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FOOT 1 ANKLE

Reconstruction for Subtalar Instability: A Review

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ABSTRACT
Instability of the subtalar joint has become a more well-defined clinical entity in recent years. While there have been several articles which have discussed diagnosis of this condition, there has been little written on the surgical treatment. Reconstructive techniques with which we have had experience are presented. Technical aspects of these methods are described in detail.

Recently there has been a resurgence of interest in subtalar instability.[2] Most reports have focused on the etiology end evaluation of this entity, but few have addressed reconstruction for the instability. In this light the authors rave undertaken cadaveric study and clinical evaluation of the various tendon transfer techniques. (Two of the following reconstructions are currently being investigated in clinical protocols.) Although it is not always necessary to resort to a tendon transfer to restore subtalar stability, in most cases these techniques are more reliab! tfian imbrication or repair This isparticularly true in the following situations: longstanding or severe instability, generalized ligamentous laxity, previous reconstruction/repair, or industrial injuries. In other circumstances imbrication of tne calcaneofibular ligament may be sufficient with or without augmentation by proximal transposition of the extensor digitorum brevis or by flapping down the distal fibula periosteum. ft is not our intention to advocate one repair over another, but to lacerate reproduction of the technique in an indicated clinical situation.

Except where otherwise noted these procedures should be performed in the supine position with a bolster under the patient's ipsilateral hip to provide sufficient internal rotation of the foot during the procedure. Even though it ts probably easier to perform these operations under general anesthesia (spinal or endotracheal), we have had good success performing these procedures with ankle Mocks and supplementary local anesthetic in the regions of the peroneal or planters tendons. Although most surgeons feet more comfortable operati with a tourniquet, we do not feel this is always necessary.

In all the procedures a lateral incision is made along the course of the peroneal tendons beginning proximal to the tip of the fibula and extending towards the base of the fifth metatarsal. Alternatively, when using the piantans tendon, an Ollier incision may be used (Fig. 1).

The sural nerve branches in the region of the fifth metatarsal and must be avoided. Blunt and sharp dissection are carried out through the subcutaneous tissue ana identity tne peroneal tendon sheaths, the calcaneofibular ligament, tne anterior talofibular ligament, the ridge between the need and dome of the talus, the cervical ligament, and the lateral wall of the calcaneus just distal to Gissane's angle (Fig. 2). It is often necessary to cut the inferior portions of the extensor retinaculum as they insert onto the calcaneus lateral to the cervical ligament. A small longitudinal incision in the peroneal sheath distal to the tip of the fibula we aid in identification of the calcaneofibular ligament. Occasionally a small anterolateral capsulotomy fa performed superior to the edge of the antenor talofibular igarnant to ensure that the bone tunnels do not oornprorraea the articular cartilage. At this point we recommend performing stress tests of tne subtalar joint, observing not oray the amount of gapping with inversion strew, but the amount of rotational instability (i.e., excessive sliding or anterior draw of the subtalar joint).

Strict attention to tendon gran ttngoi ts critical . J will obviate cornpromlaing the reconstruction. Following the harvesting of tne gran tne tendon should be wrapped in a saane soaked gauze to prevent desiccation.

After creating tne bony tunnels a hemostat and a curved curette should ensure a smooth unobstructed

