

TECHNICAL NOTE

Anatomic Spring Ligament and Posterior Tibial Tendon Reconstruction: New Concept of Double Bundle PTT and a Novel Technique for Spring Ligament

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Received: 01 April 2017

Accepted: 29 April 2017

Abstract

A new technique in spring ligament reconstruction using medial half of posterior tibial tendon is demonstrated as a means of supporting the arch. In addition a new concept of double bundle PTT reconstruction based on anatomical attachments of original PTT is presented with the goal of obtaining the full function of PTT.

Keywords: Anatomic, Posterior tibial tendon reconstruction, Spring ligament, Technique

Introduction

Calcaneonavicular ligament, known as spring ligament, is part of the acetabulum pedis, which transfers body weight to the midfoot. Functionality of this acetabulum needs proper anatomy and work of all components consisting of anterior and middle facets of calcaneus, plantar spring ligaments, and navicular articular surface [Figure 1B]. Spring ligament is also the main static support for medial longitudinal arch, which works in accordance with dynamic structures including posterior tibialis tendon. This ligament consists of three main bundles (superomedial, inferomedial, and inferocentral) with attachments to superficial deltoid ligament (1). Spring ligament attenuation has been reported in 81% of posterior tibial tendon (PTT) deficiency cases (2). Mann believed that in reconstructions for PTT deficiency, spring ligament plication is not associated with improved results, which emphasized the importance of reconstruction (3).

Among all options for spring ligament reconstruction, peroneus longus (PL) tenodesis technique became popular although it is technically demanding with some donor site morbidity. Comparing these techniques to the original ligament anatomy, no one

is a true anatomic reconstruction (4-6). In spite of new trends toward internal bracing in spring ligament augmentation, it does not substitute the ligament because the spring ligament is an intra-articular fibrocartilage structure (4, 6).

The main three branches of posterior tibial tendon are medial bundle attached to the navicular tuberosity, central bundle attached to the plantar surface of all 3 cuneiforms, cuboid, and base of the 2nd, 3rd, and 4th metatarsals, and third direct bundle attached to sustentaculum tali of calcaneus [Figures 1A; 2]. All attachments together guarantee full function of this tendon. Firing of posterior tibialis muscle in the third rocker pulls the heel into varus position (navicular and sustentacular attachments) and locks the foot arch while tensioning the central plantar attachments. Improper function of this tendon and subsequently spring ligament leads to collapse of the arch, and a hyperpronated abducted foot.

It is compelling that PTT reconstruction is an inseparable part of adult flexible flat foot correction surgery with some evidence supporting transfer of flexor digitorum longus (FDL) and flexor hallucis longus (FHL) to posterior tibialis tendon (7-12). To the best

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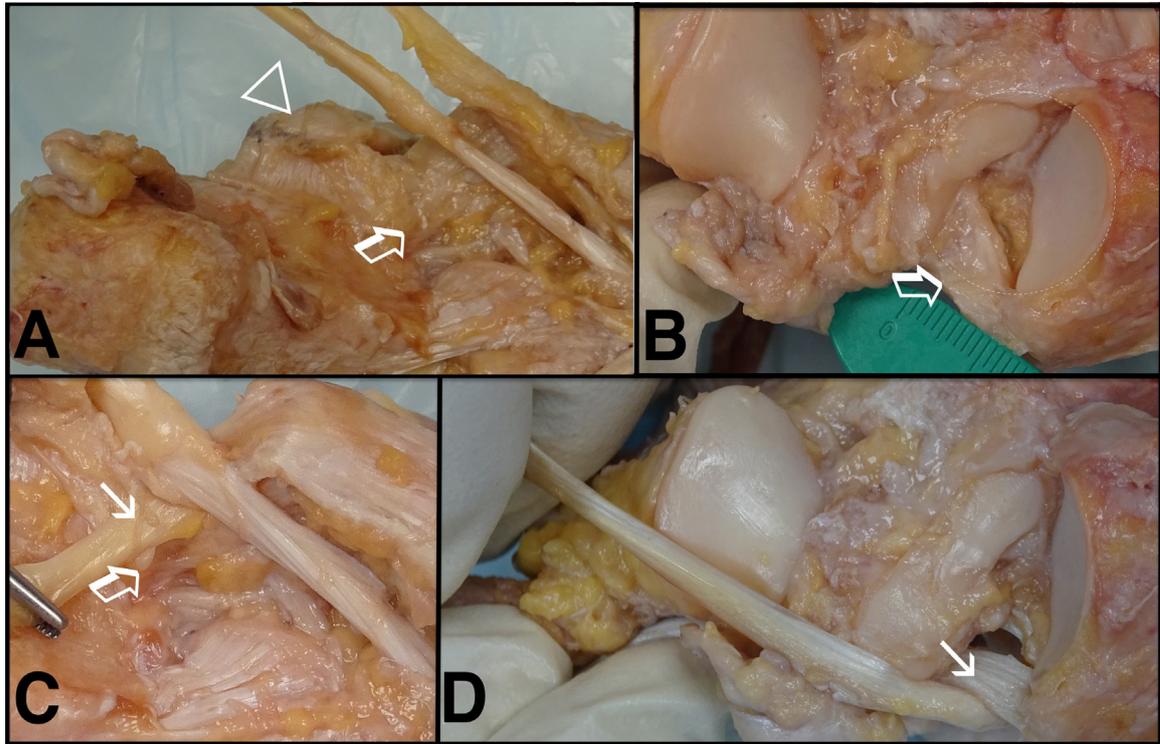


