although a patient may have documented evidence of ankle joint instability, subtalar joint instability may exist in conjunction with ankle joint instability. Subtalar joint instability is difficult to evaluate. One can hold the foot dorsiflexed in the ankle joint mortise while conducting varus stress to assess the posterior subtalar joint. Subtalar joint instability can be assessed radiographically by placing the foot in neutral position with 30 degrees of internal rotation on the leg. The tube can be tilted 45° while varus stress is applied to the calcaneus. Unfortunately, measurements for stability testing of the subtalar joint have been difficult to reproduce. Brostrom suggested that the diagnosis of subtalar joint instability be considered when there is more than 5 mm of medial displacement of the talus relative to the calcaneus. He also describes subtalar joint instability as being present when talocalcaneal tilt is greater than 5°.[8]

SURGICAL TECHNIQUES

Various procedures have been recommended for surgical management of chronic ankle instability. Tendon transfers, capsulodesis, fasciodesis, grafting maneuvers, local tissue rearrangement and tenodesis have all been recommended as procedures for reconstruction of the lateral collateral ligament complex.

The authors prefer tenodesis when 1) lateral ankle instability has been present for longer than 10 years; 2) radiographs demonstrate impending degenerative joint disease within the ankle joint; 3) there is objective evidence of collateral ligament incompetence; or 4) there is a previously failed anatomic repair. Their preferred method is a modified Chrisman-Snook lateral ankle stabilization.[9]

This procedure is performed under general inhalation anesthesia with the patient in a lateral decubitus position. A pneumatic tight tourniquet is used for hemostasis. The procedure is performed through a three-incision approach (Figure 3). The anterior incision is started along the anterior aspect of the lateral malleolus and extends distally toward

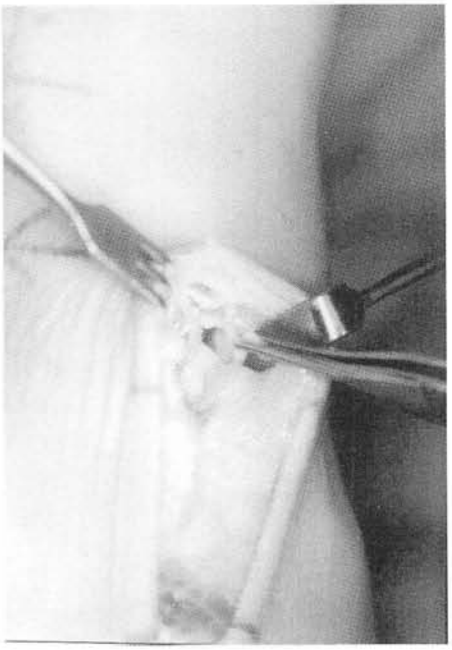

Figure 4. Dissection of the anterior lateral joint capsule permitting visualization of the talar dome.

Figure 5. Drill hole being developed from anterior to posterior through the lateral malleolus. This should approximate the level of the ankle joint.

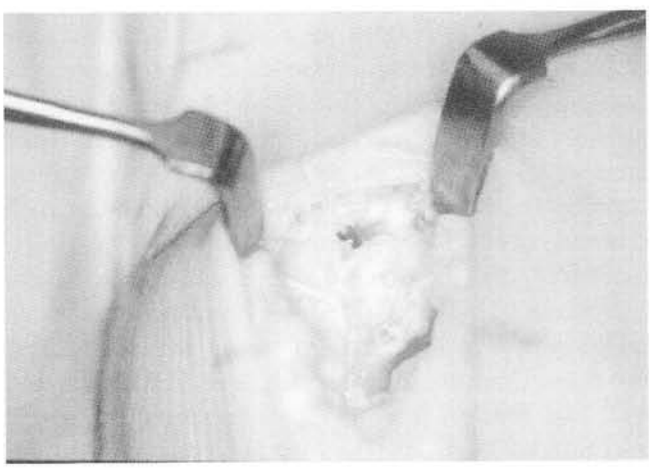

Figure 6. Anterior view of the osseous canal. this canal should be placed midline between the lateral and medial cortices of the lateral malleolus.

the fifth metatarsal base. This incision allows access to the anterior lateral aspect of the ankle joint, making it possible to inspect the dome of the talus for osteochondral lesions or other osseous pathologic conditions. The inferior aspect of the incision provides access to the distal portion of the peroneus brevis tendon.

