Abduction Stress Imaging to Assess Medial Column Stability in Subtle Lisfranc Injuries

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STATEMENT OF PURPOSE

Gently displaced or highly comminuted Lisfranc fracture-dislocation injuries are easy to diagnose on standard radiographs, while subtle injuries are more challenging to identify. The medial column is particularly prone to primarily ligamentous injury which is often not displaced or unquantified on standard radiographs. MRI or CT (Figure 1). Early diagnosis of an unstable pattern of injury has implications when choosing the appropriate treatment. A delayed diagnosis can lead to poor long term outcomes. Abduction stress imaging is ideal, but the exam is painful in the acute setting, may be limited by guarding, limited to a specific location, and may be unable to be performed without sedation or a standardized protocol. We therefore determined to perform an abduction stress examination, with the MRI and CT showing sustained abduction, to assess for subtle ligamentous injuries. A positive or negative MRI or CT findings should be considered as the test is set up to work off of initial scan's imaging abnormalities.

LITERATURE REVIEW

Traumatic injuries to the tarsometatarsal (TMT) joint, or Lisfranc joint, account for 0.2-0.5% of all fractures sustained by non-athletes (3). Lisfranc injuries with gross dislocation or comminution often appear obvious on standard radiographs, but subtle injuries can be more challenging, with acutely displaced trauma or fractures potentially manifesting the clinical picture of a type of subtle injury more difficult to diagnose. It has been reported that Lisfranc injuries are missed in up to 31% of cases, especially in subtle Lisfranc injuries (2,3). Initial imaging should include weight-bearing AP (or anterior-posterior), (medial, oblique) and lateral views (2). Due to natural occurring bone overlap in the midfoot area, it may be difficult to identify fractures or ligamentous injury on standard radiographs. Nuclear scans found 50% of their athletes who had Lisfranc sprains had normal radiographs (4). When radiographs are inconclusive, further imaging such as weight-bearing (WB) radiographs, stress imaging, CT, or MRI may be considered.

CT has been proven to be superior to radiographs (5) and MRI has been shown to correctly classify 90% of Lisfranc joint injuries (6). However, these modalities are expensive, not always available, and do not image the foot under stress. Radiographs are an alternative imaging modality to be considered in the work-up for subtle Lisfranc fracture-dislocation. In 2007, Kael and colleagues reported their results on a cadaveric study, concluding that compared with WB radiographs, manual stress radiographs showed greater ankle joint translational displacement and could evaluate for instability (7).

The study demonstrated that the lateral aspect of the 1st cuneiform and the medial aspect of the 2nd metatarsal on the AP view is the primary parameter used to identify displacement or instability of the TMT joint on both WB radiographs and stress images. The 2nd metatarsal base is a highly significant parameter base which acts as the "keystone" to provide stability to the midfoot (8). A range of 2 to 5 mm of diastasis generally indicates a secondary instability and has a sensitivity of 2/3 as clinical instability in the cadaveric study (7). Assessment of the alignment of the 1st and 2nd metatarsal with their respective cuneiform joints may be used to evaluate for instability.

Stress imaging techniques vary but the stress trauma abduction maneuver involves grasping the 2nd metatarsal head with the thumb and index finger of one hand to apply an abduction force. The other hand palpates the talus and assesses for abnormal motion on the AP ray or instability and only independently evaluate the medial column. We propose an abstraction imaging protocol with greater focus on the medial column for subtle or seemingly non-displaced Lisfranc injuries. This technique is simple, safe, and non-invasive with no radiation exposure. It allows for a more accurate identification of instability in the midfoot. This technique is effective in identifying instability within the tarsal-metatarsal joint.

MEDIAL COLUMN STRESS ABDUCTION IMAGING TECHNIQUE

Abduction stress imaging is performed with the patient in the supine position on a radiography table with the leg relaxed in slight plantarflexion. The examiner stands or sits at the lateral side of the affected foot (right foot in this description). The exam's right hand is placed over the affected right foot sole with multiple fingers wrapped around the distal half of the 1st metatarsal & 1st toe. Counter pressure is applied laterally at the cuboid with the exam's left hand. The heel posteriorly is wrapped against the lateral side of the heel while applying counter pressure with the left thumb at the lateral aspect of the foot. This maneuver is performed against the plantarflexion plane of the foot and attempts to create a "breaking" abduction force through the entire midfoot. This technique minimizes superposition of the examiners hands at the area of interest and can be performed with leaded gloves. The abduction stress imaging can be captured with a static AP x-ray or using fluoroscopy (Figure 4). A proper AP x-ray placed with the tube angling 80 degrees to the dorsal aspect of the metatarsal shafts (or 75 degrees off of the plantar surface of the foot). A positive test will show lateral displacement and gapping of the first and second TMT joints (Figure 3). A negative stress test can be followed by an isolated second ray stress exam, similar to the traditional technique, which we rarely find necessary. The examiners left hand is placed over the second ray with the heel posteriorly wrapped around the medial side of the heel while applying counter pressure with the left thumb at the lateral aspect of the medial cuneiform. This technique is effective in identifying instability within the medial column.

Figure 2. Variable Hand Placement for Abduction Stress Imaging leads to inconsistent and Possibly Irrelevant Results

The examiners right hand is placed over the right forefoot with the fingers grasping the medial aspect of the 1st metatarsal head and hallux. Counter pressure is applied to the cuboid lateral with the examiners right thumb. The examiners left hand grasps the heel posteriorly with the finger wrapped around the medial side of the heel while applying counter pressure with the left thumb at the lateral aspect of the right cuboid. An abduction "breaking" force is applied to the medial column while obtaining an AP radiograph or fluoroscopic imaging.

Figure 3. Standard Radiographs for Lisfranc Injuries

Figure 4. A Clinically Based abstraction stress imaging is performed with the patient lying supine, the knee bent and the foot positioned flat on a cassette for an AP x-ray view as shown on the right foot. The examiners right hand is placed over the affected right foot sole with multiple fingers wrapped around the distal half of the 1st metatarsal & 1st toe. Counter pressure is applied laterally at the cuboid with the exam's left hand. The heel posteriorly is wrapped against the lateral side of the heel while applying counter pressure with the left thumb at the lateral aspect of the foot. This maneuver is performed against the plantarflexion plane of the foot and attempts to create a "breaking" abduction force through the entire midfoot. This technique minimizes superposition of the examiners hands at the area of interest and can be performed with leaded gloves. The abstraction stress imaging can be captured with a static AP x-ray or using fluoroscopy (Figure 4). A proper AP x-ray placed with the tube angling 80 degrees to the dorsal aspect of the metatarsal shafts (or 75 degrees off of the plantar surface of the foot). A positive test will show lateral displacement and gapping of the first and second TMT joints (Figure 3). A negative stress test can be followed by an isolated second ray stress exam, similar to the traditional technique, which we rarely find necessary. The examiners left hand is placed over the second ray with the heel posteriorly wrapped around the medial side of the heel while applying counter pressure with the left thumb at the lateral aspect of the medial cuneiform. This technique is effective in identifying instability within the medial column.

Figure 5. An AP View is Obtained While a "Breaking" Abduction Force is Applied Through the Midfoot with Focus of Stress on the Medial Column

Figure 6. Case 1 - Delayed diagnosis of subtle Lisfranc fracture-dislocation with positive intraoperative stress imaging performed in the OR

Figure 7. Case 2 - Acute presentation of subtle Lisfranc fracture-dislocation with positive intraoperative stress imaging performed in the OR

REFERENCES