Assessing the Need for Additional Syndesmotic Stabilization in Open Reduction of the Posterior Malleolus

A Biomechanical Study

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Background: The treatment of ankle fractures involving the posterior malleolus (PM) has changed in favor of open reduction and internal fixation (ORIF), and the need for additional syndesmotic stabilization has decreased; however, there are still doubts regarding the diagnosis and treatment of residual syndesmotic instability. The aim of the present study was to evaluate the effect of fixation of the PM and to assess the need for additional stabilization methods. We hypothesized that ORIF of the PM would not sufficiently stabilize the syndesmosis and that additional syndesmotic reconstruction would restore kinematics.

Methods: Eight unpaired, fresh-frozen, cadaveric lower legs were tested in a 6-degrees-of-freedom robotic arm with constant loading (200 N) in the neutral position and at 10° dorsiflexion, 15° plantar flexion, and 30° plantar flexion. The specimens were evaluated in the following order: intact state; osteotomy of the PM; transection of the anterior inferior tibiofibular ligament (AITFL) and interosseous ligament (IOL); ORIF of the PM; additional syndesmotic screw; combination of syndesmotic screw and AITFL augmentation; and AITFL augmentation.

Results: A complete simulated rupture of the syndesmosis (PM osteotomy with AITFL and IOL transection) caused translational (6.9 mm posterior and 1.8 mm medial displacement) and rotational instability (5.5° external rotation) of the distal fibula. ORIF of the PM could eliminate this instability in the neutral ankle position, whereas sagittal and rotational instability remained in dorsiflexion and plantar flexion. The remaining instability could be eliminated with an additional procedure, without notable differences between screw and AITFL augmentation.

Conclusions: In our model, isolated PM osteotomy and isolated AITFL and IOL rupture (after PM refixation) only partially increased fibular motion in dorsiflexion and plantar flexion, whereas the combination of PM osteotomy and AITFL and IOL rupture resulted in an unstable syndesmosis in all planes.

Clinical Relevance: In complex ankle fractures, ORIF of the PM is essential to restore syndesmotic stability; however, residual syndesmotic instability can be detected by a specific posterior shift of the fibula on stress testing. In these cases, anatomical AITFL augmentation is biomechanically equivalent to the use of a syndesmotic screw.

Complex ankle fractures involving the posterior malleolus (PM) are associated with poor functional outcomes[1,2]. One reason for these poor outcomes is that the posterior inferior tibiofibular ligament may be attached to this PM fragment, which can lead to syndesmotic instability. Because of the correlation of syndesmotic instability exceeding 2 to 3 mm with

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posttraumatic arthritis, current literature recommends reduction of these fragments to stabilize the syndesmosis[3-5].

After completion of the osteosynthesis of the PM and other components, such as a distal fibular fracture or a medial malleolar fracture, the diagnosis and subsequent treatment of residual syndesmotic instability remain challenging. Evidence for clinical assessment of syndesmotic instability following open reduction and internal fixation (ORIF) is limited, with only medial clear space widening compared with the uninjured ankle during external rotation stress testing appearing to be reliable[6].

Clinically, ORIF of the PM has decreased the use of syndesmotic screws compared to indirect anterior to posterior screws or untreated PM fragment[7,8]; however, clinical evidence regarding the best method and the need for additional syndesmotic stabilization is lacking. Common treatment options include tricortical syndesmotic screw fixation or the use of a dynamic suture-button system[9]. However, additional syndesmotic stability after ORIF of the PM was lacking with both adjunctive procedures[10,11]. Recently, anatomical augmentation of the anterior inferior tibiofibular ligament (AITFL) with a suture tape showed promising clinical results[12,13]. Initial biomechanical studies demonstrated similar or better syndesmotic stabilization with the AITFL augmentation compared with the use of a syndesmotic screw or the suture-button system[11,14-16].

The purpose of the present study was to evaluate the kinematics of the syndesmosis following osteotomy and ORIF of a PM fracture in a biomechanical model of an intact and a deficient AITFL and interosseous ligament (IOL). The study was designed to mimic the common clinical problem after PM osteosynthesis in assessing and treating residual syndesmotic instability. We evaluated the additional stabilization of the distal tibiofibular joint with either a syndesmotic screw, AITFL augmentation, or the combination of both. We hypothesized that the occurrence of a PM fracture with associated rupture of the AITFL and IOL would cause syndesmotic instability and that isolated ORIF of the PM would not restore syndesmotic stability. We hypothesized that additional AITFL augmentation would reduce syndesmotic instability better than a syndesmotic screw.

Materials and Methods

The study was approved by the ethics committee of the Medical Association of Westfalia-Lippe and the University of Munster (approval number 2021-770-f-s).

Specimens

Eight unpaired, fresh-frozen, male human cadaveric lower legs from 8 different individuals (mean age, 72.4 years; range, 53 to 86 years) with no history of previous injury or rigid deformity were utilized. Radiography was performed to exclude specimens with evidence of osseous or degenerative abnormalities.