Figure 1. A, plantar view of two main bundles of PTT. B, dorsal view showing main bundle of spring ligament. C, demonstration of SM (superomedial) and IM (inferomedial) bundles of spring ligament comparing to its reconstructed position using medial half of PTT. D, dorsal view of reconstructed spring ligament. (large arrow shows original spring, arrow head is sustentaculum and small arrow is going to be reconstructed spring ligament).

of our knowledge, existing reconstruction techniques only restore the main navicular attachment of PTT, and few surgeons might preserve the native PTT in place hoping to restore the function of all attachments. Moreover, we did not find any prior work introducing the concept to appreciate the main lateral bundle of this ligament.

In this paper, we are going to introduce a novel technique in reconstruction of the spring ligament along with the new concept of simultaneous double bundle PTT reconstruction, which helps achieve a more functional and anatomic PTT in compare to the conventional single bundle technique [Figure 2-4].

Technical note

We followed the standard reconstruction technique for a flexible flat foot using medial displacement or lateral lengthening calcaneal osteotomy with FDL transfer to navicular tuberosity. In patients with partial function of the PTT, medial incision is made just inferior to medial malleolus and extends distally for 3cm toward the navicular tuberosity [Figure 6A]. PTT sheath is then opened. Touch the inferior surface of the medial cuneiform with a blunt trochar. This is

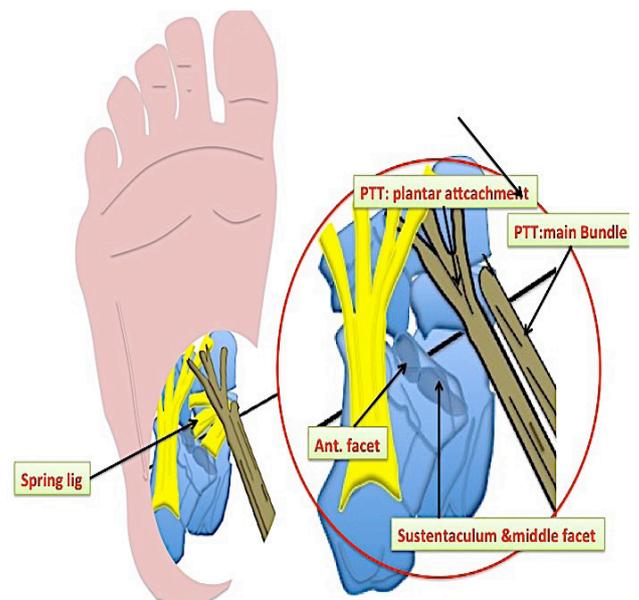


Figure 2. Plantar medial view of schematic spring ligament and PTT. Main medial bundle of PTT is separated from the rest, distal to proximal with medial cuneiform as starting point.

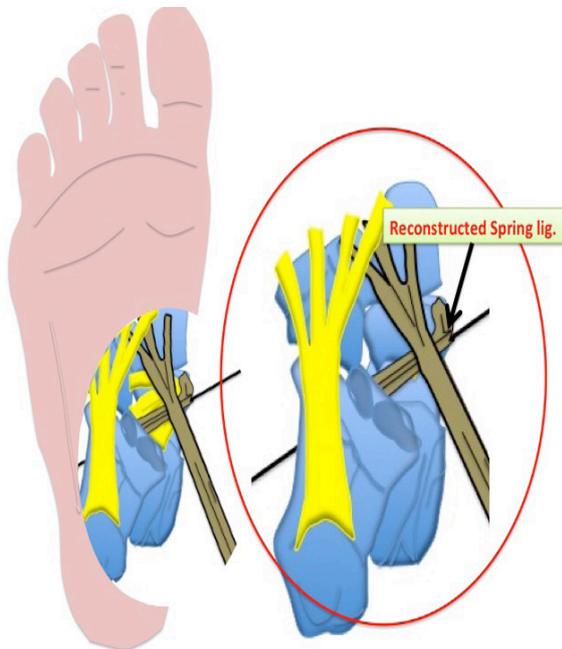


Figure 3. Schematic plantar view, demonstrating reconstruction of main SM and IM bundles of spring ligament using medial half of PTT. Its anatomic insertion in calcaneus is between anterior and middle facet.

where the PTT splits to 2 separate branches [Figure 6B].

