Open Ankle Reconstruction of Lateral Ligaments (O-Anti-RoLL)

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Abstract: Ankle instability is a disabling condition that severely affects people's quality of life. Nonoperative options have been suggested however a surgical procedure is often required to improve symptomatology and function of the ankle joint. In the current paper we describe a surgical technique of an open ankle reconstruction of the lateral ligaments (O-Anti-RoLL), which is a simple and safe surgical technique that utilizes an anatomic Y-graft.

Level of Evidence: Diagnostic Level V. Expert opinion. See Instructions for Authors for a complete description of levels of evidence.

Key Words: ankle lateral ligaments, reconstruction, allograft, open ankle stabilization surgery, ankle instability

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LEARNING OBJECTIVES

After participating in this CME activity, orthopaedic surgeons should be better able to:

(1) Describe proper surgical "open ankle reconstruction of the lateral ligaments (O-Anti-RoLL)" technique.
(2) Explain patient assessment for O-Anti-RoLL.
(3) Identify patients with underlying foot deformities predisposing ankle instability.

HISTORICAL PERSPECTIVE

Ankle sprains are among the most common musculoskeletal pathologies, 70% of the people that sustains an ankle sprain may develop a disabling condition including chronic ankle instability.[1]

Most acute ankle sprains are treated with nonoperative modalities including, rest, ice, compression, immobilization, and functional rehabilitation with subsequent bracing and balance training.[2] The surgical options are lateral ligament repair or reconstruction that may be performed using traditional open[3] or minimally invasive techniques.[4–6]

Anatomic repair techniques utilize pre-existing ligament remnants that are either reattached or tightened to improve stability of the ankle, whereas surgical reconstruction techniques are designed to replace an absent or incompetent anterior talofibular ligament (ATFL) and/or calcaneofibular ligament (CFL) in an anatomic or nonanatomic manner.[7,8] The surgical techniques can be open versus arthroscopic; each requiring different skill sets.[9]

In 2005, an open anatomic reconstruction technique using a gracilis Y-graft and inside-out technique was reported with good outcomes.[10] More recently, a Percutaneous and Arthroscopic Ankle Reconstruction of the Lateral Ligaments (P-Anti RoLL and A-Anti-RoLL, respectively)[11,12] has been described. The P-Anti RoLL is a new minimally invasive surgical technique for anatomic reconstruction of the lateral ligaments of the ankle that utilizes the anatomic Y-graft and a percutaneous technique assisted by intraoperative fluoroscopy, whereas the A-Anti-RoLL utilizes ankle arthroscopy to help visualize and reconstruct the ankle lateral ligaments.

In the current paper we describe the technique tip of an open ankle reconstruction of the lateral ligament (O-Anti-RoLL), which is a simple and safe surgical technique that utilizes the same anatomic Y-graft of the previously published P and A-Anti-RoLL. The advantage of the O-Anti-RoLL technique is that it does not require ankle arthroscopy and as such the procedure is faster and not technically

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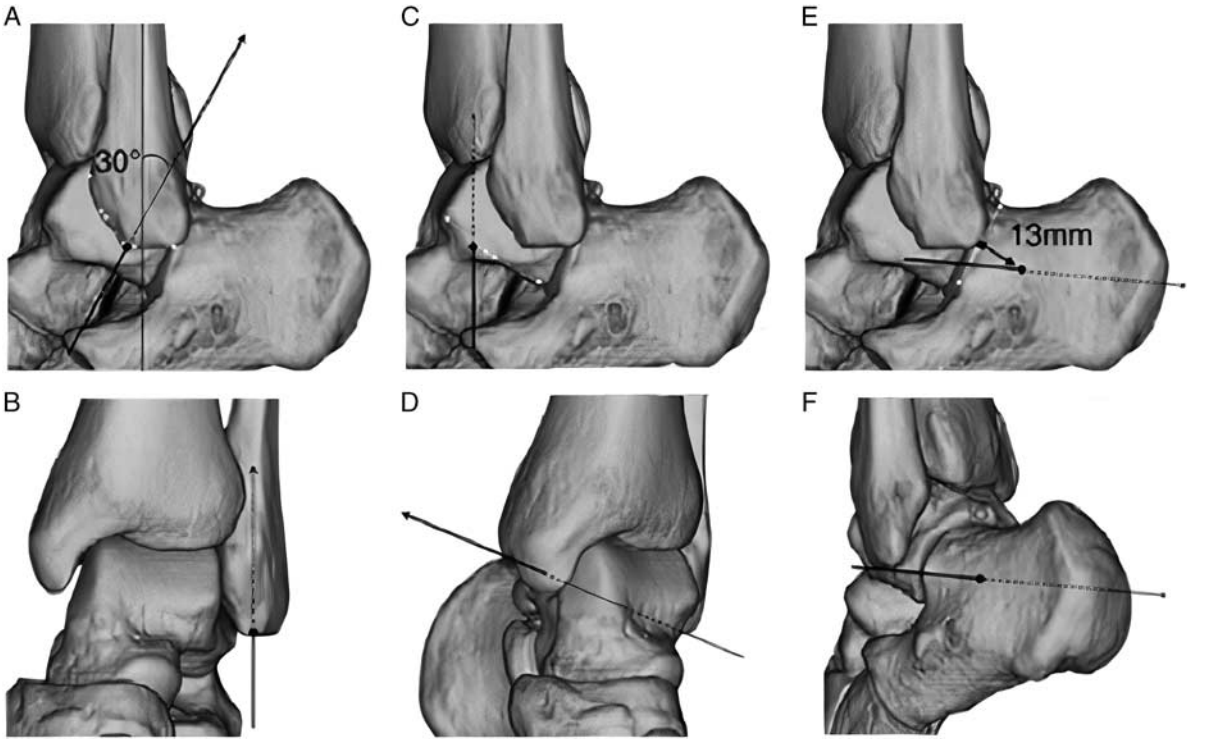

FIGURE 1. Landmark (black dot) and direction (arrow lines and broken lines) of each guide pin. A, Fibular bone tunnel, lateral view. White arrows show the alternative landmark. B, Fibular bone tunnel, anterior-posterior view. C, Talar bone tunnel, lateral view. White dots show the alternative landmark. D, Talar bone tunnel, anteromedial oblique view. E, Calcaneal bone tunnel, lateral view. Black arrow with black box shows the alternative landmark. F, Calcaneal bone tunnel, posterolateral oblique view.

demanding to perform. Further, fluoroscopic guidance allows a safer and anatomic positioning of the donor graft to the ATFL and CFL ligament origin and insertion sites.