Specimens were stored at –20°C and thawed 24 hours before testing. The skin and muscle of the lower leg were resected. The ligaments, joint capsule, and interosseous membrane were preserved. Two angular-stable proximal tibial plates and 3 cancellous-spanning subtalar screws were implanted. The calcaneus was embedded in a metal alloy (Cerrobend; Bolton Metal Products) and attached to the robotic arm (Fig. 1). Placement of subtalar screws increased the rigidity of the hindfoot fixation, allowing the robotic arm to directly control the hindfoot, resulting in optimal control of talar kinematics. At the proximal end, the specimens were embedded by using the metal alloy to fuse the proximal plates and joint together in a fixture attached to a load cell. During the 4 hours of testing, the specimens were kept moist with a saline solution.

Biomechanical Setup

Biomechanical testing was performed on a 6-degrees-of-freedom robotic setup (KR 60/3; KUKA) with an accuracy of ±0.06 mm, and the kinematics of the ankle were measured with a 6-degrees-of-freedom force/torque load cell with an accuracy of ±0.25 N and ±0.05 Nm. Custom software with an ankle tool for robotic simulation (simVitro; Cleveland Clinic BioRobotics Laboratory) was utilized. A passive path from 10° dorsiflexion to 30° plantar flexion, with motion-controlled flexion under 50 N of compression and minimal forces in all other directions, was performed to optimize the coordinate system for subsequent movements. The x axis was oriented laterally along a line from the medial to the lateral malleolus on the joint line level. The z axis was in the plane of the tibial shaft axis and was defined perpendicular to the x axis. The y axis was oriented posteriorly and orthogonal to the other 2 axes. The coronal, sagittal, and axial planes were defined along these axes. The origin of the coordinate system was set at the lateral border of the distal fibula at the level of the ankle joint. Coronal and sagittal displacements were expressed as relative lateral and dorsal shifts of the fibula in millimeters, and axial motion was expressed as relative external rotation in degrees, with all translations referenced to the specific neutral position at the start of each step of the study protocol. An optical 2D/3D measuring system (ARAMIS Adjustable 12M System; Carl Zeiss GOM Metrology) with an accuracy of 0.0085 mm and a precision of ±0.0075 mm was utilized to monitor the movement of the fibula (Fig. 1)[17]. The position and forces were measured at a frequency of 7 kHz.

Study Protocol

A 7-step study protocol was conducted. A specific sequential cutting order (steps 1 to 3) and sequential reconstruction order (steps 4 to 7) was established. Following PM fixation, the order for additional syndesmotic stabilization was randomized (Fig. 2).

The specimens were loaded with a continuous axial compression of 200 N in order to mimic partial weight-bearing and were moved in a physiologic range of motion from 10° dorsiflexion to 30° plantar flexion. The ankle response to an externally applied 5 Nm external rotation torque was quantified in all 3 planes at 10° dorsiflexion, in the neutral position, and at 15° and 30° plantar flexion.

Osteotomy and Dissection

A standardized posterolateral PM fragment was osteotomized in order to mimic a Bartoniček/Rammelt type-2 fracture. Two

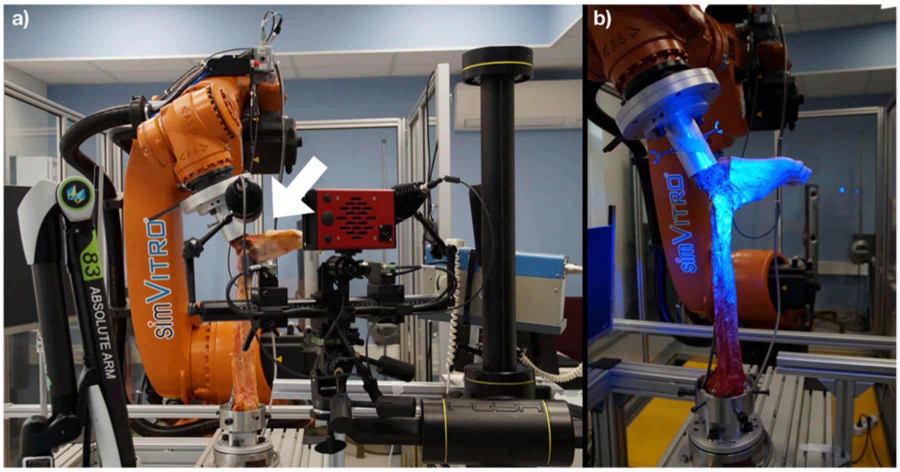

Fig. 1

Figs. 1-A and 1-B Study design. **Fig. 1-A** Six-degrees-of-freedom robotic arm with specimen mounted; ARAMIS Adjustable 12M System for optical measurement. White arrow: specimen mounted to the robotic arm upside-down. **Fig. 1-B** Mounting of the specimen on the robot in detail, with blue light to assess the kinematics within the optical measurement system.

parallel 2.0-mm Kirschner wires were inserted at the lateral margin of the posterior tibial tendon groove, directed toward the anterior facet of the fibula. The posterior malleolus was osteotomized parallel to the wires with an oscillating saw (Figs. 3-A, 3-B, and 3-C).

Afterward, the AITFL and IOL were transected up to 5 cm proximal to the ankle joint line to mimic a common triligamentous syndesmotic injury with an osseous avulsion of the posterior inferior tibiofibular ligament and transligamentous injury of the AITFL and IOL (Fig. 3-C).