After opening this space with a No.15 blade, split the PTT proximally for 3cm. Detach and free the medial band as shown in the image [Figure 6c]. Release the lateral band off of the navicular for later tensioning.

The spring ligament is sometimes visible after retracting the medial half of the PTT. This ligament can be loose especially after lateral column lengthening [Figure 6d].

The next step is anatomic canal placement. Put the guide wire over the sustentaculum tali and advance it one centimeter distally where it is located between the middle and anterior facets of calcaneus [Figures 3; 4]. With a power drill, insert the wire from medial to lateral and incline 10 degrees inferiorly to avoid the articular surfaces. It can also be directed distal to proximal with an angle of 20 to 30 degrees in case a lateral column lengthening is not planned [Figure 6E]. If a calcaneal lengthening is planned, a lateral approach and a Evans or Hintermann type calcaneal osteotomy is recommended just next to proposed spring ligament trajectory. After wards, ream the canal over the guide wire with a 3.2 mm drill bit. Suture the detached medial bundle with a modified Kessler technique using Vicryl No. 2/0, [Figure 6G]. A classical FDL transfer is being performed into the navicular tuberosity. Figure 5 aims to show a schematic view of this whole technique.

Tensioning of the ligament will be done after fixation of all calcaneal osteotomies. First apply tension on the reconstructed spring ligament with a tenodesis screw, and then tension and fix the transferred FDL. In this later step tension is applied to the lateral bundle of the PTT to tighten the plantar structures of the foot.

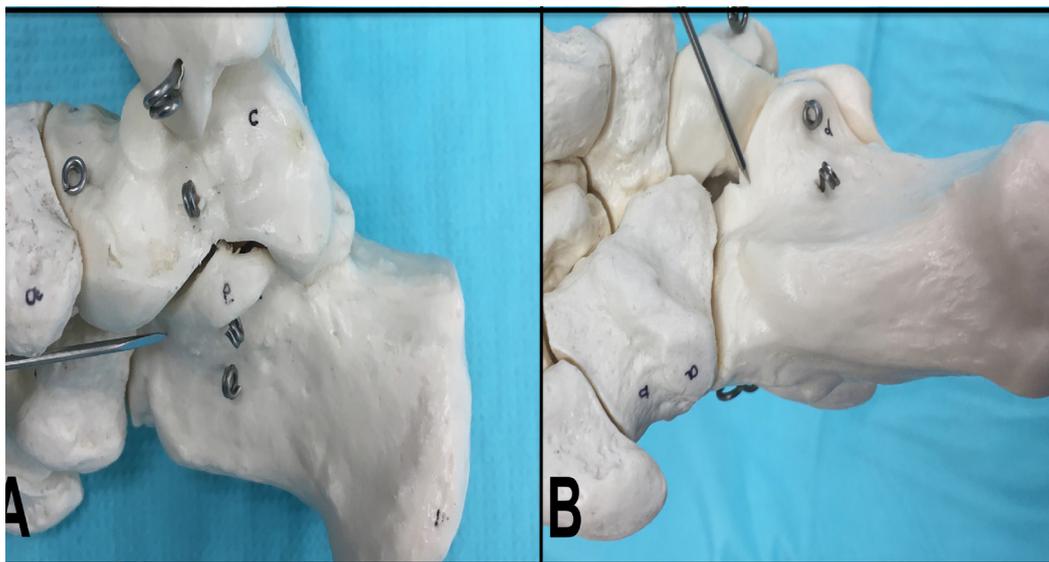


Figure 4. A and B, starting point for anatomic canal placement in spring ligament reconstruction. The canal trajectory is 10-degree plantar and proximal ward aiming peroneal tuberosity. Adjustment applies in case of lateral column lengthening procedure.