INDICATIONS AND CONTRAINDICATIONS

The open-anti RoLL technique is indicated for patients with chronic ankle instability posterior to a single severe episode of ankle sprain or multiple minor ankle sprains[13] confirmed by magnetic resonance imaging (MRI) that had failed nonoperative treatment for at least 6 months, have insufficient lateral ligaments remnant to allow surgical repair or failed a previous Brostrom-Gould repair. This technique could be used indistinctly the patient's weight or level of activity.

An absolute contraindication is an active infection which would lead to a significant risk of failure of the surgery.

PREOPERATIVE PLANNING

Preoperative planning would include an open discussion with the patient on the risks, benefits, and limitations of a lateral ankle stabilization. Patients should have a history and physical examination to determine medical fitness for surgery. If underlying foot deformities are found during the examination, they should be considered for corrective surgery, such as calcaneal osteotomies or first metatarsal dorsiflexion osteotomy corrections for cavovarus deformities that will predispose to ankle sprains.

Patients should be examined for ankle instability with positive anterior drawer test and varus stress test.

Patients may require an MRI to confirm complete rupture of ATFL and/or CFL ligaments and ankle radiographs to determine if there is another concomitant injury. Stress radiographs may be helpful to support clinic but the diagnosis must be confirmed with the clinical exam and MRI correlation.

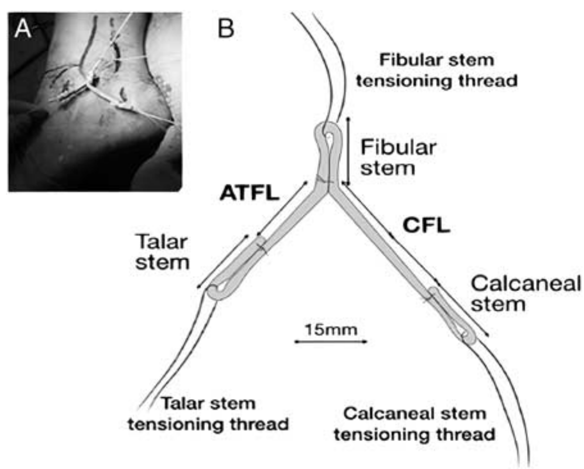

FIGURE 2. Construction of the anatomic Y-graft. A, Intraoperative photograph shows the configuration of the Y-graft and landmark for incision. B, Schematic diagram of the Y-graft showing 15×9 mm components and construction of each looped stem, the ligaments part [anterior talofibular ligament (ATFL) and calcaneofibular ligament (CFL)] and each tensioning thread (gray line).

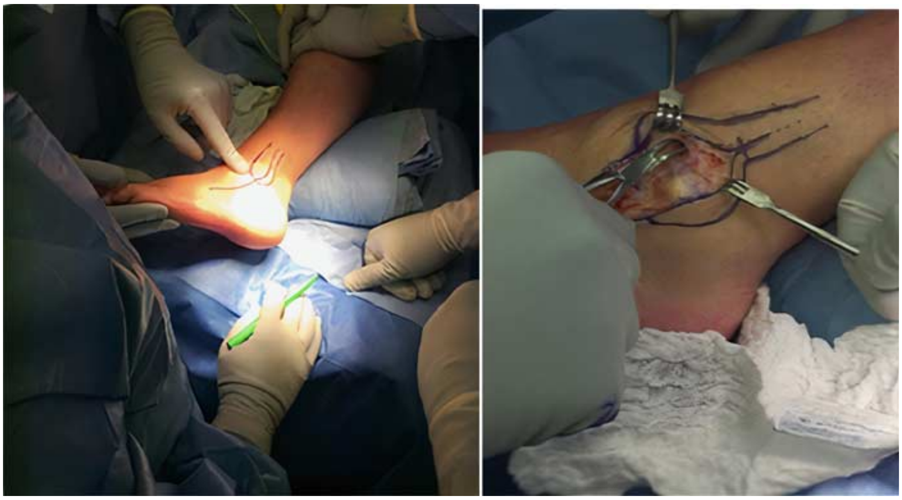

FIGURE 3. Following the incision, the anterolateral joint capsule is identified and a small anterolateral capsular window is made to allow the introduction of a hemostat or a similar instrument to view anterolateral comer of the talar dome.

OPERATIVE TECHNIQUE

Landmark and Patient Positioning

The patient is positioned lateral decubitus with a support under the leg to allow access to the medial side of the ankle on an operating table that will allow perfect anterior-posterior and lateral fluoroscopic examinations throughout the procedure to enable accurate anatomic landmark identification.

Anatomic landmarks should be drawn on the patient's skin before starting surgery. The O-Anti-RoLL anatomic landmarks include the distal edge of the tibial plafond, the lateral and medial malleoli. The landmark for the fibular origin of the ATFL and CFL when using an anatomic Y-graft should be between the ATFL and CFL origin sites on the fibula. This ATFL and CFL origin site can be localized at the fibular obscure tubercle (FOT) on the anterior-inferior border of the fibula (Fig. 1A). If the FOT is not detectable, the inferior one-third point between the inferior tip and anterior tubercle of the fibula on its anterior border would be the alternative (Fig. 1A).[14]

FIGURE 4. Following the anterolateral arthrotomy, a hemostat or similar instrument is then passed underneath all soft tissue structures which include; capsule and anterior talofibular ligament as 1 unit to allow inspection of ATFL.

