Simultaneous Radiographic Technique to Evaluate Ankle Instability

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Abstract: The use of ankle stress radiographs is common to evaluate ankle instability. However, the majority of the studies report the use of a manual method to apply the stress, increasing radiation exposure to the physician. Furthermore, as reported in other studies, the force applied during the stress may vary between examiners according the strength and experience. In this Technical Note, we describe our preferred method to evaluate ankle instability, either using an inversion or eversion stress, avoiding the necessity of a physician in the radiographic room.

Ankle ligament injuries are common and often evaluated by general orthopaedic surgeons in emergency departments.[1-3] The majority of ligament injuries in the ankle involve the lateral ligament complex, which lead to significant pain and instability.[2,3] If not addressed properly in the acute setting, many lateral ankle injuries lead to chronic instability and dysfunction. This chronic instability may cause degenerative damage to the cartilage, functional limitations, and a decrease in quality of life.[4-7] For the correct diagnosis, a thorough physical examination and complementary examinations including magnetic resonance images (MRIs) and stress radiographs may be necessary. Although MRI specifically has been shown to have a high positive predictive value for lateral ankle injuries,[8] it fails to provide objective information in regards to severity of the injury.

The purpose of this Technical Note is to describe our preferred technique to evaluate ankle instability, using our customized hinge device to apply a controlled and repeatable stress force and to eliminate radiation exposure to the physician.

Radiographic Technique

Patient Position

Following the physical examination, the patient is brought to the radiographic room and placed supine on the radiographic table (Video 1). Both limbs are extended and the patient is asked to relax the inferior limb muscles. Both feet are placed in neutral position, avoiding rotation of the limbs. The customized wooden hinge device is brought to the radiographic table.

Application of the Device

To perform our radiographic technique, no expensive device is needed. We use a customized wooden hinge device to apply the stress on the ankle. This same device is used to apply either the eversion (Fig 1) or inversion (Fig 2) stress. With the patient positioned with the limbs in neutral position, both feet are secured to the device using a strap. Each foot is secured individually to the device, and care must be taken to ensure that the same position of the strap was made in both ankles. We suggest placing the strap at the joint line, avoiding the movement of the strap during the application of the stress.

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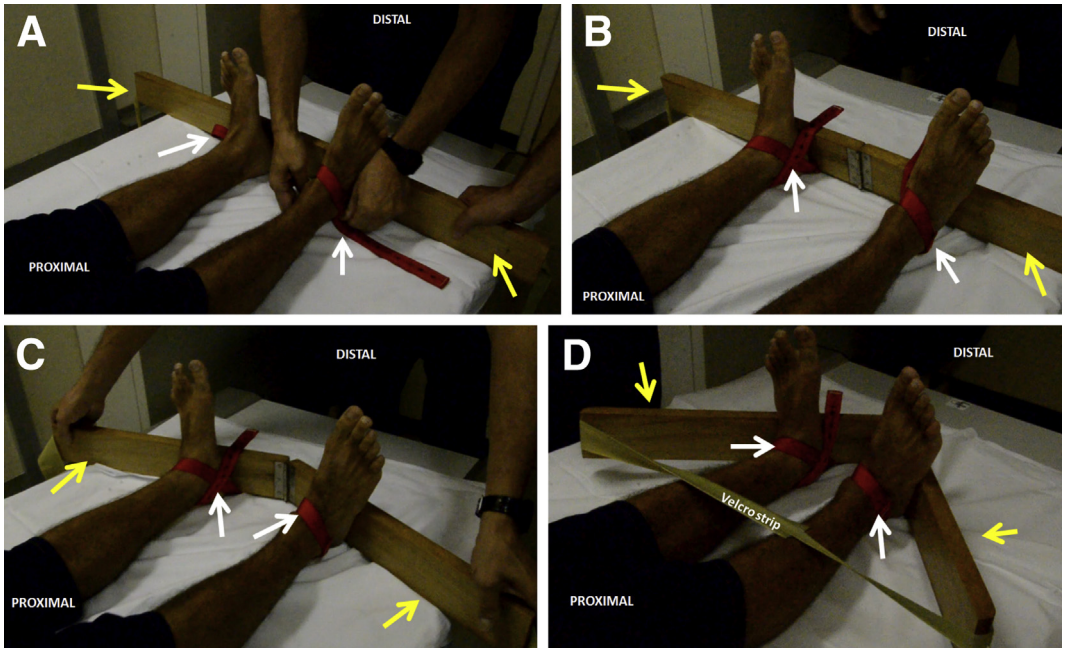