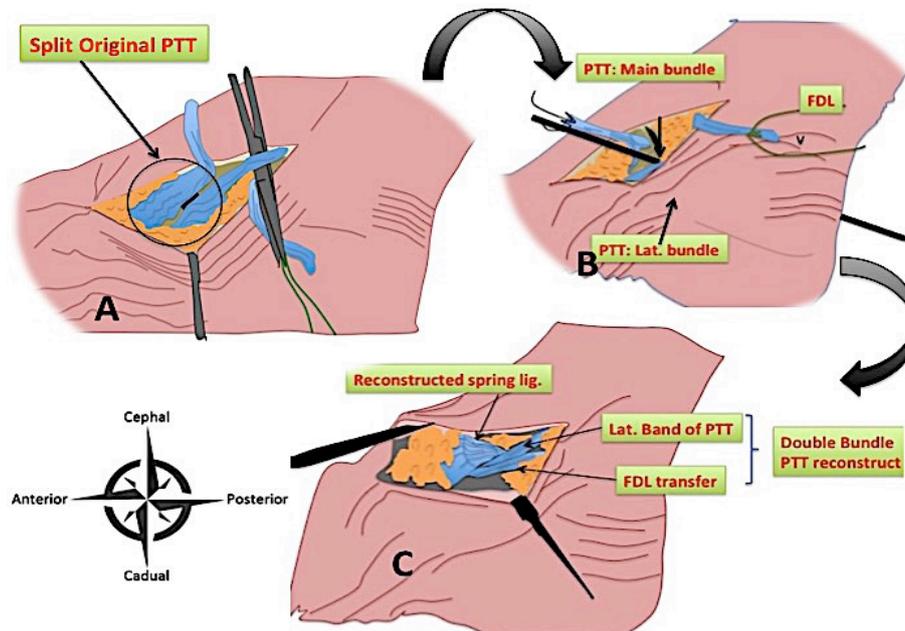


Figure 5. Schematic view of spring ligament reconstruction and novel concept of double bundle PTT reconstruction, the aim is restoration of dynamic central tension of this tendon.

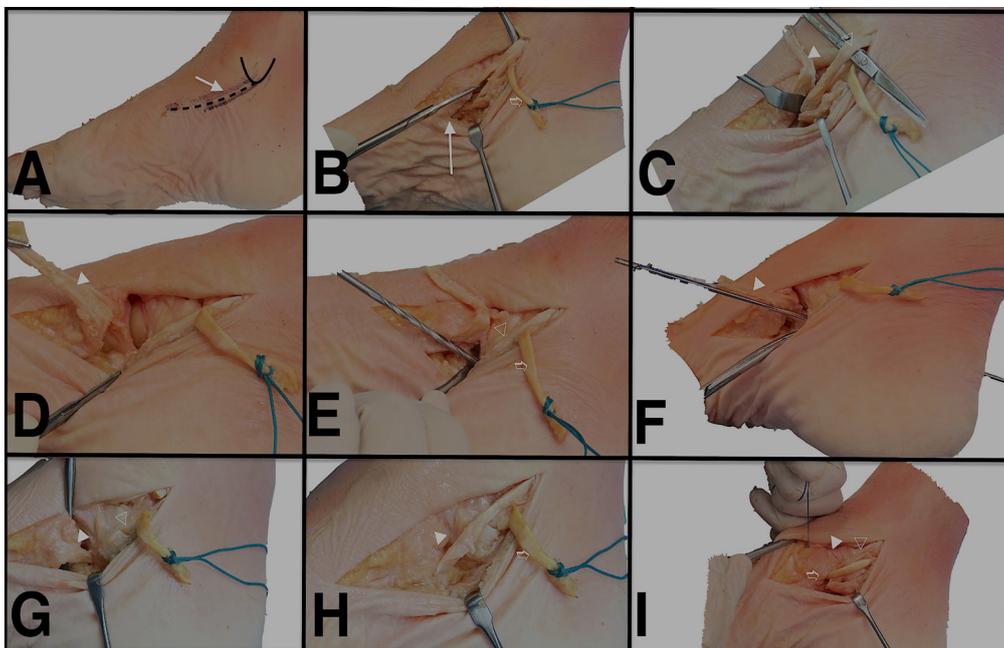


Figure 6. A. 4 cm medial incision from medial malleolus tip toward navicular tuberosity, B. finding anatomic separation between two main branches of PTT on the plantar surface of middle cuneiform with a blunt trocar and then bisecting the tendon in half with 4 cm length, C. leave lateral branch of PTT intact and detach the medial bundle (white arrow head), D. you can see native spring ligament and its trajectory in this view. E. Find sustentaculum, slip the guide wire 1 cm distally, then insert guide wire and rim it medial to lateral, 20 degree anteriorly and slightly inferiorly with 3.2 mm cannulated drill, F. pass the tendon using slotted guide wire, G & H, tension the detached bundle of PTT through the canal, this tension will nicely reduce the talar head coronally and sagittally both, Drill the conventional navicular canal and pass the detached FDL to it and tension it, finally under tension to lateral bundle of original bundle of PTT, repair it to FDL as the second bundle of PTT (with this reconstruction both bundles of original PTT will be restored).

Under this tension a side-to-side repair will be done between FDL and PTT.

Discussion

In this novel modified technique, we tried to reach to a near anatomical position and function of both the spring ligament and PTT based on appreciating their anatomical attachments. The limitation of this technique is in cases of sever PTT degeneration. A biomechanical assessment of this reconstruction is suggested, which is under investigation.

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