The landmark for the talar insertion of the ATFL should be the talar obscure tubercle (TOT) on the anterolateral border of the talar body (Fig. 1C).[15] If the TOT is not detectable, the point just proximal to the midpoint between the superior corner and inferior corner of the talar body would be the alternative (Fig. 1C).

The landmark for the calcaneal insertion of the CFL should be the tuberculum ligamenti calcaneofibularis (TLC) on the lateral wall of the calcaneus (Fig. 1E). If the TLC is not detectable, the point at 13 mm distal and on the vertical line down from the center of the subtalar joint would be the alternative (Fig. 1E).[12,15]

Constructing the Anatomic Y-graft for Anti-RoLL

The surgeon and patient may choose from an autograft (eg, gracilis tendon) collected from the ipsilateral knee using a tendon harvester, or an allograft of at least 135 mm length: (15 mm×9 components) and ~5 mm diameter. Both autograft and allograft offer satisfactory results with this technique, however, autograft would have an increased risk in morbidity because of an extraincision and allograft could increase costs of the surgery depending on health care system.

The graft is prepared in the anatomic "Y" configuration with 3 looped stems (fibular, talar, and calcaneal) by doubling the graft to a length of 15 mm at all 3 ends of the "Y" configuration to facilitate attachment of a "tensioning thread" for graft delivery. The 15 mm doubled over looped stems will be anchored in the bone tunnels with single 15 and 30 mm stems reconstruct the ATFL and CFL, respectively (Fig. 2).

Incision

A skin incision is made centered on the fibula with slight anterior curve toward the sinus tarsi. The joint capsule is then identified, and a small anterolateral capsular window is made

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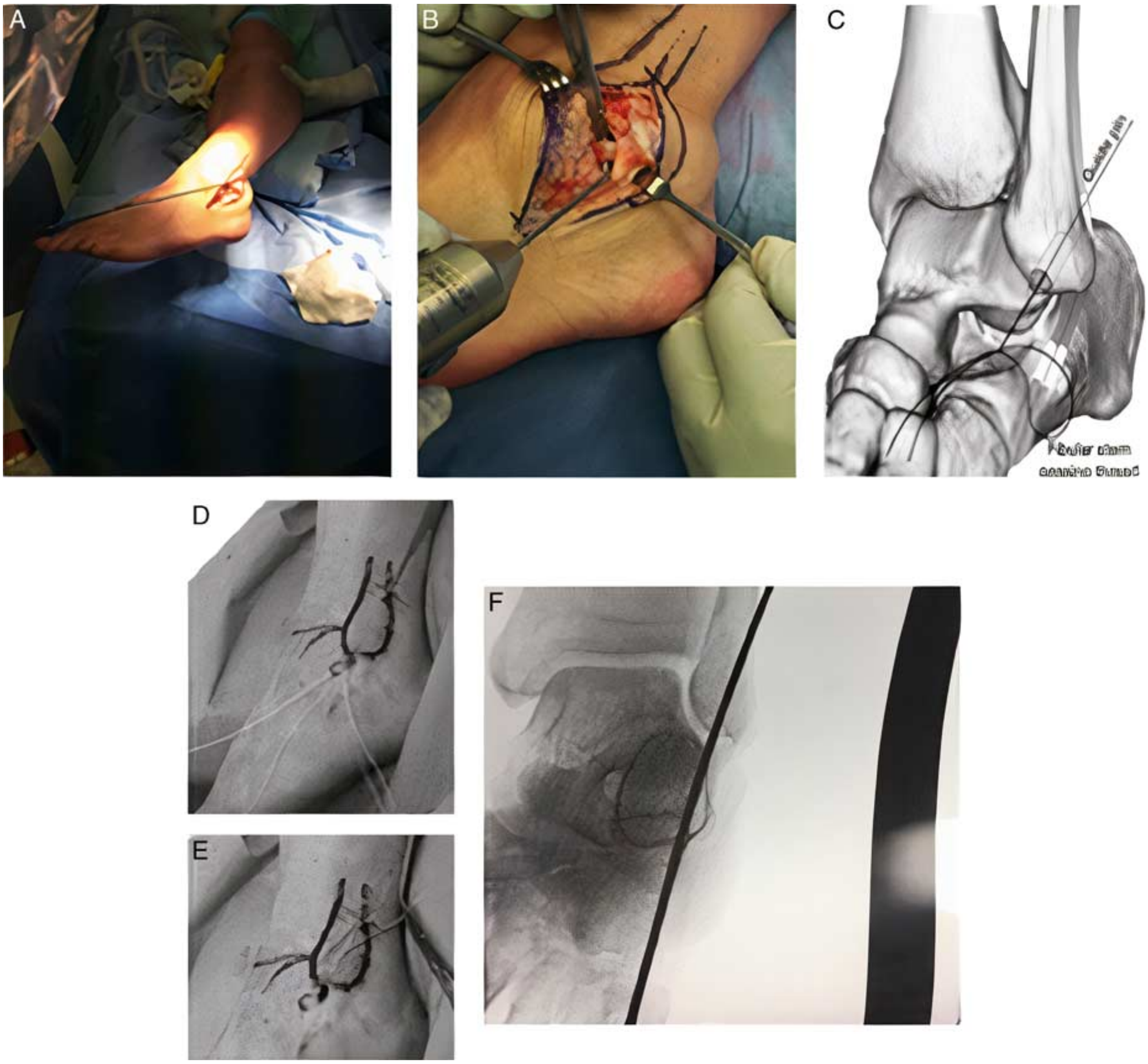