The second incision is placed posterior starting along the inferior aspect of the lateral malleolus and extending proximally in a linear fashion. This incision gives access to the peroneus brevis muscle-tendon junction and the proximal portion of the tendon. The incision allows access to the posterior aspect of the lateral malleolus permitting visualization of the drill bit or rotary bur as the osseous canal is developed. The third incision is placed along the lateral aspect of the heel. This incision is placed vertically beneath the posterior facet of the subtalar joint paralleling the relaxed skin tension lines and allows access to the lateral calcaneal wall. The tendon is anchored to this area to simulate the anatomic location of the calcaneal fibular ligament and to provide subtalar joint stability.

The anterior incision is made, a capsular incision is performed and the ankle joint is inspected (Figure 4). The inferior portion of the posterior incision is then made and the peroneal tendons

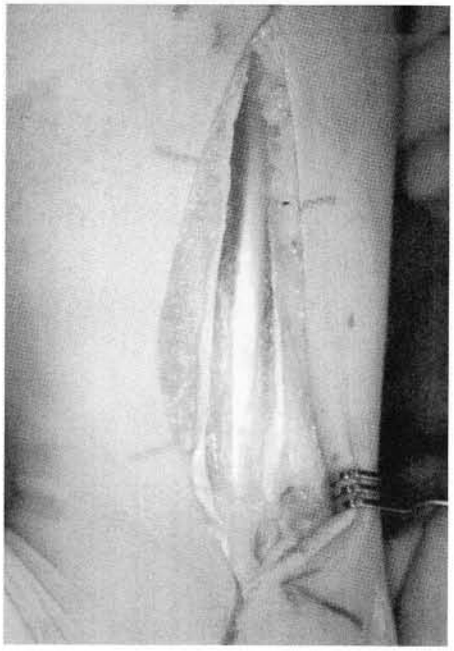

Figure 7A. Exposure of the peroneal tendons.

Figure 7B. Tubilization of the peroneus brevis tendon following harvest from the sheath.

are retracted. An osseous canal is developed from anterior to posterior with a drill or burr (Figure 5). The canal must be large enough to accommodate the entire tendon. The drill hole is made at the level of the ankle joint and placed directly in the central portion of the malleolus to avoid violating the ankle joint medially or the cortex laterally (Figure 6). Attention is then directed to the lateral aspect of the heel where the third incision is carried down to the lateral calcaneal wall, and the periosteal tissue is elevated in preparation for the tenodesis. The posterior incision is then extended proximally to the level of the peroneus brevis muscle belly. The peroneus brevis tendon is isolated with umbilical tape along the inferior aspect of the incision. Muscle tissue is removed from the peroneus brevis tendon as proximal as possible and the tendon is then incised from the muscle belly. The entire peroneus brevis tendon is harvested and tubulized with absorbable suture (Figure 7) Through the anterior incision, umbilical tape is placed around the distal portion of the peroneus brevis tendon and pulled form the tendon sheath in an anterior direction (Figure 8). A subperiosteal channel is then created along the anterior lateral aspect of the hindfoot. The tendon is passed from inferior to superior through this subperiosteal channel (Figure 9). The tendon is then passed from anterior to posterior through the fibular drill hole (Figure 10). The foot is dorsiflexed at 90 degrees and held in a neutral position. One must be careful not to overpronate the heel because overpronation might substantially decrease subtalar joint motion. The tendon is then sutured into the anterior aspect of the lateral malleolus with non-absorbable suture. A subperiosteal channel is then creased from the posterior aspect of the lateral malleolus to the lateral calcaneal wall of the calcaneus. The foot is maintained in the same position and a large barbed staple is placed along the lateral calcaneus to secure the tendon (Figure 11). The tendon is then flipped around the staple and tied to itself. The pneumatic thigh tourniquet is released and hemostasis is achieved. Closure is performed in layers.

The postoperative course consists of 4 weeks in a short-leg cast with patient on strict nonweightbearing. The patient begins weightbearing at 4 weeks in a rocker bottom brace for 2-3 weeks then progresses into standard footgear.