Fig 1. Eversion stress radiographs technique performed simultaneously in both limbs. A wooden hinge device (yellow arrows) is used to secure both limbs in neutral position. The straps (white arrows) are placed around the ankle (A), at the joint-line level, and secured in the device (B). Following this, the physician pushes both extremities of the device proximally, and consequently a eversion stress is applied in both ankles (C). A Velcro strip is then used to secure the hinge device in position, avoiding the need of a physician inside the radiographic room during the acquisition of the radiographs (D).

Once the feet are secured to the device, the physician progressively bends the hinge device to simultaneously apply the same stress force in both feet. Attention must be taken to avoid rotation of the limbs during this maneuver. To apply the inversion stress, the physician must pull both parts of the device distally. As the plantar aspect of the foot on the hindfoot is in close contact with the device, the foot will follow the same direction as the device, and the tibia movement will be minimal. If the eversion stress is necessary, the maneuver with the device must be the opposite, with the physician pushing the device proximally. We suggest applying enough pressure to ensure the same position the foot would be at if a traditional manual stress were performed individually to each foot. Care must be taken to avoid patient discomfort during the application of the stress, and this maneuver must be slow.

Once both feet are in the desired position, a Velcro strip connecting both ends of the hinge device is secured, avoiding the necessity of the physician in the radiographic room during the acquisition of the radiographic images (Siemens, Munich, Germany). Once the radiographic image is collected and proper position is ensured, the Velcro strip is released and the feet will turn back to the normal position. The radiographic examination is performed in a standard fashion. Advantages and disadvantages as well as pearls and pitfalls associated with the technique are summarized in Tables 1 and 2, respectively.

Discussion

Ankle and subtalar stress radiographs are used to provide additional information regarding the joint instability.[9,10] However, radiation exposure is a concern during radiographic evaluation. Although most of the radiation-induced damage will be repaired with no further consequences, misrepaired damages in the DNA can lead to induction of mutation including point mutations, chromosomal translocation, and gene fusions.[11] As a consequence of this concern about radiation risks, changes in the medical practice that decrease or avoid the radiation exposure to the patient or health care employees are extremely incentivized and highly encouraged.

Several studies have reported on the use of stress radiographs for the diagnosis and evaluation of ankle or subtalar joint instability.[9,10,12-17] Many of these studies used manual stress techniques, exposing the health care employee to radiation. Ahovuo et al.[18] and Sauser et al.[19] reported the use of special mechanical devices to apply the stress force, that we believe to be much more expensive than our hinge device. According to Sauser et al.,[19] the use of a mechanical device eliminates radiation exposure to the physician and produces a more constant stress, as manually applied stresses vary significantly according to the strength and experience of the surgeon. Furthermore, the authors report that the ideal stress device should be able to eliminate exposure to the physician, maintain the applied force, and