FIGURE 5. Construction of the fibular bone tunnel. A, Inserting a guide pin under fluoroscopy. B, Over drilling with cannulated drill. C, Schematic diagram of changing the guide pin to the fibular passing thread. D, Introducing the passing thread by pulling the guide pin. E, Holding the passing thread with a clamp. F, Fluoroscopy confirming proper position of the guide pin.

to allow the introduction of a hemostat or a similar instrument (Fig. 3). Following the superior anterolateral arthrotomy, a hemostat or similar instrument is then passed underneath all soft tissue structures exiting at tip of fibula which include; capsule and ATFL as one unit. If ATFL tissue is adequate and robust then one may elect to proceed with an open Brostrom procedure. If ATFL tissue is inadequate or a more robust reconstruction is desired for high-demand patients, then O-Anti-Roll is preferred. Inspection and treatment of any concurrent intra-articular pathology before the reconstruction could be performed, such as lateral osteochondral lesions of the talus, distal tibia osteophytes, and lateral gutter synovitis.

A secondary 2 to 3 cm incision parallel to the first incision is made for the calcaneus tunnel construction with fluoroscopic guidance. This incision should be centered over the TLC on the lateral wall of the calcaneus (Fig. 1E) and care should be taken to avoid sural nerve damage. If the TLC is not identified, the point at 13 mm distal and on the vertical line down from the center of the subtalar joint would be the alternative.

Construction of Bone Tunnels and Insertion of Passing Threads

Construction of the 3 bone tunnels (fibula, talus, and calcaneus) and insertion of a passing thread in each bone tunnel is required to accept the Y-graft insertion and interference screw fixation. Access to these bony tunnels is through the same incisions made. Identification of the anterolateral capsule and a capsulotomy is made first as shown in Figure 3. The next step is to identify the remnant of ATFL, retinaculum and scar of tissue originating from the fibula toward the talus (Fig. 4).

Identification of the ATFL and CFL origin sites at the FOT through direct visualization of the foot print is easily possible through the open technique. A guide pin is introduced at the common ATFL and CFL origin site using the FOT anatomic landmark on the fibula described above and passed

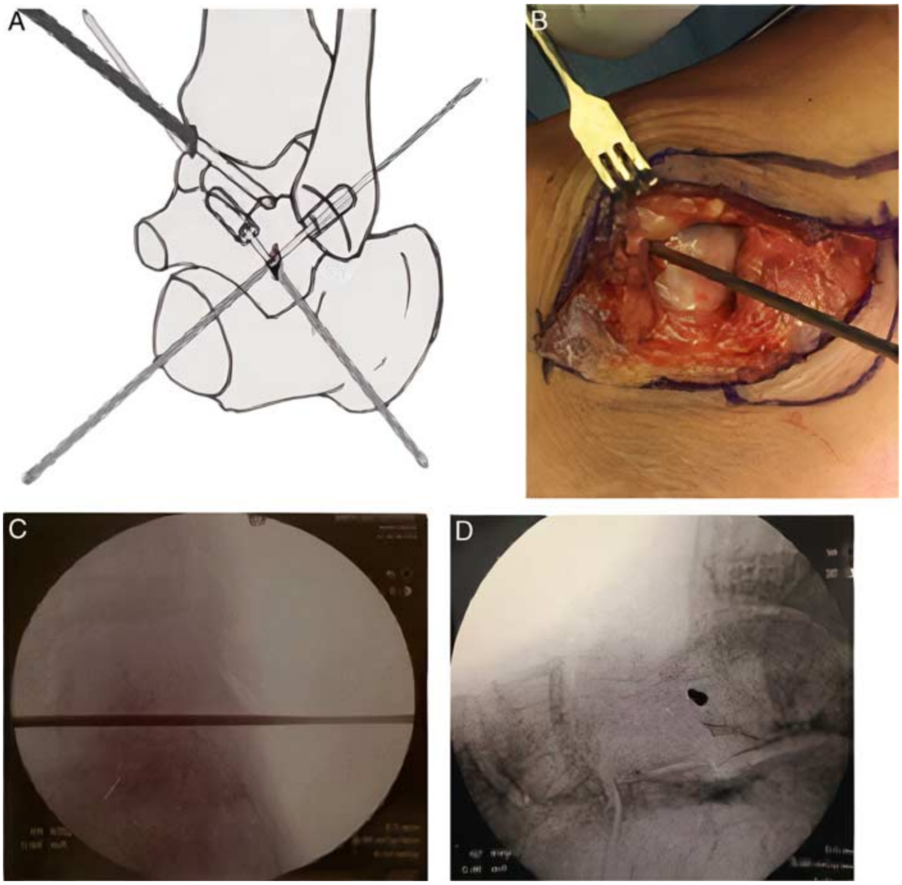

FIGURE 6. Construction of the talar bone tunnel to serve as the docking site for the talar stem of the anatomic Y-graft. A, The location of the guide pin in the talus directed slightly proximal and posterior toward a point just distal and anterior to the tip of the medial malleolus. B, Intraoperative photo showing the entry site of the guide pin. C and D, Anterioposterior and lateral radiographs to confirm central location of the guide pin to avoid iatrogenic talus fracture with eccentric pin location during the reaming step.

through the far cortex of the bone (Fig. 5A). It is important that the guide pin is directed to the posterior cortex of the fibula ~30 degrees to the long axis of the fibula. Fluoroscopic anterior-posterior views may be used to ensure that the guide pin is passed through the central portion of the fibula to prevent fracture when it is over drilled (Fig. 5F). A cannulated drill is then used to over drill the guide pins, constructing a bone tunnel diameter of 6.5 mm and a depth of 15 mm. A passing thread is attached to the hole at the end of the guide pin and introduced through the bone tunnel by antegrade pulling of the guide pin. Leave one end (closed loop) of the passing thread exiting from the pin entry site incision and the other end (the second limb of the thread) exiting from the skin at the guide pin exit site (Figs. 8A, B).