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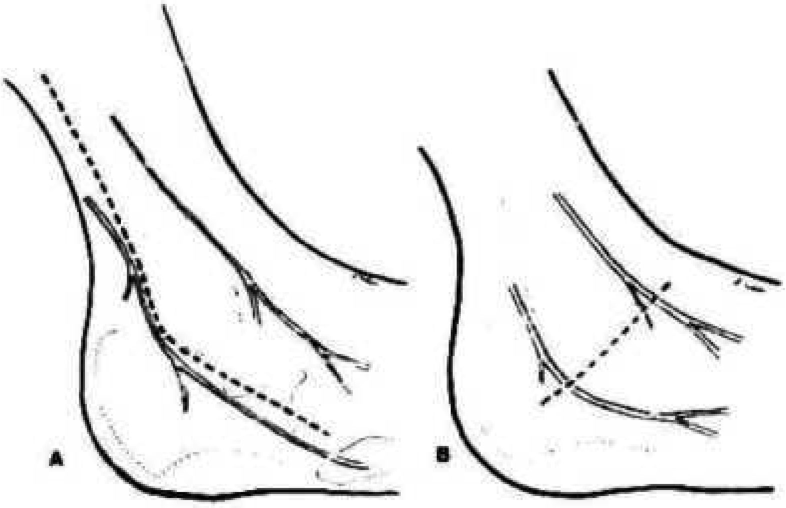
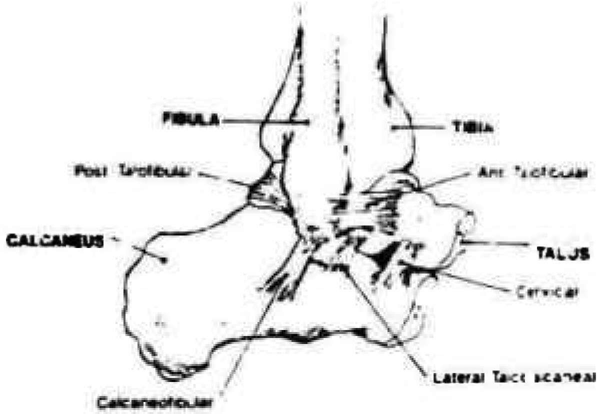


Fig. 1. *A*, Standard lateral rover, *B* Ollier incision.



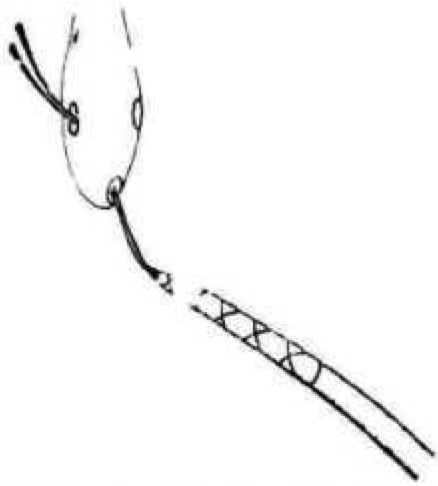


Fig. 3. The 'Chinese finger trap sutur e technique' diminishes fraying at the end of the tendon at it paaaaa through tfia bony channels.

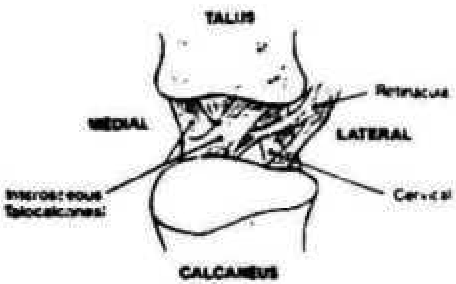


Fig. 2. Anatomy of the ankle (lateral view) and subtalar joint (posteroanterior view).

passageway. The bone holes - - - - - - - - - avoid sharp edges at the entranshould oe contoured to Tendcn routing can be facilitated and exit points. wire loop or a flexible ligament by using a 22-gauge finger trap suture' will eliminate passer. A "Chinese the tendon graft as it courses fraying of the end ot 3).[3] through the tunnels (Fig.

During the tendon routing the ankle and subtalar joints are held in the reduced position (aversion and external rotation). A bump of towels or sheets under the distal tibia prevents inadvertent anterior subluxation of the calcaneus. With each passage of the graft the slack is taken up prior to the next step. Once the procedure is complete each limb of the reconstruction is sutured to surrounding tissues. When possible the attenuated or torn ligaments should be repaired by imbrication. If necessary, the repairs may ba further fortified by proximally advancing the extensor digitorum brevis or by flapping down periosteal tissue from the fibula. The peroneal sheath should be closed to orevent subluxation of the tendons.

Postoperatively, the patients are placed in a short tag cast and are nonweight-bearing for approximately 3 weeks. After the second week sutures are removed and the cast is changed. An absorbable subcuticular suture may be used for closure so the cast can be changed at 3 weeks. From the third through the sixth week weight bearing in the cast is instituted. At 6 weeks a removable off-the-shelf ankle-foot orthosis is applied and the patients begin active assisted range of motion of the ankle and foot. Over the course of the next 6 weeks they are weaned from the brace whie no⁻mal activities are resumed.