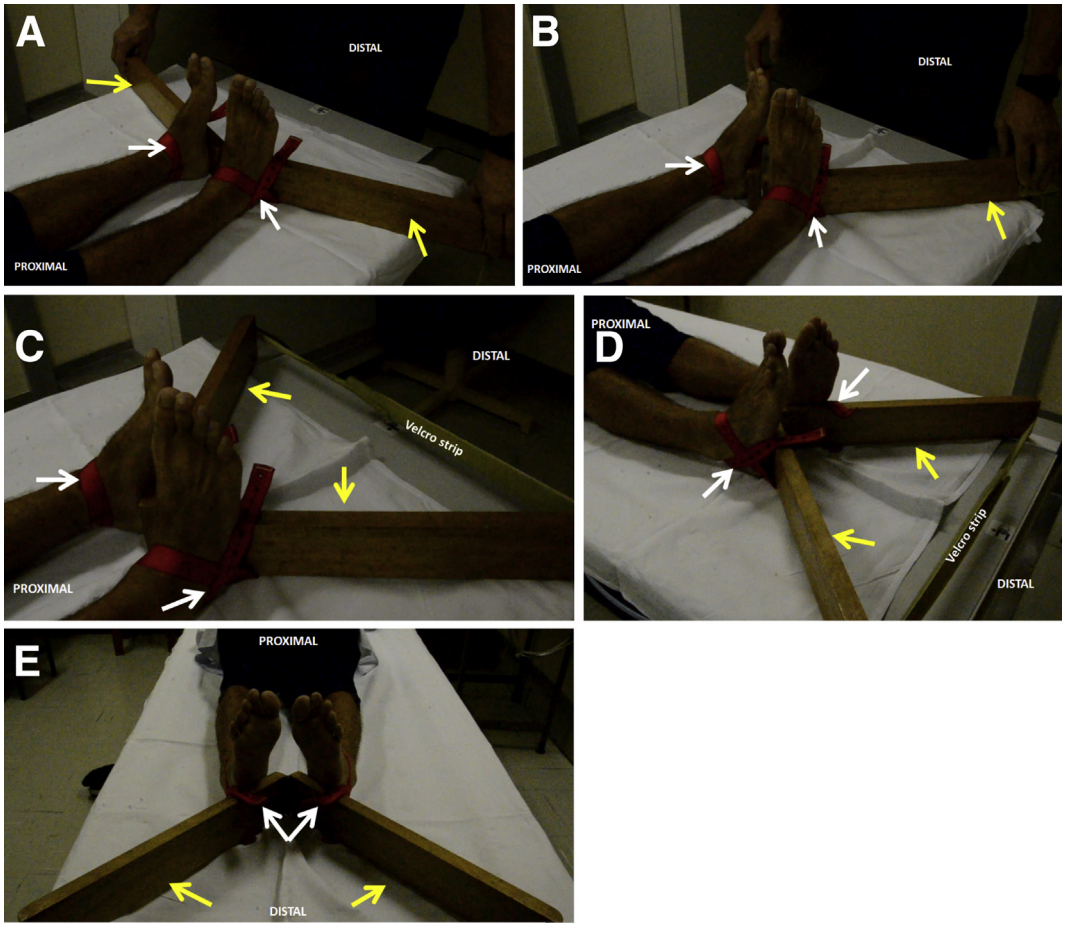

Fig 2. The same wooden hinge (yellow arrows) device can be used to apply an inversion stress to the ankle. The straps (white arrows) are placed over the ankle joint in the same fashion as the eversion test. However, to apply the inversion stress, the physician must pull both extremities of the device distally at this time (A and B), and consequently an inversion stress will be applied. The same Velcro strip is used to keep the device in the desired position (C, D, and E).

gradually apply the stress. All these criteria are present in our technique, with the benefits of using the same hinge device to apply either inversion or eversion stress to the ankle and being low cost.

In this Technical Note, we describe our preferred radiographic technique to apply either an inversion or eversion stress to the tibiotalar and subtalar joint. With this technique, both limbs are evaluated at the same time, with the same stress force applied to each side. The use of a similar device as the one created in our service allows a stable and continuous stress force. Furthermore, the use of the Velcro strip allows the realization of the radiographs without the need of the physician in the radiographic room, decreasing the radiation exposure to health care employees. We believe that the use of a device to apply the stress radiographs can be reproducible, and a single device can be used for all the patients, as it does not require sizing match. We

Table 1. Advantages and Disadvantages of Our Technique

Advantages	Disadvantages
Low-cost and reproducible	Difficult and may be painful to be performed in acute cases
Does not require the physician in room, avoiding radiation exposure	Not a validated method to apply stress force
Can be used to apply inversion or eversion stress radiographs	
Has been used for more than 35 years in our institution with success	

Table 2. Pearls and Pitfalls of Our Technique

Pearls	Pitfalls
Ensure that both limbs are in neutral position	Rotation of the limbs may alter the radiographic evaluation
The correct placement of the straps is essential to avoid movement of the tibia during the stress	The use of this device can increase the stress strength and cause pain to the patient
The stress must be slow and gradual to avoid pain or discomfort to the patient	

also acknowledge the description of a similar device by Louwerens et al.,[20] Brantigan et al.,[21] and Rubin et al.[22] However all these authors focused their description more on the inversion test, and in one study the physician was exposed to radiation.[20] Although we recommend the use of our technique, further long-term studies are necessary to validate this method.

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