Fixation of the PM Fragment

Prior to the osteotomy of the PM, a 3-hole one-third titanium tubular plate (DePuy Synthes) was applied to the distal dorsal tibia, and 2.5-mm drill holes were created. Following the osteotomy, the PM fragment was reduced. Reduction was achieved with use of three 3.5-mm screws inserted into the predrilled holes (see Fig. 3-D).

Additional Stabilization with Tricortical Syndesmotic Screw

Prior to the osteotomy of the PM, the syndesmotic screw was predrilled 2 cm above the ankle joint and parallel to the joint line. Following PM fixation, the syndesmosis was reduced and a 3.5-mm tricortical screw was inserted (Fig. 3-E).

Additional Stabilization with AITFL Augmentation

The AITFL was anatomically augmented with an InternalBrace (Arthrex). A 4.75-mm SwiveLock Anchor with a FiberTape (Arthrex) was inserted into the distal anterolateral tibia. The FiberTape was shuttled from anterior to posterior through a 2.7-mm drill hole in the fibula and tensioned to 60 N. A 3.5-mm SwiveLock Anchor (Arthrex) was inserted (Fig. 3-F).

Statistical Analysis

An a priori power analysis was performed with use of G*Power (version 3.1.9; Heinrich-Heine-Universität Dusseldorf). On the basis of means and standard deviations from previous biomechanical studies testing syndesmotic instability[14], it was determined that a sample size of 8 would be able to detect changes in rotation of 1° (with a standard deviation of 0.6°) and translation of 1.1 mm (with a standard deviation of 0.8 mm) with 95% power and significance set at 0.05. Results are presented as the mean with standard deviation. Normally distributed data were analyzed by 1-way repeated-measures analysis of variance, followed by a Tukey range test. In the case of non-normal distribution, a Friedman test and Dunn correction were performed. In all cases, significance was set at 0.05. Fibular instability was defined as a significant increase in motion in response to the external rotation stress test in at least 1 direction. All significant differences were shown with horizontal lines in Figs. 4 through 7. Statistical analyses were performed with use of Prism 9 (GraphPad Software).

Results

Osteotomy of the PM Fragment and Cutting of the AITFL and IOL

Osteotomy of the PM fragment did not increase the sagittal or coronal shift or the rotation of the fibula, except for the external rotation in 30° plantar flexion ($p = 0.04$). AITFL and IOL resection significantly increased the instability of the distal fibula in all planes and positions. This instability resulted in a posterior displacement of the fibula of 2.0 ± 0.5 mm in the intact state, 2.8 ± 1.1 mm with PM osteotomy, and 8.9 ± 3.4 mm with cutting of the AITFL and IOL in the neutral position (all comparisons, $p < 0.001$).

Fixation of the PM Fragment and Syndesmotic Augmentation

In the neutral position, fixation of the PM significantly reduced the instability of the fibula in all 3 planes compared with the PM osteotomy with transected IOL and AITFL (posterior displacement, 8.9 ± 3.4 to 4.0 ± 1.7 mm, $p < 0.001$; medial displacement, 3.3 ± 1.9 to 0.55 ± 0.94 mm, $p < 0.001$; external

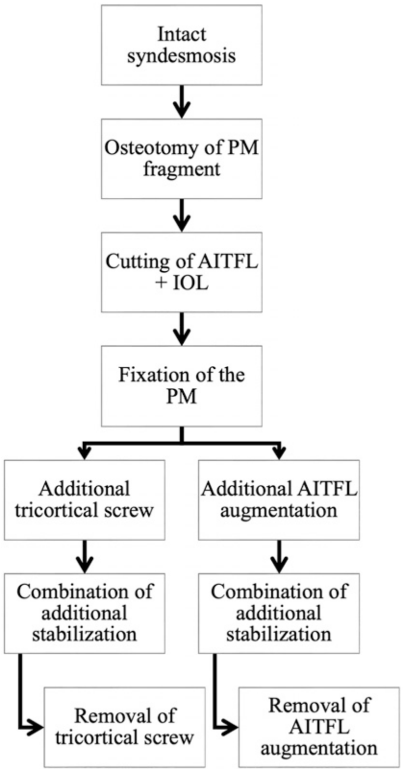

Fig. 2
Flow diagram showing the sequential cutting order (steps 1 to 3) and sequential reconstruction order (steps 4 to 7). After PM fixation, the order for additional syndesmotic stabilization was randomized.

rotation, 8.9° ± 3.1° to 4.7° ± 1.9°, $p < 0.001$) (Fig. 4). ORIF of the PM restored fibular kinematics without significant differences compared with the intact state (posterior displacement, 2.0 ± 0.5 to 4.0 ± 1.7 mm, $p = 0.11$; medial displacement, 1.5 ± 0.8 to 0.55 ± 0.94 mm, $p = 0.28$; external rotation, 3.5° ± 1.0° to 4.7° ± 1.9°, $p = 0.24$) (Fig. 4).