LARSEN PROCEDURE[9]

A lateral incision is made beginning approximately 11 cm proximal to the tip of the distal fibula and ending at the base of the fifth metatarsal (Fig. 4). The entire peroneus brevis tendon is harvested and the remainder of the muscle beffy is sutured to the peroneus longus tendon. A minimum of 16 cm of tendon is needed for this reconstruction. The anterior portion of the peroneus brevis sheath is incised in the region overlying the extensor tfgrtorum brevis muscle to allow transposition of the peroneus brevis tendon anteriorly.

The first bone tunnel (tunnel A) is drifted from the superior edge of the fibular origin of (he anterior talofibular igarnant and is directed posteriorly to a point approximately 4 cm proximal to the tip of the distal fibula (hole 2). A 4.5 mm drill bit should be used. The second bone tunnel (tunnel B) begins at the inferior border of the antenor talofibular ligament (which is also the point of origin of the calcaneofibular ligament) and is deeded toward that same point, hole 2. The finn tunnel begins on the calcaneus at the attachment site of the calcaneofibular igarnant and is directed proximally and posteriorly, exiting at the superior aspect of the posterior tubercle of the os calcis.

Tendon routing is accomplished in the following manner. The entire peroneus brevis is brought into hole 1, passed through tunnel A, and out hole 2. Next, it is passed from hole 2, through tunnel B, and out hole 3.

Fig. 4. The Larsen procedure for ankle and subtalar instability uses the entire peroneus brevis.

The tendon is then passed from hole 3, underneath the peroneal tendons, into hole 4, and through tunnel C. The end of the tendon is secured into tne calcaneus with either a suture, a staple, or a Mitek/Statak (Mitek, Surgerical Products, Inc., Norwood, MA; Statak, Zimmer, Warsaw, IN) device (Fig. 5).

MODIFIED ELMSLIE REPAIR[1,6,7,10,11]

A lateral incision is made beginning 11 cm proximal to the tip of the distal fibula and extending towards the base of the fifth metatarsal (Fig. 6). The peroneus brevis muscle and tendon are identified, and the tendon is longitudinally split in half. If the tendon is thin, the entire tendon may be used. The harvested tendon once again should be approximately 16 cm long in order to perform the procedure.

The fibular bone tunnel is created using a 3.5 mm drill beginning above the origin of the antenor talofibular ligament and directed perpendicular to the midfibular axis, or sightly oblique in a proximal direction. It is necessary to aim the dm to a pint about 1 cm medial to the posterolateral edge of the fiUia to prevent peroneal subluxation. The calcaneal bone tunnel is made about 2.5 cm from the fibular tip inferior to the origin of the calcaneofibular ligament and straddāng the peroneal tubercle. A 4.5 mm dri bit is used to create the tunnel, which is 'V shaped in configuration. The two holes should be approximately 1.5 cm to 2 cm apart.

The tendon is first routed from the base of the fifth metatarsal through the fibular bone tunnel A. It, subsequently, travels deep to the peroneal tendons into hofe 3 and through calcaneal tunnel B. Once exiting hole 4, it courses superficial to the peroneal tendons and is reattached to the first fimb of the reconstruction as it enters into hole 1. Although most authors recommended suturing the first and the last limbs of the reconstruction to the anterior talofibular igament, Zwipp and Krettek[11] reattached the end of the graft to the first limb near the calcaneocuboid joint. Leech et al.* modified the procedure by evoking the calcaneal tunnels and attaching the graft to a trough in the calcaneus using a staple. Another variation by Snort, and Chrismar' recommended passing the posterior limb of the graft superficial to the peroneal tendons to prevent their subluxation.