TECHNICAL CONTROVERSIES

The authors prefer to use the entire peroneus brevis tendon rather than splitting the tendon and using one half. St. Pierre et al have performed Cybex testing of patients following Evans tenodesis

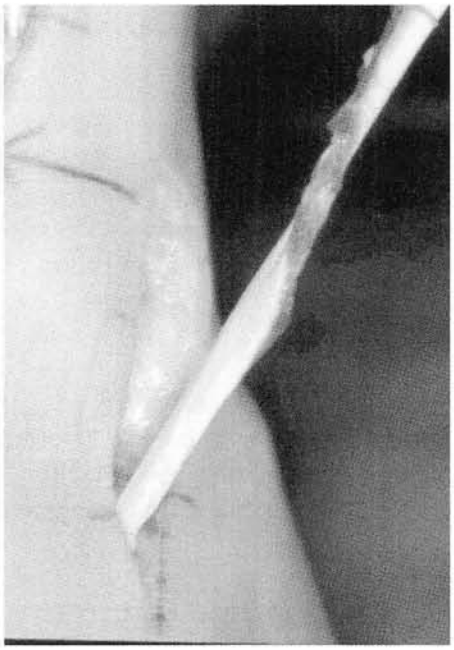

Figure 8A. The tendon graft has been pulled through the sheath and into the anterior incision.

Figure 8B. Assimilation of the course of the graft for tenodesis.

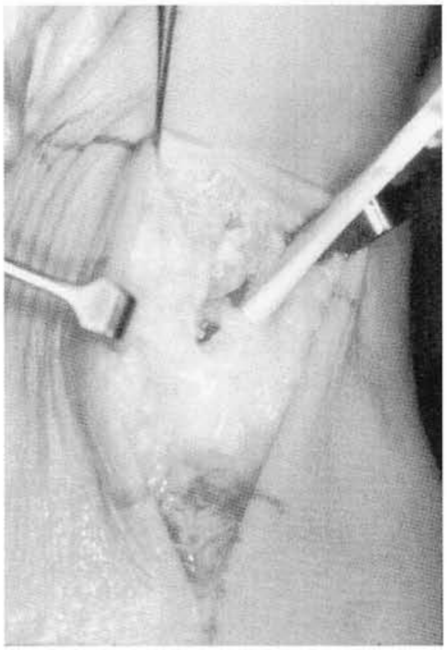

Figure 9. The tendon graft has been passed through the subperiosteal channel.

Figure 10. The tendon graft has been passed from anterior to posterior through the osseous canal in the fibula and is prepared to be passed through the subperiosteal channel to the lateral calcaneus.

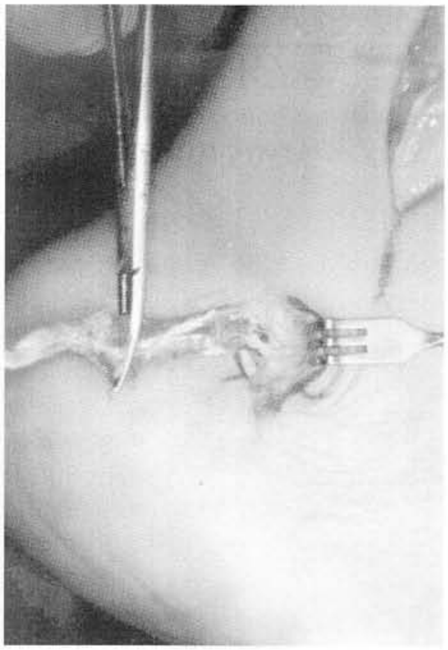

Figure 11. The tendon graft has been passed from the posterior aspect of the lateral malleolus to the lateral aspect of the calcaneus.

utilizing the entire peroneus brevis. Their testing demonstrated no significant loss of eversion, strength, or power when compared with the contralateral limb.[10]

The most difficult portion of the procedure is to determine the appropriate amount of graft tension. A graft that is too tight may significantly alter ankle joint and subtalar joint kinematics. Unfortunately, there is no measurement to assess intraoperative graft tension. Extreme tightness of the peroneal reconstruction can be an essential factor contributing to poor results. Tenodesis will increase intra-articular pressure in the subtalar joint. Overtightening should be considered a serious complication that must be avoided.[11,12]

The authors place the tendon directly onto the lateral calcaneal wall without any special preparation. One animal study evaluating tendon healing to cortical bone compared with healing to a cancellous trough demonstrated no significant advantage to the creation of trough to expose the tendon to cancellous bone.[13]

COMPLICATIONS

Complications following the procedure include sural nerve injury, restricted motion caused by non-isometric repair and pain at the drill hole site. Many of these complications result from overtighening during the tenodesis procedure. Therefore, strict attention must be given to graft tension during the procedure. The authors have seldom experienced sural nerve injury with a three-incision approach. Pain at the drill hole site usually resolves over 6 to 12 months. The restricted dorsiflexion is often beneficial for patients who have preoperative signs of degenerative joint disease. Decreased subtalar joint motion can be avoided by placing appropriate tension on the graft.