At 10° dorsiflexion, fixation of the PM significantly reduced posterior displacement and external rotation compared with the PM osteotomy with transected IOL and AITFL (posterior displacement, 9.9 ± 3.3 to 4.0 ± 1.8 mm, $p < 0.001$; medial displacement, 3.6 ± 2.4 to 0.9 ± 1.1 mm, $p < 0.001$; external rotation, 9.8° ± 3.0° to 5.4° ± 2.0°, $p < 0.001$) (Fig. 5), but with residual instability compared with the intact state in the sagittal plane ($p = 0.01$) and axial plane ($p = 0.009$) (Fig. 5). Only additional stabilization of the syndesmosis restored fibular motion in all planes. There were no significant differences across fixation methods for posterior displacement (intact, 1.8 ± 0.5 mm; screw, 2.5 ± 0.8 mm; AITFL, 2.7 ± 0.9 mm; screw + AITFL, 2.2 ± 0.7 mm), medial displacement (intact, 1.6 ± 0.8 mm; screw, 1.1 ± 0.9 mm; AITFL, 1.3 ± 1.2 mm; screw + AITFL, 1.0 ± 0.8 mm), or external rotation (intact, 3.3° ± 1.1°; screw, 4.6° ± 1.5°; AITFL, 3.9° ± 1.6°; screw + AITFL, 3.9° ± 1.4°) (Fig. 5).

At 15° plantar flexion, ORIF of the PM did not restore fibular stability in the sagittal ($p > 0.99$) and coronal planes ($p = 0.16$) (Fig. 6). In the sagittal plane, only the addition of a syndesmotic screw stabilized the fibula compared with the PM osteotomy with transected IOL and AITFL ($p < 0.001$). Thus, there was a nonsignificant dorsal shift of the fibula of 1.9 ± 1.5 mm with ORIF of the PM, 1.3 ± 1.5 mm with AITFL augmentation, and 0.3 ± 0.9 mm with a syndesmotic screw compared with the intact syndesmosis. In the axial plane, only the use of AITFL augmentation significantly reduced rotational instability compared with the intact syndesmosis ($p = 0.002$). Thus, there was a nonsignificant increase in external rotation of 1.1° ± 1.7° with ORIF of the PM, 0.9° ± 1.3° with a syndesmotic screw, and 0.4° ± 1.5° with AITFL augmentation. Only the combination of the syndesmotic screw and AITFL augmentation stabilized the syndesmosis in all planes.

At 30° plantar flexion, fixation of the PM reduced rotational and coronal instability but not sagittal shift. The use of a syndesmotic screw and the combination of both AITFL augmentation and a syndesmotic screw stabilized the syndesmosis in all planes, whereas the InternalBrace did not provide any additional stability compared with PM fixation (Fig. 7).

Discussion

A major finding of our study was that ORIF of the PM could restore intact fibular motion in the neutral ankle position despite transection of the AITFL and IOL. The residual instability in dorsiflexion and plantar flexion of the ankle could only be restored with additional stabilization with either a syndesmotic screw or AITFL augmentation. Contrary to clinical speculation[6], the residual instability resulted in posterior displacement and external rotation of the fibula rather than lateral translation. Anatomic augmentation of the AITFL showed similar additional syndesmotic stabilization compared with a rigid syndesmotic screw and may therefore be an alternative option without the need for implant removal.

The current literature shows the superior biomechanical stability of ORIF of the PM compared with the use of syndesmotic screws or suture-button fixation alone[15,18]. Gardner et al. showed that a syndesmotic screw restored 40% of the ankle stiffness in response to an external rotation torque of 4 Nm, whereas ORIF of the PM restored 70%[18]. These results are similar to those of the present study, which showed 76% restoration in the neutral position (sagittal displacement of the distal fibula in the neutral position, 1.3 mm with ORIF of the PM versus 5.5 mm with PM osteotomy + transected AITFL and IOL). However, Gardner et al. only tested specimens in the neutral position and only measured external rotation of the fibula. Stake et al. showed that ORIF of the PM stabilized the syndesmosis better than a regular syndesmotic suture-button[15]. In that study, a significant increase in posterior translation and external rotation remained with ORIF of the PM compared with the intact state in the neutral position, whereas in our study, ORIF of the PM restored syndesmotic stability compared with the intact state. Stake et al. fixed the PM with a single 3.5-mm screw, whereas in our study, a 3-hole 3.5-mm one-third tubular plate was implanted, which has previously been shown to be biomechanically superior[15,19]. Although the other authors showed an additive benefit of AITFL augmentation following