THE TRILIGAMENTOUS RECONSTRUCTION USING THE PLANTARIS TENDON

After preparing to perform a procedure that requires harvesting the plantaris the surgeon should have an alternative method available if the plantaris tendon cannot be found (approximately 7% of cases) or is inade-

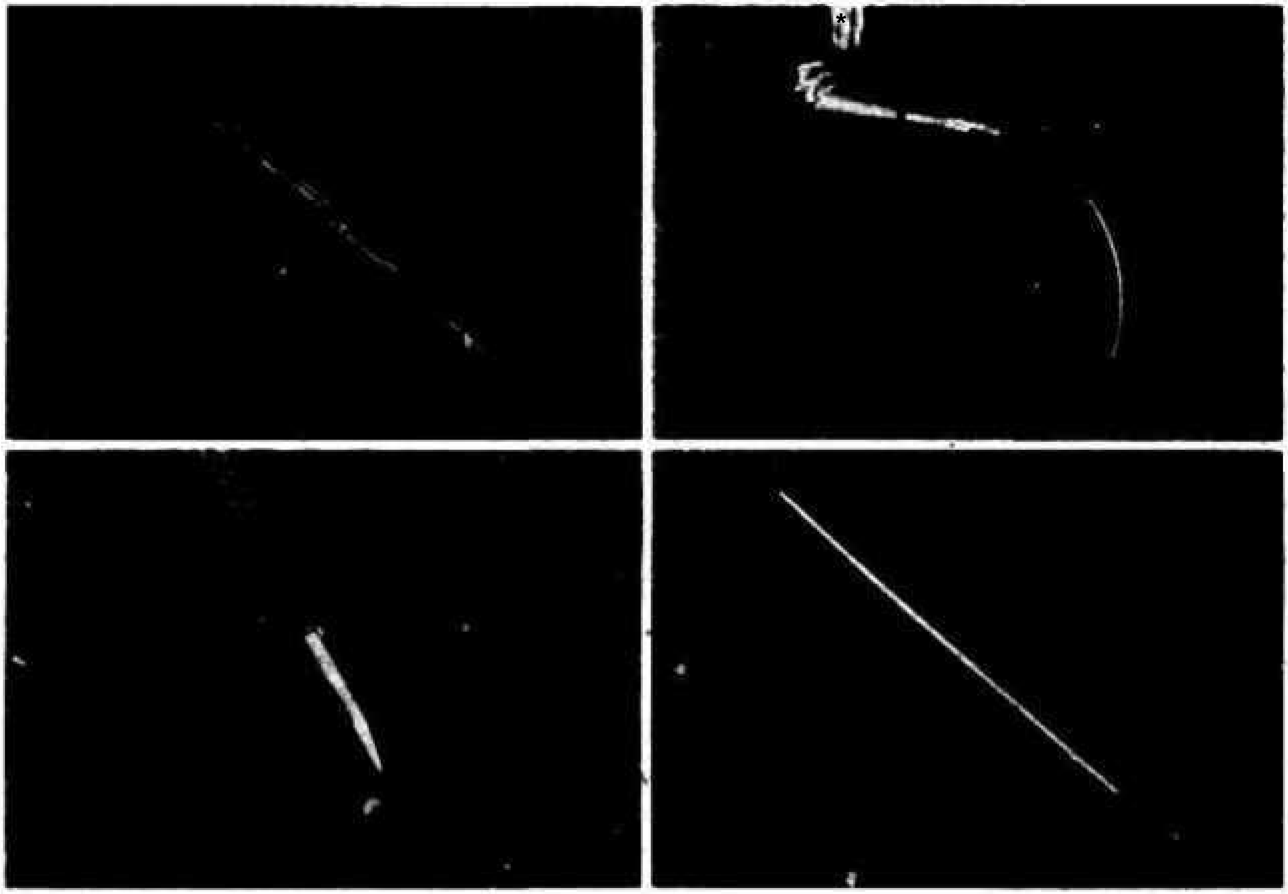


Fig. 5. A, B, Mitek staple. C, D Statak device.

Fig. 6. The modified Elmslie procedure for subtalar instability with or without ankle instability uses all or one half of the peroneus brevis.

quate. Storen* and Soldheim et al.* recommended using the medial third of the tendo Achätes for this procedure.

To facilitate exposure a bolster should be placed under the ipsiateral hip to permit adequate internal rotation without limiting the external rotation required to harvest the plantaris medially.