Next, the talar bone tunnel is constructed through the same incision. The talar guide pin is inserted at the TOT or the alternative landmark mentioned above on the anterolateral border of the talar body (Fig. 6D). The guide pin should be directed slightly proximal and posterior toward a point just distal and anterior to the tip of the medial malleolus to prevent neurovascular bundle damage (Fig. 6). This pin direction allows the guide pin to run through the center of talar neck and body intersection (this can be verified with a fluoroscopy) to place the interference screw in dense cancellous bone and prevents talar neck fracture, misdirection through the talus or sinus tarsi can risk a damage to the posterior tibial neurovascular bundle. A cannulated drill is then used to over drill the guide pins, constructing a bone tunnel diameter of 6.5 mm and a depth of 20 mm. A passing thread is attached to the hole at the end of the guide pin and introduced through the bone tunnel by antegrade pulling of the guide pin. Leave one end (closed loop) of the passing thread exiting from the pin entry site incision and the other end (the second limb of the thread) exiting from the skin at the guide pin exit site. These 2 ends are clamped (Figs. 8A, B).

The calcaneal tunnel is constructed last by inserting a guide pin at the TLC or the alternative landmark on the lateral wall of the calcaneus (Fig. 7). The sural nerve will be visualized or avoided and protected to introduce the guide pin which should be directed toward the inferior, medial, and posterior area of the calcaneus, the medial calcaneal branch of the tibial nerve is in close proximity to this tunnel. A cannulated drill is then used to over drill the guide pins, constructing a bone tunnel diameter of 6.5 mm and a depth of 20 mm in the calcaneus. A passing thread is attached to the hole at the end of the guide pin and introduced through the bone tunnel by antegrade pulling of the guide pin. Leave one end (closed loop) of the passing thread exiting from the pin entry site incision and the other end (the second limb of the thread) exiting from the skin at the guide pin exit site. These 2 ends are clamped (Figs. 8A, B). It is essential that local neurovascular structures and tendons be protected when using these techniques to avoid complications.

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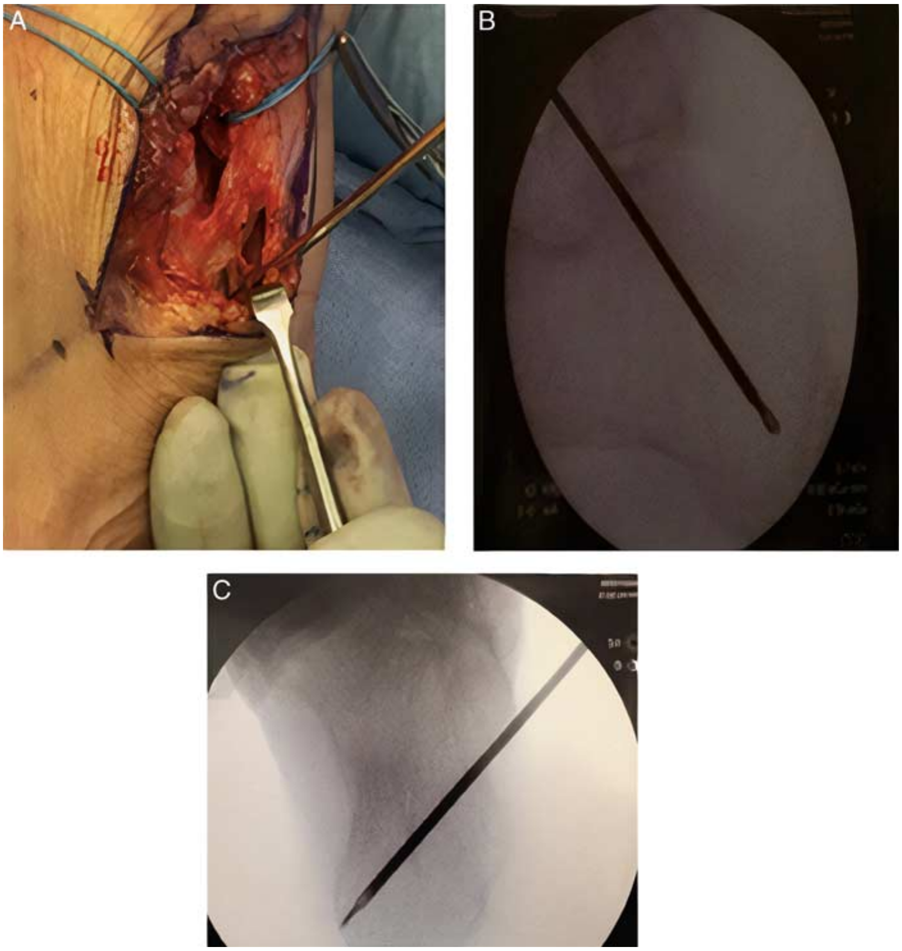

FIGURE 7. Construction of the calcaneal bone tunnel to serve as the docking site for the calcaneal stem of the anatomic Y-graft. A, The guidewire is inserted through the same incision, ~15 mm posterior to the anterior edge of the posterior facet and about 10 mm inferior to the joint line. B and C, Fluoroscopic confirmation of both the lateral and axial views, respectively, confirming the proper position of the foot print of calcaneofibular ligament, safe guidewire placement before drilling.

