Anatomic Percutaneous Ankle Reconstruction of Lateral Ligaments (A Percutaneous Anti ROLL)

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Introduction

Ankle stabilization is required when a patient has ankle instability following an injury or deformity that causes pain and functional problems such as recurrent giving way. If non-operative treatments fail then surgical treatment may be required to improve patient pain and function.

Surgical options include both repair and reconstruction techniques. Repair techniques utilize pre-existing ligament remnants that are either repaired or tightened to improve stability of the ankle. If pre-existing ligament structures have been damaged beyond repair or are insufficient to allow repair then surgeons will choose a reconstructive technique.

In this demonstration we describe a new technique for ankle reconstruction of the lateral ligaments. The Percutaneous Ankle Reconstruction of the Lateral Ligaments "P-Anti RoLL" is a technique that is done percutaneous using fluoroscopic guidance. The advantage of the P-Anti RoLL technique is that it does not require ankle arthroscopy and as such the procedure is faster and not technically demanding to perform. Further,
Surgical Technique

**General pre-operative technique considerations:** Prior to surgery the surgeon should determine whether an arthroscopic procedure as well as the reconstruction of the lateral ligaments is necessary. We would recommend standard ankle arthroscopy with an ankle stabilization procedure to treat any associated ankle pathology. However, the Percutaneous Anti RoLL technique does not require arthroscopy to reconstruct the ankle lateral ligaments.

**Landmark drawing, portal placement:** The anatomic landmarks should always be drawn on the patient’s skin prior to anesthesia when patient is awake and able to voluntarily contract muscular landmarks. The bony landmarks are drawn including the distal edge of the tibial plafond, the lateral and medial malleoli. We recommend Fluoroscopy to verify these landmarks are accurate prior to commencing surgery.

**Patient positioning**
If standard ankle arthroscopy is to be performed concurrent with ankle stabilization the patient is positioned lateral with support under the knee to allow room for access to anteromedial portal and room for percutaneous portal guide wire insertion. The sterile noninvasive ankle distractor with strain gage monitor are then attached to the ankle harness. Distraction is not necessary for Percutaneous Anti-ROLL.

**Ankle Joint Access through Arthroscopic Portals**

**Constructing the Anatomic Y-Graft for Ankle Anti-ROLL**
The surgeon and patient may choose an autograft (e.g. gracilis tendon) harvested from the patients ipsilateral knee using a tendon harvester or an allograft of sufficient size.
(approximately 135 mm length) and strength for the reconstruction of the ATFL and CFL. The graft is prepared in an anatomic “Y” configuration with graft loops at all three ends of the anatomic Y-graft to facilitate attachment of a suture for graft delivery (Figure 1). The base or fibular anchor site of the Y-graft is constructed by doubling the graft to a length of 15 mm. The calcaneal limb of the Y-graft is constructed to a total length of 55 mm with the most distal 15 mm doubled to form the calcaneal bone tunnel anchor site. The talar limb of the Y-graft is constructed to a total length of 30 mm with the most distal 15 mm doubled to form the talar bone tunnel anchor site.

**Construction of the Anti-Roll Bone tunnels**

The description of the interference screw technique to secure the anatomic Y-graft described below is not technically demanding using the percutaneous technique. However, construction of the 3 bone tunnels required to accept the Y-graft and interference screws will require fluoroscopic guided passage of a guide wire through the recipient bone. It is essential that local neurovascular structures and tendons are protected when employing these techniques to avoid the complications.