A 4 to 5 cm longitudinal incision is made beginning approximatefy 10 cm distal to the tibial tubercle and 3 cm posterior to the posterior medial border of the tibia (Fig. 7). The plantaris tendon fa located between the gastrocnemius and the soleus. Care shoul' be taken to avoid the saphenous nerve end vein that lie superfidel to the muscles. The plantaris tendon is usually about 5 mm wide and may be palpated with a probing finger in the intermuscular interval. Once it fa identified a clamp is placed on this end and it is cut proximally. The graft should measure 32 to 34 cm for performing the triligamentous reconstruction. Next a 3-cm distal incision is made at the supenor border of the os calcis paraaeang the medial border of the tendo Achilles. By pulling the proximal end of the tendon, the distal end can be found. Using a Brandt tendon stripper proceeding from proximaJly to distally the tendon is harvested. This must be performed in a gentle fashion to avoid rupturing the plantaris. When an obstruction is encountered during stripping, a small incision is made to free the graft. If no such tendon stripper is available, the tendon can be released from surrounding tissues with gen tle blunt dissection through several smai incisions along its course.

Once the tendon is deivered from the distal wound, the leg is internally rotated to approach the lateral aspect of the ankle. The length of the lateral incision is about 15 cm beginning approximately 6 to 7 cm proximal to the tip of the fibula and extending towvd the base of the fifth metatarsal.

After the lateral landmarks are exposed, as described in the general comments section, the bone tunnels can be created. The starting point of the first calcaneal bone tunnel (A) is based at the insertion of the calcaneal fibular ligament. Traveling 4 cm along an imaginary ane from the tip of the fibuie to the posterior inferior heel, one locates the point for starting hole 1 Using a long 35-mm drill bit the tunnel is created from this point to a point along the superior medial border of the posterior calcaneal tuberosity.

The fibular tunnels are also created with a 35 mm drill bit. A unicortical hole (3) should be made through the lateral cortex of the fibula approximately 2 cm proxrnal to the distal tip of the fibula and *2* cm posterior to the anterior border of the fibula, hole 2. Next, tunnel B is made from the anterior distal tip of the fibula (hole 2) at the origin of the calcaneofibular igament and directed towards hofe 3. Then tunnel C is created beginning at the anterior superior border of the anterior talofibular igament and also directed towards hofe 3.

In order to create the "V" shaped talar tunnel the talar ridge must be identified The first taiar hofe (5) is drilled from dorsal to plantar aiming sightly medially using a 3.5-mm drill bit. Then the plantar hole (6) is [illegible] made inferior to tne talar noge directed dorsomedially The starting point of the final calcaneal tunnel (hole 8) rs located on the lateral waft of the calcaneus, plantar to Gissane s angle The tunnel is drilled from this cortex aiming towards the calcaneal origin of the cervical ligament, hole 7.

The plan tans tendon is routed from the medial aspect of the calcaneus through tunnel A. out hole 1. Next using a hemostat, the graft is passed underneath the peroneal tendons into hofe 2. It courses through tunnel B and out hofe 3. The tendon is then passed back in through bote 3 through tunnel C, and out hole 4. The plantaris courses from hofe 4 to hole 5. and through tunnel D out hole 6. From hofe 6 ft courses through to hole 7 through tunnel E, and out hole 8. The tendon la passed from hole R rito bote 6 end through tunnel D. out hole 5. beck into hole 4, through tunnel C. and out hole 3. Then it goes beck in through hole 3 coursing through tunnel B out hole 2 and into hole 1. running underneath the peroneal tendons. Finally, the tendon courses through tunnel A and is secured to the tissues along the posterior medial aspect of the os calcis or to itself.

TRILIGAMENTOUS RECONSTRUCTION USING THE PERONEUS BREVIS TENDON

This procedure may be performed when the plantaris tendon is insufficient or unobtainable. Essentially, the same procedure as described for the plantaris reconstruction is utilized An incision over the peroneal tendons is made approximately 15 cm proximal to the tip of the distal fibula in order to harvest 20 cm of tendon required for the procedure. The peroneus brevis (half or whole) is removed from its sheath and delivered Into the distal wound (Fig. 8).

[illegible] The drill holes are made as described for the plantaris triligamentous reconstruction wan tne following exceptions Tunnel E should be drilled from a more distal

Fig. 7. The triligamentous procedure for subtalar instability with or without ankle instability using the plantaris tendon.

Fig. 8. The triligamentous procedure using the peroneus brevis.

starting point on the calcaneus, closer in line with the course of the peroneus brevis tendon. Tunnel A is created by drilling from hole 8 in an oblique and distal direction towards hole 2. Finally, all the tunnels should be made with a 3.5 mm or 4.5 mm drill bit depending on the thickness of the graft.