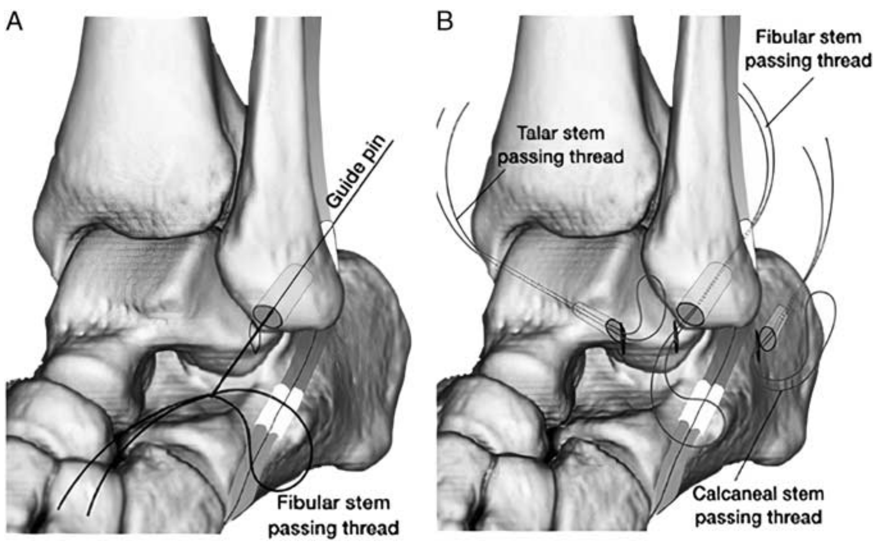

FIGURE 8. A, Schematic diagram of changing the guide pin to the fibular passing thread. Introducing the passing thread by pulling the guide pin. B, Schematic diagram of 3 bone tunnels and passing thread out from the corresponding bone tunnels.

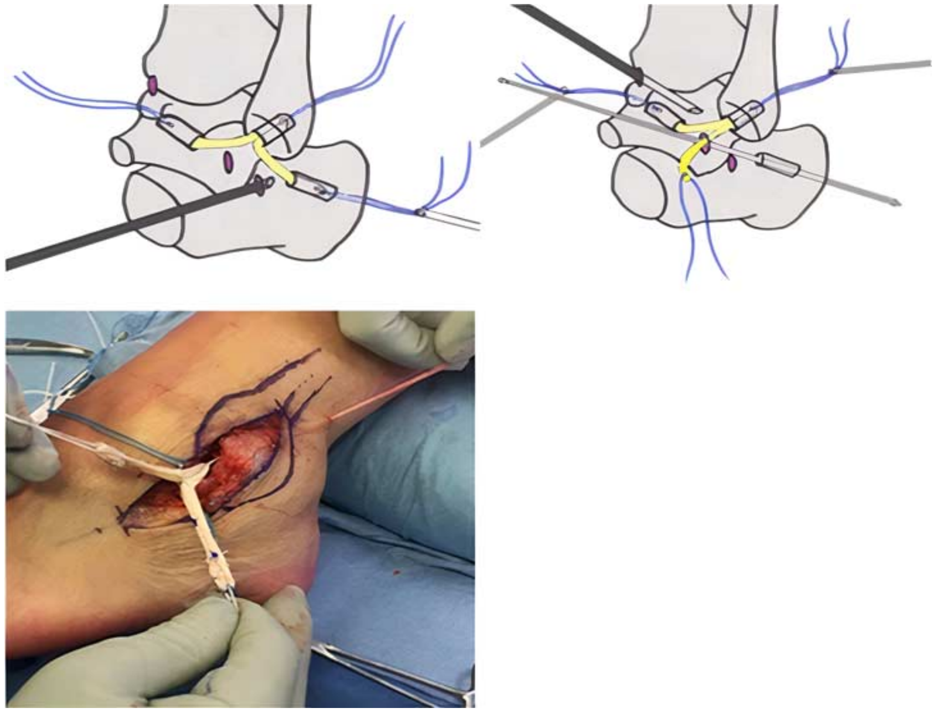

FIGURE 9. All 3 stems of the anatomic Y-graft are delivered through the accessory anterolateral portal using an inside-out technique. First, the sutures passing through the talar stem loop of the graft are attached to a guidewire, which is then passed through the talar tunnel. Similarly, the sutures passing through the fibular and calcaneal stem loops are attached to a guidewire and passed through their respective tunnels in sequence to pull the grafts through the accessory anterolateral portal and into position.

Delivery and Fixation of Each Looped Stem of the Y-Graft to the Corresponding Bone Tunnels With Inside-Out Technique

All 3 looped stems of the Y-graft are delivered through the bone tunnels using an inside-out technique by pulling each passing thread through their respective bone tunnels (Fig. 9). First, a tensioning thread is passed through the fibular looped stem of the Y-graft and connected to the fibula passing suture loop that exits the fibular tunnel. Then the passing thread that comes out from the posterior aspect of the fibula is pulled through this allows the fibular stem of the Y-graft to be delivered into the fibular bone tunnel with the tensioning thread exiting the posterior aspect of the fibula (Fig. 10).

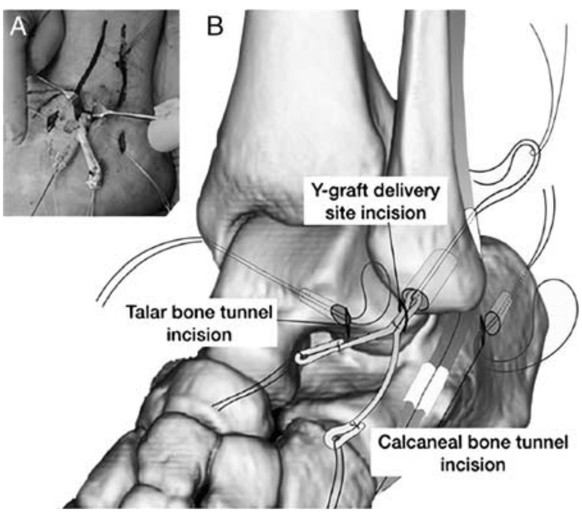

FIGURE 10. Inside-out passage of the anatomical Y-graft stem into the fibular bone tunnel. A, Intraoperative photograph of inserting the Y-graft into fibular bone tunnel. B, Schematic diagram of inserting the Y-graft into fibular bone tunnel.