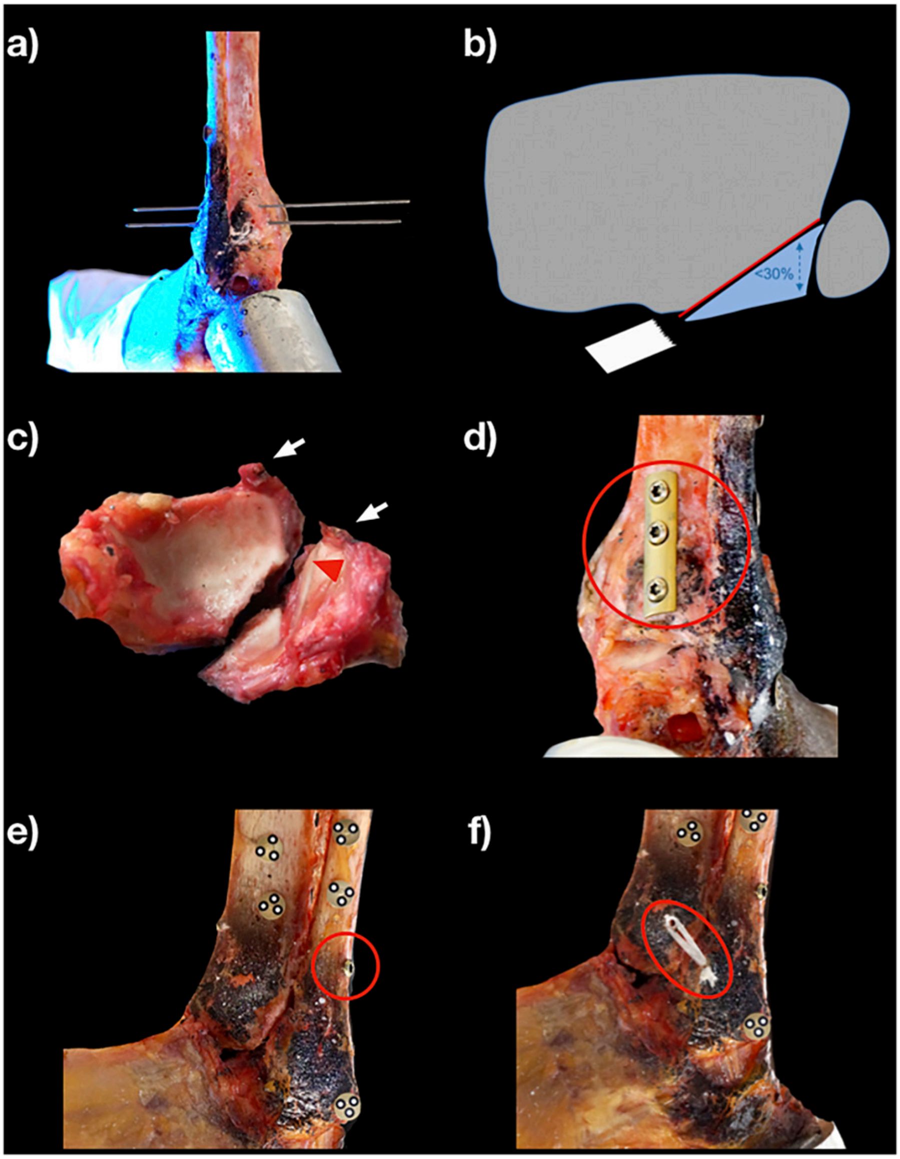

Fig. 3

Figs. 3-A through 3-F Test sequence with an example cadaveric left foot specimen. A black spray pattern was added in the region of the AITFL to enhance optical measurement of the elongation of the fibers, but only the optical markers were included in the final analysis. **Fig. 3-A** Two Kirschner wires parallel to the PM osteotomy. **Fig. 3-B** Schematic image of the PM osteotomy plane in an axial view. **Fig. 3-C** Tibial plafond after dissecting the foot at the end of testing, showing the PM osteotomy and transected AITFL (white arrows) and IOL (red arrow). **Fig. 3-D** ORIF of the PM. **Fig. 3-E** Implantation of the syndesmotic screw. **Fig. 3-F** AITFL augmentation.

ORIF of the PM, similar to our results, they did not evaluate stability in dorsiflexion.

Another finding of our study was that additive stabilization with either a syndesmotic screw or AITFL augmentation stabilized fibular kinematics of the syndesmosis in plantar flexion as well, with no significant differences between the 2 groups or with the combination of both procedures. Comparing the 2 procedures, the syndesmotic screw tended to reduce fibular sagittal shift, whereas AITFL augmentation tended to better stabilize external rotation. Shoji et al. demonstrated restored syndesmotic stability with AITFL augmentation, whereas syndesmotic screw stabilization was more rigid and overconstrained. Differences between that and the present study were the implantation of a quadricortical 4.5-mm syndesmotic screw, the use of manual weights to load the syndesmosis, and the measurement of only lateral displacement and external rotation of the fibula but not the sagittal motion[14]. Another biomechanical study showed equal restoration of syndesmotic stability with AITFL augmentation combined with a syndesmotic suture-button compared with a syndesmotic screw[20]. In that