The tendon is routed from the base of the fifth metatarsal into hole 1 through tunnel E. out hofe 2. Then, through tunnel 0. out hole 4, into hole 5, through tunnelC, and out hole 6. Next, the tendon is reinserted into hole 6, through tunnel B, out hole 7. passed underneath the peroneal tendons and into hole 8. Finally, the tendon is passed through tunnel A and attached to itself and surrounding soft tissue.

ANATOMIC RECONSTRUCTION OF THE CERVICAL LIGAMENT

This procedure is advocated for patients with mild subtalar instability. A lateral longitudinal incision is made beginning approximately 5 cm above the tip of the distal fibula extending toward the fifth metatarsal base for 6 cm (Fig. 9). Half of the peroneus brevis is made beginning approximately 5 cm above the tip of the distal fibula extending toward the fifth metatarsal base for 6 cm. Haff of the peroneus brevis is harvested and removed from its sheath. Approximately 10 cm of graft is required for this procedure.

The calcaneus bone tunnel is drifted from a starting point just dorsal to the peroneal sheaths, about 15 mm inferior to the superior edge of the calcaneus, and approximately 7 mm proximal to the calcaneocuboid joint. The hofe begins in the lateral wall of the calcaneus and is directed obliquely in a superior, medal and posterior fashion towards the calcaneal origin of the cervical ligament (tunnel A). Using a 3.5-drill bit, a "V" shaped tunnel is creeled around the talar ridge as described previously.

The tendon is passed from the base of the fifth metatarsal into hole 1 through tunnel A, out hole 2, and into hole 3, recreating the cervical ligament. Then, ft passes through tunnel B, out hole 4, and fa sutured to itself.

CONCLUSIONS

The Larser procedure uses the entire peroneus brevis in a partiaty anatomic reconstruction of the subtalar ligaments. The portion of the reconstruction from the base of the peroneus brevis to the fibula acts as a nonanatomic checkrein which controls Inversion. Although the procedure is technically eesy to perform, securing the end of the tendon into the calcaneal bone tunnel may pose some difficulties. Trie step has been made easier by the recent introduction of the Mitek / Statak devices.

The modified Elmslie procedure acts as a CTVJOUWI to instability of the subtalar joint. The procedure is relatively uncomplicated, but is moderately difficult to perform. Preserving half of the peroneus brevis tendon permits adequate graft for reconstruction without completety compromising the function of this muscle. Interestingly, the original procedure described by Elmslie used a free graft of fascia lata and is quite different from its subsequent modifications[3] (Fig. 10)

The triligamentous procedure reconstructs the calcaneofibular, anterior talofibular, and cervical ligaments in a near anatomic fashion resulting in stability without compromise of functional range of motion of the ankle or subtalar joints. Using the plantaris tendon avoids sacrificing the peroneus brevis and preserves a muscle that plays a role in proprioceptive stability of the ankle and subtalar joint. Nonetheless, there are some prob-

Fig. 9. The anatomic reconstruction of the cervical ligament using one half of the peroneus brevis is indicated for cases with mild or moderate subtalar instability without ankle instability.

Fig. 10. The original Elmslie procedure described a fairly anatomic reconstruction of the calcaneofibular and anterior talofibular ligaments using a rolled fascia lata graft

lems in relying on the plantaris. The plantaris tendon is occasionally difficult to find especially for those unfamiliar with its anatomy. Often extra medial incisions are required when the tendon stripper meets obstructions. Excessive force when harvesting the tendon wis typicafty feed to rupture. Sometimes the tendon is too fragile for reconstructive purposes. Finally, this procedure requires several more incisions than the others and may not be cosmetically suitable to the patient.

The anatomic reconstruction of the cervical igament provides a relatively easy, technically uncomplicated procedure for mild or moderate subtalar instability. The major benefit of this procedure is that the range of motion of the ankle join: is not impaired. In cases with severe subtalar instability without ankle instability, we have found it necessary to loop the tendon through a bone tunnel beginning dorsal to the talar ridge and ending in the body of the talus along the inferior lateral edge of the insertion of the anterior talofibular ligament. This provides more of a nonanatomical check rein to subtalar instability and may restrict motion.

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