Next, the talar and calcaneal stems are introduced into each bone tunnel using the same inside-out technique (Fig. 10). The trailing end of the talar passing thread is attached to the talar stem thread to allow delivery of the talar stem through the talar bone tunnel. Finally, the trialing end of the calcaneal passing thread is attached to the calcaneal stem thread to allow delivery of the calcaneal stem through the calcaneal bone tunnel (Fig. 10) being certain to pass underneath the peroneal tendons. This will allow the CFL portion of the Y-graft to pass along the lateral wall of the talus and calcaneus on a path nearly anatomic to the native CFL.

Fixation of Anatomic Y-Graft to the Bone Tunnel

With the ankle in neutral dorsiflexion position, the Y-graft is balanced and tensioned by pulling the tension threads. Once the graft placement and tension is appropriate, a blunt-tipped interference screw guide pin is inserted into each bone tunnel, and each looped stem of the Y-graft in the bone tunnel is fixed using a 6×15 mm interference screw for the fibular tunnel and 6×20 mm for talus and calcaneus tunnels (Fig. 11A). Tension should be maintained on the sutures during screw insertion to prevent graft extrusion. Once all 3 stems of the anatomic Y-graft are fixed, the tensioning threads are removed, and the wound is closed using vicryl sutures subcutaneously and nylon sutures in the skin. The lower extremity is dressed and immobilized with a below-knee cast in slight eversion.

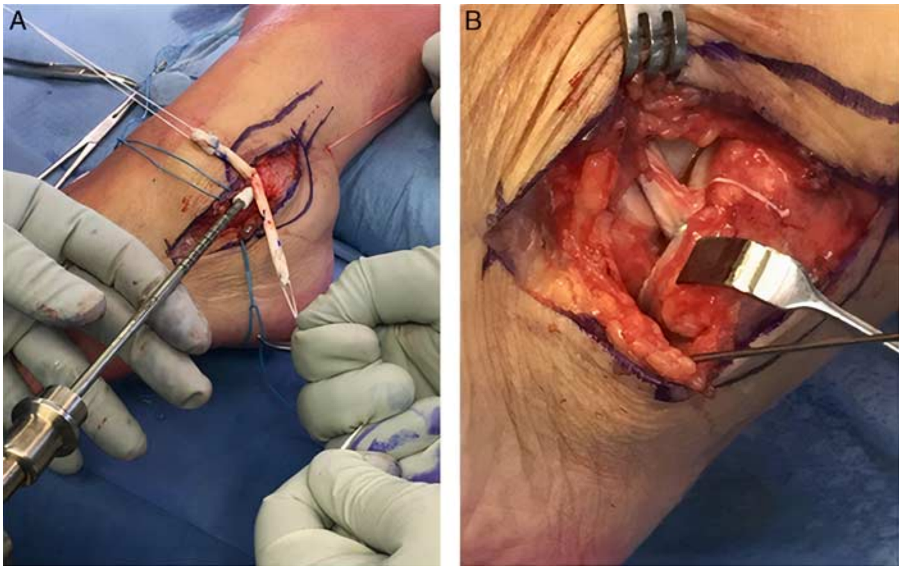

FIGURE 11. A, The 3 anatomic Y-graft stems are inserted into their respective tunnels. Each bony attachment of the tendon graft is fixed with interference screw while a 30-N tension force is applied. First, the fibular stem is fixed; then, the talar attachment is fixed while the ankle is in a neutral position. Finally, the calcaneal attachment is fixed in the same manner as the talar attachment. B, Final graft position.

COMPLICATIONS

Complications after ankle ligament reconstruction are wound infections (0% to 4%) and local nerve complications (1.9–9-7%) that may cause problems in the early postoperative period. The sural nerve appears to be at greater risk in this type of procedures rather than the superficial peroneal nerve which is at greater risk with acute or delayed repair of the ligaments, however, the O-Anti-RoLL may provide an extraprotection because of direct visualization of the nerve. Complex regional pain syndrome could be present in 1.3% of the cases.[16] Postoperative stiffness of the ankle and subtalar joint as well as recurrent instability could be reported.

POSTOPERATIVE MANAGEMENT

The operated extremity is immobilized in a below-knee cast with slight eversion of the ankle for a total of 6 weeks nonweightbearing. Wound inspection and suture removal is performed at 2 weeks postoperatively and a walking cast boot is applied to allow progressive weightbearing (~25% body weight per week) with strength and range of motion exercises when fully weightbearing.

DISCUSSION

There are no studies comparing arthroscopic to open anatomic lateral ankle ligament reconstruction with autograft or allograft. However, there are some papers comparing arthroscopic to an open lateral ligament repair. Corte-Real and Moreira showed an The American Orthopedic Foot and Ankle Score score of 85 with a 2-year follow-up in 28 patients after arthroscopic lateral ligament repair; there was a 29% complication rate including wound issues, nerve injuries, and deep venous thrombosis.[17] Another study from Vega and colleagues. using an all-inside technique and knotless anchors in 16 patients resulted in an The American Orthopedic Foot and Ankle Score score of 97 at 2 years with a 13% complication rate consisting of superficial wound issues that resolved with conservative treatment.[18]

In 2018, Guelfi et at[19] performed a systematic review comparing open to arthroscopic ankle lateral ligament repair identifying an overall complication rate of 15% after arthroscopic ligament repair as compared with 8% when the procedure was performed open.