LITERATURE REVIEW

Several published studies have evaluated the effectiveness of tenodesis procedures for chronic lateral ankle instability. Korkala et al presented their long-term results using the Evans procedure for lateral instability of the ankle. They reported on 40 ankles followed for 9 to 12 years. Excellent or good results were reported in 83% of the patients. Functional results showed no positive correlation with stress radiographic analysis.[14]

Smith et al reviewed a modified Chrisman-Snook procedure for reconstruction of the lateral ligaments of the ankle. Their study included a retrospective review of 18 ankles. Average follow-up was three years. They described the modified Chrisman-Snook procedure as being a more anatomic repair than other lateral ankle stabilization procedures. Their procedure increased the stability of the ankle and subtalar joint and reduced talar tilt from 13.7 degrees to 2.3 degrees. Their results also demonstrated no reduction in eversion strength following the use of one half of the peroneus brevis tendon and no subtalar joint narrowing, subchondral sclerosis or marginal spurring after a 3-year follow-up.[15]

Therrmann et al described a treatment plan for chronic ankle and subtalar joint instability. In their view 223 patients, anatomic reconstruction utilizing regional tissue was performed in 102 patients, the Evans tenodesis procedure was performed in 97 patients and Chrisman-Snook procedure was performed in 34 patients. No patients in either treatment group had clinically significantly ankle instability. Ninety percent of the patients showed good or excellent results. Results of the 31 of the 34 Chrisman-Snook procedures were rated good or excellent.[16]

Rosenbaum et al performed a functional evaluation after modified Evans repair for chronic ankle instabity. Nineteen patients were reviewed with a follow-up of 10 years. Foot function, electromyogram, stress radiographs and gait analysis were performed. The authors believed that persistent clinical problems and functional changes indicate that the disturbed ankle joint kinematics have permanently altered foot function and may subsequently support the development of arthrosis.[12]

Sugimoto et al performed a long-term review of tenodesis of the ankle. This group evaluated 34 ankles that were followed for 10 to 14 years. This study reported excellent or good results. Progression of osteophytosis without joint pace narrowing was found in 18 ankles (69%). No relationship was found, however, between clinical results and radiographic changes. Also, results did not deteriorate over the long term.[17]

Becker et al reviewed outcomes after modified Watson-Jones tenodesis for ankle instability. They reported on 25 patients with a mean follow-up of 12 years. Good or excellent results were reported in 72% of the patients. There was no difference in plantar pressure distribution following surgery. The modified Watson-Jones tenodesis effectively corrected lateral ankle instability with no clinical deterioration over time and no influence on gait.[18]

Kitoaka et al compared acute repair and delayed reconstruction for lateral ankle instability. A 20 year follow-up study was performed. Forty-eight patients in the study had primary repair and 31 patients had delayed reconstruction. The clinical and radiographic results were similar in both groups.[19]

Sammarco presented a series of patients undergoing surgical revision after failed lateral ankle reconstruction. This review included 10 ankles with an average of 31 months follow-up. Seven tenodesis procedures and three modified Brostrom-Gould procedures were performed. Ninety percent of the patient returned to their previous functional levels. They emphasized the importance of assessing subtalar joint stability.[20]

SUMMARY

The goal of lateral ankle stabilization is restoration and stability without any functional deficit. Obviously, only anatomic reconstruction can prevent deficits in range of motion. As a result, motion loss is unavoidable with tenodesis procedures. Unfortunately, no procedures are available for anatomic reconstruction of subtalar joint instability Therefore, when there is objective evidence of subtalar joint instability, tenodesis procedures must be considered.

The authors believe that stability is more important than range of motion when degenerative changes are present within the ankle joint. Tenodesis results are good for the short term (less than 5 years) but may deteriorate over time (after more than 9 years). Some residual pain is common following tenodesis procedures.

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