**Fibular Bone Tunnel** (Figure 2) - The fibular bone tunnel is constructed to serve as the docking site for the fibular stem of the anatomic Y-graft. A guide wire is inserted percutaneously to penetrate the distal tip of the fibula between the origin sites of the ATFL and CFL ligaments. The guide wire is directed to exit the posterior cortex of the fibula at a point that is 4cm proximally and posteriorly from the tip if the distal end of the fibula. Care is taken to pass the guide wire through the central portion of the Fibula in the coronal axis prevent fracture with over drilling. The guide pin is passed though the skin posterior to the fibula taking care not to damage the Sural nerve or peroneal tendons. Over drilling is then performed to a diameter of 6mm and a depth of 20mm

**Talar Bone Tunnel** (Figure 3) - The talar bone tunnel is constructed to serve as the docking site for the talar stem of the anatomic Y-graft. A guide wire is inserted percutaneously to penetrate the talus at the insertion site of the ATFL. Fluoroscopic guidance should be used to confirm this position which is located directly above the sinus tarsi where the anterior edge if the talar dome meets the neck if the talus midway
between the superior and inferior surface of the talus. The guide wire is directed towards a point 1cm anterior and 1 cm distal to the tip of the distal end of the medial malleolus. Care is taken to pass the guide wire through the anterocentral body of the talus to prevent fracture or penetration of the anterior and superior surfaces of the talus. The guide pin is passed though the medial wall of the talus and then through the skin taking great care not to damage the tibial neurovascular bundle. Over drilling is performed to a diameter of 6 mm and a depth of 20 mm.

**Calcaneal Bone Tunnel** - The calcaneal bone tunnel is constructed to serve as the docking site for the calcaneal stem of the anatomic Y-graft (Figure 4). A guide wire is inserted percutaneously to penetrate the calcaneus at the insertion site of the CFL. Fluoroscopic guidance should be used to confirm this position which is located approximately 15mm posterior to the anterior edge of the posterior facet and about 10mm inferior to the joint line. A guide wire is used to penetrate the calcaneal insertion site of the CFL and directed towards the central posteromedial cortex of the calcaneus taking great care not to damage the tibial neurovascular bundle posterior to the medial malleolus. The guide pin is then over drilled to a diameter of 6 mm and a depth of 30 mm.

**Delivery and fixation of the anatomic Y-graft to the bone tunnels**

All three stems of the Anatomic y-graft are delivered through the Y-Graft delivery site made with a 1 cm incision in the vertical plane directly over the previously determine site of Fibula bone tunnel guide wire insertion site between the 2 origin points of the ATFL & CFL using inside-out technique (Figure 5.).

First the sutures passing through fibular stem loop of the graft are attached to guide wire which is then passed through the Y-graft delivery site and then the fibular tunnel. Similarly, the sutures passing through talar and calcaneal stem loops are attached to a guide wire and passed through the Y-graft delivery site and their respective bone tunnels in sequence. After passing the guide wire with sutures attached to Y-graft into the Y-graft delivery site and before passing the guide wire through the talar and calcaneal bone tunnels one must make certain that the guide wire passes deep
to all soft tissue structure on the talus and calcaneus respectfully from the Y-graft delivery site to the bone tunnel origin site. This is to avoid trapping any neurovascular structures, peroneal tendons and any other soft tissues structures thus allowing free passage and final placement of the anatomic Y-graft into its anatomic position.

In order to pull and tension the anatomic Y-graft limbs through their respective tunnels and into position. Each graft end is tensioned using the threads exiting the skin at the opposite side of each bone tunnel.

The 3 anatomic Y-graft stems are inserted into their respective tunnels to a depth of at least 15 mm and fixed with interference screws (Figure 5). Each bony attachment of the tendon graft is fixed with a 5mm diameter interference screw while applying 30-Newton tension force. First, the fibular stem is fixed, then the talar attachment is fixed while the ankle is in a 0-degree flexed neutral position. Then the calcaneal attachment is fixed in the same manner as talar attachment. Once all 3 stems of the Anatomic Y-graft are fixed the sutures are removed and the portal sites are closed using nylon sutures and the lower extremity is dressed and immobilized with a below knee plaster of Paris cast.
Figures

Figure 1. Construction of the Anatomic Y-Graft
Figure 2. Construction of the Fibular bone tunnel.
Figure 3. Construction of the Talar bone tunnel.
Figure 4. Construction of the Calcaneal bone tunnel.

A

B

C

D
Figure 5. Passage placement and fixation of the Anatomic Y-Graft stems into their respective bone tunnels.
Figure 6. Final Anatomic Percutaneous Anti RoLL construct.