Although, there have been advances in the field of minimally invasive ankle stabilization techniques that may allow faster recovery compared with open techniques, the advantage of the open technique is that it is less technically challenging, requires less intraoperative radiation and relies mainly on intraoperative anatomic foot print of the graft.

FUTURE OF THE TECHNIQUE

Open-anti RoLL technique is a feasible, anatomic reconstruction technique for chronic instability of the ankle. This procedure with an open incision provides surgeons with less experience a good option to perform a lateral ligament reconstruction, and also permits the surgeon to obtain the expertise required for more technically demanding procedures as minimally invasive percutaneous[11] and arthroscopic[12] anti-RoLL procedures.

Further prospective studies on efficacy and safety with a large number of patients followed over the long term is necessary to establish the safety and effectiveness as well as to verify the advantages it offers over previously reported operative techniques.

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CME QUESTIONS

1. Which patient mentioned below would be best suitable for an Open Anti-RoLL procedure?

    A. 32-year-old patient with severe ankle sprain 4 weeks ago with swelling and significant function restriction, ongoing physiotherapy
    B. 25-year-old patient with history of multiple ankle sprains, did physiotherapy, no subjective instability, MRI shows thickening of ATFL
    C. 28-year-old patient with history of multiple ankle sprains, using ankle brace, previous failed Brostrom-Gould procedure
    D. 35-year-old patient with one single episode of severe ankle sprain 1 year ago, failed non-operative treatment, MRI shows ATFL tear (fibers could be appreciated)

2. Which type of foot has more predisposition to multiple ankle sprains?

    A. Pes planus with neutral heel
    B. Planovalgus foot deformity
    C. Cavovarus foot deformity
    D. Hallux valgus deformity

3. Which exit point of the guide pin should be aimed during the preparation of the talar bone tunnel in Open Anti-RoLL procedure to avoid tibialis posterior neurovascular bundle damage?

    A. Proximal and posterior
    B. Distal and anterior
    C. Proximal and anterior
    D. Distal and posterior

4. During the calcaneal tunnel construction in the Open Anti-RoLL procedure, which nerve should be visualized and avoided?

    A. Sural nerve
    B. Superficial peroneal nerve
    C. Deep peroneal nerve
    D. Tibialis posterior nerve

5. Which is the correct positioning of the calcaneal stem of the tendon graft in respect of the peroneal tendons during the Open Anti-RoLL procedure?

    A. Calcaneal stem of tendon graft should be above the peroneal tendons.
    B. Calcaneal stem of tendon graft should be underneath the peroneal tendons.
    C. Calcaneal stem of tendon graft does not have any relation with the peroneal tendons.
    D. Calcaneal stem of tendon graft is found distal to the peroneal tendons.

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ANSWER SHEET FOR TECHNIQUES IN FOOT & ANKLE SURGERY
CME PROGRAM EXAM
June 2022

Please answer the questions on page 120 by filling in the appropriate circles on the answer sheet below. Please mark the one best answer and fill in the circle until the letter is no longer visible. To process your exam, you must also provide the following information:

Name (please print): ______

Street Address ______

City/State/Zip ______

Daytime Phone ______

Specialty ______

1. Ⓐ Ⓑ Ⓒ Ⓓ
2. Ⓐ Ⓑ Ⓒ Ⓓ
3. Ⓐ Ⓑ Ⓒ Ⓓ
4. Ⓐ Ⓑ Ⓒ Ⓓ
5. Ⓐ Ⓑ Ⓒ Ⓓ

Your completion of this activity includes evaluating it. Please respond to the following questions below.

Please rate these activities (1 — minimally, 5 — completely)	1 2 3 4 5
This activity was effective in meeting the educational objectives	O O O O O
This activity was appropriately evidence-based	O O O O O
This activity was relevant to my practice	O O O O O

Please rate your ability to achieve the following objectives, both before this activity and after it: 1 (minimally) to 5 (completely)

After participating in this CME activity, surgeons should be better able to:	Pre 1 2 3 4 5	Post 1 2 3 4 5
Describe proper surgical "open ankle reconstruction of the lateral ligaments (O-Anti-RoLL)" technique.	O O O O O	O O O O O
Explain patient assessment for O-Anti-RoLL.	O O O O O	O O O O O
Identify patients with underlying foot deformities predisposing ankle instability.	O O O O O	O O O O O

How many of your patients are likely to be impacted by what you learned from this activity?

O <20% O 20-40% O 40-60% O 60-80% O >80%

Do you expect that these activities will help you improve your skill or judgment within the next 6 months? (1 — definitely will not change, 5 — definitely will change)

1 2 3 4 5
O O O O O

Please list at least one (1) change you will make to your practice as a result of this activity:

______

How will you apply what you learned from these activities (mark all that apply):

In diagnosing patients O
In making treatment decisions O
In monitoring patients O
As a foundation to learn more O
In educating students and colleagues O
In educating patients and their caregivers O
As part of a quality or performance improvement project O
To confirm current practice O
For maintenance of board certification O
For maintenance of licensure O

Please list at least one strategy you learned from this activity that you will apply in practice:

______

How committed are you to applying these activities to your practice in the ways you indicated above? (1 — minimally, 5 — completely)

1 2 3 4 5
O O O O O

Did you perceive any bias for or against any commercial products or devices? Yes O No O

If yes, please explain:

How long did it take you to complete these activities? ______ hours ______ minutes

What are your biggest clinical challenges related to foot and ankle surgery?

______

______

[ ] Yes! I am interested in receiving future CME programs from Lippincott CME Institute! (Please place a check mark in the box)

Mail the completed Answer Sheet and a check or money order for the $10 processing fee by May 31, 2024 to:
Lippincott CME Institute, Inc.
Wolters Kluwer Health
Two Commerce Square
2001 Market Street, 3rd Floor
Philadelphia, PA 19103

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