Evaluation of Functional Ankle Dorsiflexion Using Subtalar Neutral Position

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This article presents the use of a specific technique when measuring ankle joint dorsiflexion for the purpose of determining the presence or absence of sufficient motion for ambulation. The importance of locating and maintaining the subtalar joint in the neutral position when applying either measuring or stretching techniques is emphasized. A brief discussion of selected compensatory mechanisms is presented to alert clinicians to symptoms that occur in the lower extremity and that may result from insufficient ankle dorsiflexion.

Key Words: Ankle joint, Physical therapy.

Physical therapists frequently are required to measure ankle joint motion during initial and serial assessments of the lower extremity. The purpose of these range-of-motion evaluations is to determine whether the joint motion is normal. The American Academy of Orthopaedic Surgeons has described the average normal ROM for individual joints. Because of individual variations, clinicians often must determine whether the minimum amount of motion necessary for function is present at a joint.

The purposes of this report are to 1) propose a minimal functional ROM for ankle dorsiflexion during ambulation, based on existing research data and 2) support a specific measurement technique, based on the motion of the ankle joint and the subtalar joint (STJ) during normal human locomotion. Selected psychomotor aspects of the technique are described, and clinical applications are discussed.

BIOMECHANICAL BASIS OF PROPOSED TECHNIQUE

The degree of ankle joint dorsiflexion that is sufficient varies from individual to individual depending on factors such as type of daily activities, heel height of shoes, and structure of the forefoot. Despite these differences, practitioners can determine the average amount of dorsiflexion needed for ambulation. During the mid-stance portion of stance phase of gait, the leg moving over the foot produces ankle dorsiflexion. This dorsiflexion reaches a peak just before heel-rise (Fig. 1). The magnitude of ankle dorsiflexion shows variability between subjects, but generally is in the range of 5 to 15 degrees, with Root et al reporting a minimum of 10 degrees. Based on these data, the clinician must assess whether this minimal functional motion of 10 degrees is present.

The position of the STJ during ambulation and its effect on the measurement of ankle dorsiflexion also is of critical importance. The foot has two primary functions: It must be a mobile adaptor and a rigid lever. The changing position of the STJ allows the shift from one function to the other. Figure 2 shows that during normal ambulation the STJ pronates initially, which increases the mobility of the midtarsal joint (MTJ) and allows the foot to act as a mobile adaptor. The STJ then must return to a supinated position to produce a rigid foot for propulsion. The STJ passes from a pronated to a supinated position just before heel-rise, si-
Fig. 2. Subtalar joint passing from a pronated (PRO) to a supinated (SUP) position just before heel-rise. (HS = heel-strike, FF = foot flat, HR = heel-rise, TO = toe-off.)

Fig. 3. Alignment of the arms of the goniometer.

multaneously with maximum ankle dorsiflexion.

Because maximum ankle joint dorsiflexion occurs when the STJ is in its neutral position, practitioners must measure ankle dorsiflexion with the STJ in the neutral position. During clinical measurements, if the STJ is pronated (MTJ mobility increased) dorsiflexion can occur around the oblique axis of the MTJ. This MTJ motion may be misleading to the clinician and may conceal true limitation of ankle dorsiflexion.

APPLICATION OF PROPOSED TECHNIQUE

The clinician has two tasks to perform simultaneously: 1) locating and maintaining the neutral position of the STJ and 2) dorsiflexing the ankle and measuring the angle of dorsiflexion with a goniometer. Although a detailed description of how to locate the STJ neutral position is beyond the scope of this report, a procedure that involves the palpation of the osseous structures is described elsewhere.

When the neutral position has been established, the examiner forcefully dorsiflexes the ankle while the patient actively assists the dorsiflexion force. This active assistance is necessary to achieve reciprocal inhibition of the passive tension generated in the calf muscles. The examiner then will measure the range of dorsiflexion by aligning the goniometer arms with a line bisecting the lateral aspect of the lower leg and a line from the lateral aspect of the calcaneus to the fifth metatarsal head (Fig. 3). The angle between the lower leg and the lateral border of the foot should be 80 degrees or less to be considered sufficient for ambulation. The measurement should be performed both with the knee extended and with the knee flexed in an attempt to differentiate limitations resulting from the gastrocnemius and soleus muscles. For normal ambulation, the extended position is most appropriate because the knee is close to the fully extended position when maximum dorsiflexion occurs just before heel-rise.

During the measurement of ankle dorsiflexion, clinicians may be uncertain whether they have maintained the STJ in its neutral position while dorsiflexing the ankle. The calcaneus will move in the sagittal plane as the ankle dorsiflexes. If the calcaneus everts, indicating pronation of the STJ, the MTJ then may provide "dorsiflexion," resulting in an invalid measurement. Often clinicians will observe that in patients lacking sufficient dorsiflexion, the calcaneus will try to evert when active assistance is initiated. This calcaneal eversion must be prevented manually by holding the calcaneus in the neutral position.

CLINICAL IMPLICATIONS

If this specific technique is followed, clinicians may discover many instances of patients not having sufficient ankle joint dorsiflexion. This insufficiency, if small, often is compensated for by the heel height of the individual's shoes. When the patient lacks 5 degrees or more of motion, the body is forced to compensate in some manner. These compensations frequently have deleterious effects on other structures in the lower extremity.

Early heel-rise, which does not produce harmful effects, might occur. More commonly, however, the body's compensatory mechanisms are far more injurious. Genu recurvatum and abnormal arthrokinematics of the ankle joint leading to osteophyte formation (talar exostosis) are common findings. Stress at the ankle and posterior aspect of the knee can be reduced if the STJ pronates or remains pronated during mid-stance, allowing dorsiflexion at the MTJ. Unfortunately, this compensatory pronation increases medial and rotational stress at the knee and causes the foot to be a mobile adaptor when it should be a rigid lever for propulsion. In many cases, normal ambulation will return and symptoms in the foot, leg, and knee will disappear when a sufficient amount of ankle joint dorsiflexion is restored.

This procedure not only is critical to accurate assessments but also is essential to effective stretching programs. If the well-known "leaning-into-the-wall" stretch is used, the STJ must be held in the neutral or a slightly supinated position, either actively by the person or
passively by wedging the medial border of the foot. A common practice is to instruct the person to rotate the leg medially as part of the stretching procedure to prevent STJ pronation. This method may be ineffective because the STJ, although assuming a supinated position, still can pronate during the stretch unless the individual is instructed to prevent the pronation from occurring.

SUMMARY

To determine the presence or absence of sufficient motion for ambulation, a specific technique must be used. The STJ must be located and maintained when applying either measuring or stretching techniques. This report proposes a minimal functional ROM for ankle dorsiflexion during ambulation and supports a specific measurement technique based on motion of the ankle joint and the STJ during normal human locomotion.

REFERENCES

2. Inman VT, Ralston HJ, Todd T: Human Walking. Baltimore, MD, Williams & Wilkins, 1981, pp 16-17, 46