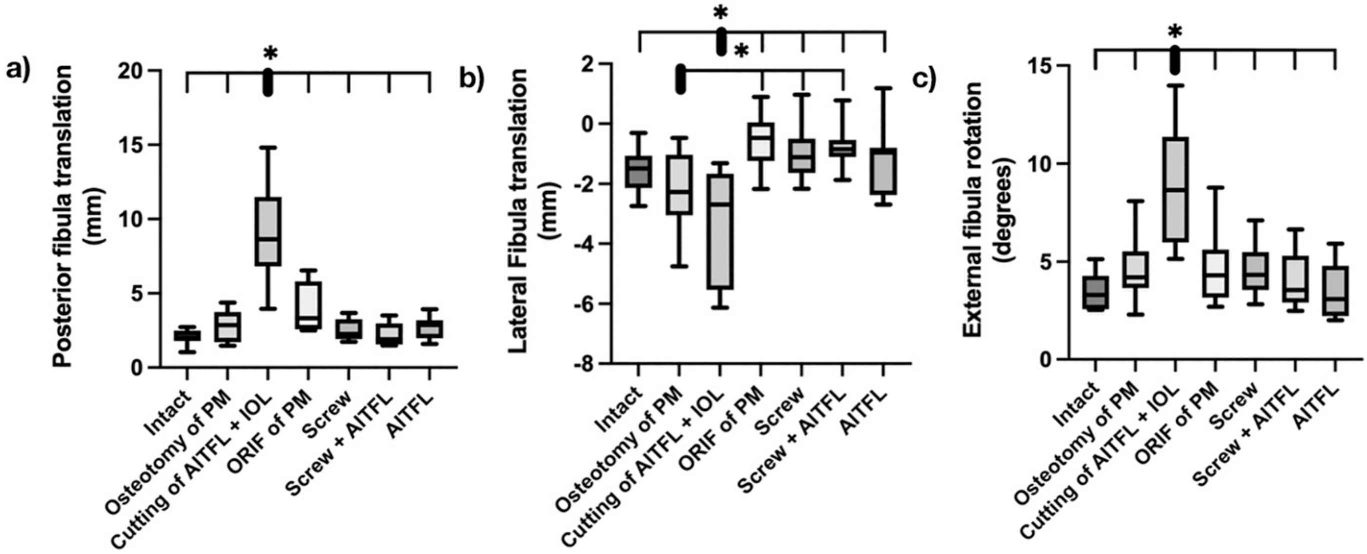

Fig. 4

Figs. 4-A, 4-B, and 4-C Kinematics of the distal fibula in the neutral ankle position in response to a 5-Nm external rotation stress test, with sequential cutting (bars 1 to 3) and sequential reconstruction (bars 4 to 7). Data were analyzed by repeated-measures 1-way analysis of variance, followed by the Tukey range test. Data are presented in box plots, with the box representing the interquartile range, the horizontal line within the box representing the median, and whiskers representing the minimum and maximum values. Horizontal bars represent significance (*p < 0.05). Significant findings may not be clinically relevant, as current literature defines relevant syndesmotic instability only as approximately 2 to 3 mm and more. **Fig. 4-A** Sagittal shift. **Fig. 4-B** Coronal shift. **Fig. 4-C** Axial rotation.

study, simulated laxity testing was performed only in the neutral ankle position and the posterior inferior tibiofibular ligament was transected instead of a PM osteotomy.

Although these studies showed similar results of additional syndesmotic screw and AITFL augmentation, it is well known that the use of screw fixation can result in complications

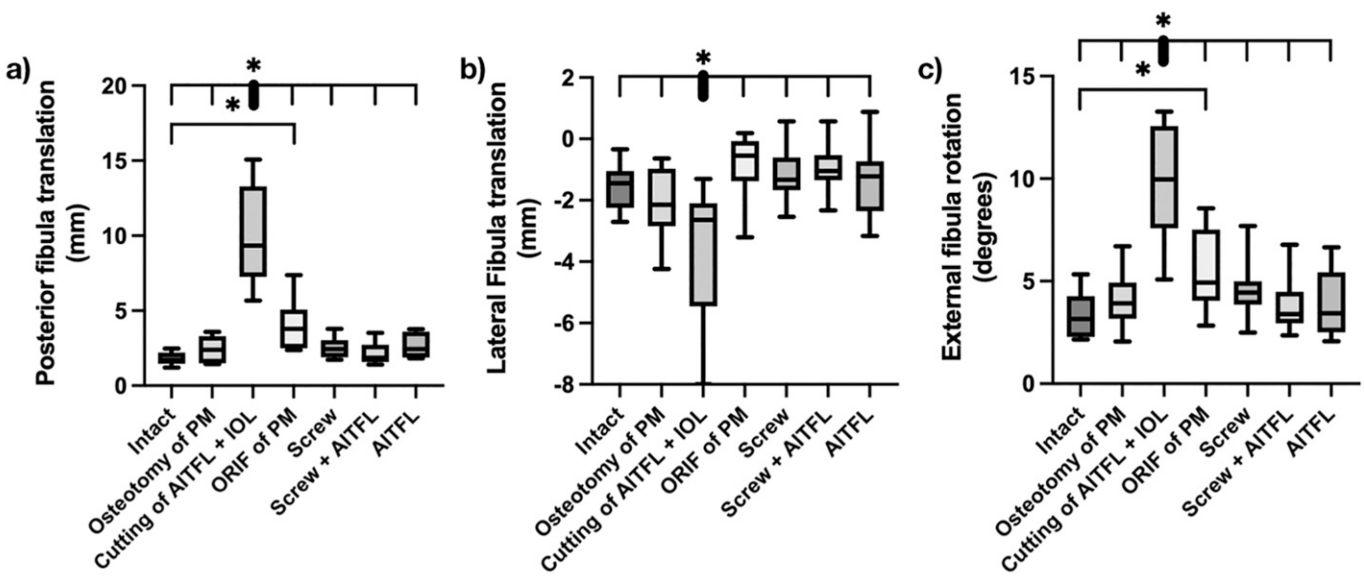

Fig. 5

Figs. 5-A, 5-B, and 5-C Kinematics of the distal fibula in 10° dorsiflexion in response to a 5-Nm external rotation stress test, with sequential cutting (bars 1 to 3) and sequential reconstruction (bars 4 to 7). Data were analyzed by repeated-measures 1-way analysis of variance, followed by the Tukey range test. Data are presented in box plots, with the box representing the interquartile range, the horizontal line within the box representing the median, and whiskers representing the minimum and maximum values. Horizontal bars represent significance (*p < 0.05). Significant findings may not be clinically relevant, as current literature defines relevant syndesmotic instability only as approximately 2 to 3 mm and more. **Fig. 5-A** Sagittal shift. **Fig. 5-B** Coronal shift. **Fig. 5-C** Axial rotation.

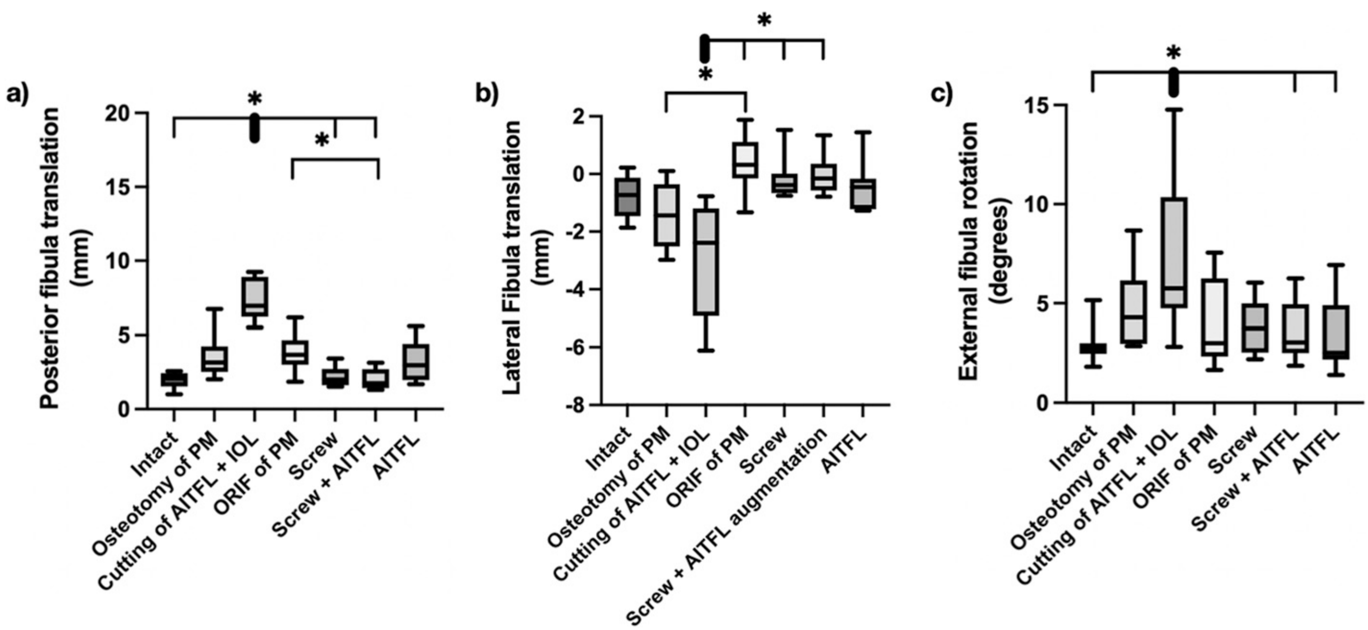

Fig. 6

Figs. 6-A, 6-B, and 6-C Kinematics of the distal fibula in 15° plantar flexion in response to a 5-Nm external rotation stress test, with sequential cutting (bars 1 to 3) and sequential reconstruction (bars 4 to 7). Data were analyzed with the Friedman test and Dunn correction. Data are presented in box plots, with the box representing the interquartile range, the horizontal line within the box representing the median, and whiskers representing the minimum and maximum values. Horizontal bars represent significance (*p < 0.05). Significant findings may not be clinically relevant, as current literature defines relevant syndesmotic instability only as approximately 2 to 3 mm and more. **Fig. 6-A** Sagittal shift. **Fig. 6-B** Coronal shift. **Fig. 6-C** Axial rotation.

such as a malreduction rate of up to 30% or recurrent syndesmotic instability after screw removal[21-23]. A prospective randomized study by Zhan et al.[12] compared the use of two 3.5-mm tricortical syndesmotic screws versus AITFL augmentation in ankle fractures involving the PM. AITFL augmentation showed equivalent functional outcomes, but earlier return to work, a

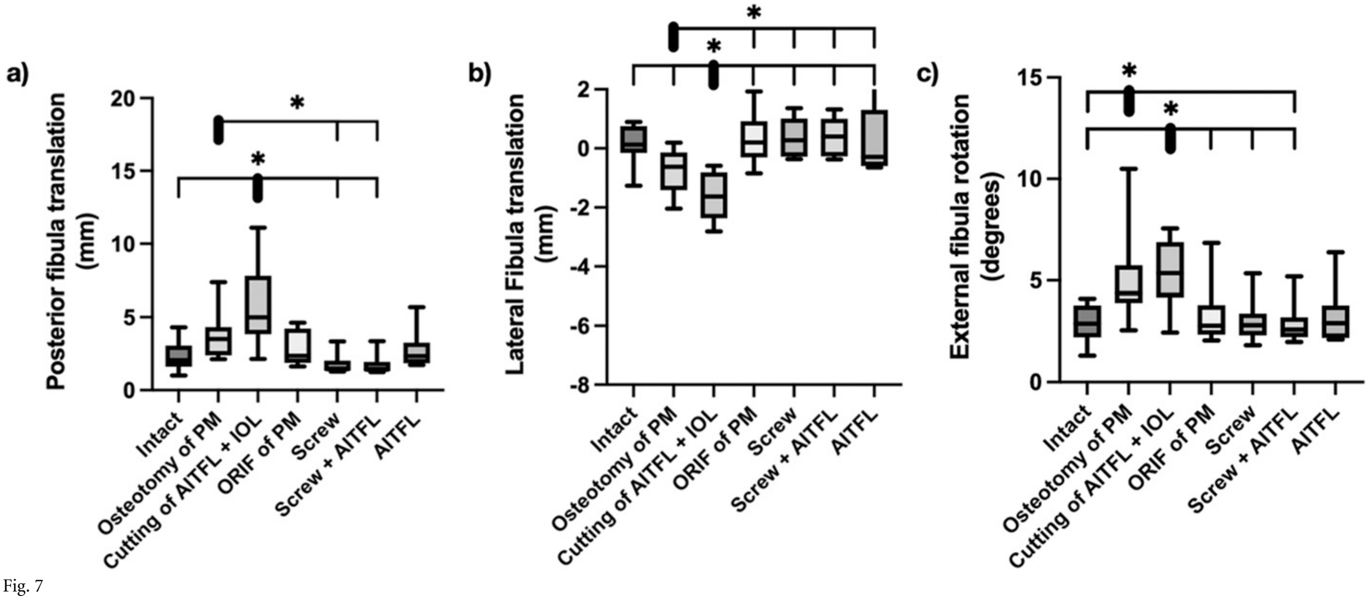

Fig. 7

Figs. 7-A, 7-B, and 7-C Kinematics of the distal fibula in 30° plantar flexion in response to a 5-Nm external rotation stress test, with sequential cutting (bars 1 to 3) and sequential reconstruction (bars 4 to 7). Data were analyzed with Friedman test and Dunn correction. Data are presented in box plots, with the box representing the interquartile range, the horizontal line within the box representing the median, and whiskers representing the minimum and maximum values. Horizontal bars represent significance (*p < 0.05). Significant findings may not be clinically relevant, as current literature defines relevant syndesmotic instability only as approximately 2 to 3 mm and more. **Fig. 7-A** Sagittal shift. **Fig. 7-B** Coronal shift. **Fig. 7-C** Axial rotation.

lower complication rate, and a trend toward a lower malreduction rate.

One of the clinical benefits of ORIF of the PM was the reduced need for additional syndesmotic screws[7,8]. However, this supposed benefit is contradicted by the results of the present study, as a 2-ligament injury of the syndesmosis followed by PM fixation still resulted in sagittal and axial instability at 10° dorsiflexion with a 2.2-mm dorsal shift and 2.0° external rotation of the fibula; however, the former is at the limit of the minimal clinically important difference, as syndesmotic instability only appears relevant at approximately 2 to 3 mm and more[3-5]. Therefore, the significant findings of our study may not be clinically relevant, especially as there is no consensus regarding the clinically relevant level of rotational instability in degrees.

Syndesmotic instability is clinically assessed on a mortise view, which is particularly sensitive in the coronal plane[6]. Our data suggest a predominantly dorsal shift and external rotation of the distal fibula as the syndesmosis becomes unstable. This finding is consistent with those of Candal-Cuoto et al., who demonstrated a sagittal instability of the distal fibula, with a dorsal shift of 8.8 mm compared with a lateral translation of the fibula of only 1.5 mm[24]. On the basis of these data, a hook test or external rotation stress test that translates the fibula posteriorly in a lateral radiograph may be more sensitive in detecting a syndesmotic instability than the use of a mortise view.

The present study had several limitations. Syndesmotic injuries often include a deltoid ligament rupture or medial malleolar fracture, which were not evaluated in this study. We decided to exclude medial instability to reduce confounding variables[15]. We compared AITFL augmentation to the syndesmotic screw and not to a suture-button system; however, it was ensured that an anatomical reduction of the syndesmosis was performed and that malreduction as a result of the predrilled channels was avoided. Our biomechanical study lacked active muscle forces, resulting in a static model with nonphysiological loading of the syndesmosis complex. The osteotomy of the PM with a saw blade (thickness, 0.6 mm) resulted in a ventral shift of the PM fragment following refixation of 0.6 mm, which could potentially bias the syndesmotic kinematics. The fixed sequence of the first part of the study protocol may have confounded our results because only the sequence of additional syndesmotic stabilization was randomized. Significant findings in our study cannot be directly extrapolated to the clinical setting, as they may differ from the definition of clinically relevant syndesmotic instability. We only analyzed the most common posterolateral Bartoníček/Rammelt type-2 fracture, while other fracture morphologies may have a different effect on syndesmotic instability.

Conclusions

ORIF of the PM was able to restore motion of the fibula to that of the intact state only in the neutral ankle position in this model of a deficient AITFL and IOL. The remaining instability in dorsiflexion and plantar flexion could only be stabilized with use of an additional syndesmotic screw or with augmentation of the AITFL.

Surgeons are advised to evaluate for residual syndesmotic instability following ORIF of the PM, which can be detected by a specific posterior shift of the fibula on stress testing. In these cases, AITFL augmentation was found to be biomechanically equivalent to a syndesmotic screw. ■

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