PROLAB ORTHOTICS
Evidence-Based Medicine

Biomechanics & Orthotic Therapy Newsletter
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## SUPINATION RESISTANCE TEST: RESEARCH EVIDENCE AND CLINICAL APPLICATION

Toward the end of my Biomechanics Fellowship at the California College of Podiatric Medicine (CCPM) in 1985, I began experimenting with a clinical test created to estimate the amount of tension force required within the posterior tibial (PT) muscle and tendon to initiate supination motion at the subtalar joint (STJ). I first described this clinical test, the Supination Resistance Test, in a chapter I coauthored with Donald Green in 1992 (Kirby KA, Green DR: Evaluation and Nonoperative Management of Pes Valgus, pp. 295-327, in DeValentine, S.(ed), Foot and Ankle Disorders in Children. Churchill-Livingstone, New York, 1992).

I created the Supination Resistance Test (SRT) since I was not convinced that any of the measurements that I had been taught to perform during my student years at CCPM were capable of determining the amount of STJ pronation moment acting on the weightbearing foot (Root ML et al.: Biomechanical Examination of the Foot, Volume 1. Clin Biomech Corp, Los Angeles, 1971). These static measurements looked at foot and lower extremity joint position in standing but did not attempt to determine the force required to rotate these joints. I had become more convinced during this time that these static measurements we were all performing at the time were useless in trying to understand the abnormal STJ pronation forces acting on the foot that caused such pronation-related pathologies as PT tendinitis and posterior tibial tendon dysfunction (PTTD).

In order to perform the SRT, the subject is placed into relaxed bipedal stance with equal weight on each foot (Fig. 1). The examiner then manually uses their index and middle fingertips to apply a lifting force to the medial aspect of the navicular bone in the medial midfoot until the STJ begins to supinate (Kirby, Green, 1992). The amount of medial navicular lifting force required to cause STJ supination is then recorded as being either a mild, moderate or a very strong lifting force. It is likely that the amount of force required by the examiner to supinate the STJ during the performance of the SRT is directly correlated to the magnitude of PT tendon and muscle tension force required to supinate the foot in relaxed bipedal stance.

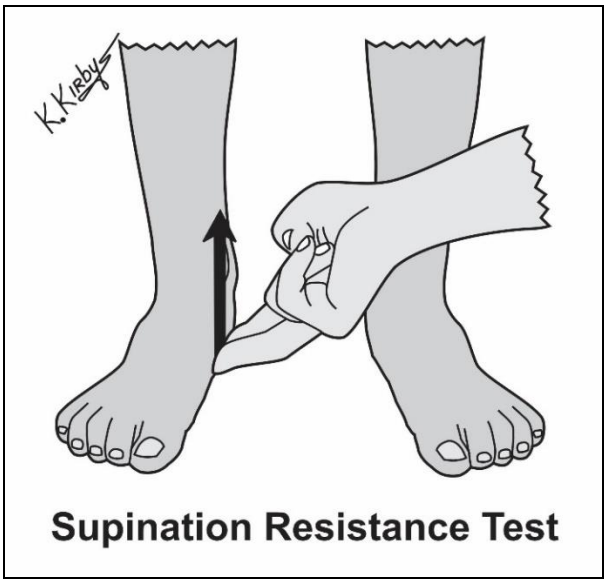


**Figure 1.** In the supination resistance test (SRT), the examiner uses their fingertips to pull upwards on the medial aspect of the navicular when the patient is in relaxed bipedal stance. The SRT can be used to estimate the amount of tension force required from the posterior tibial muscle-tendon to supinate the subtalar joint and may also serve as a valuable clinical test to determine the best custom foot orthosis modifications to treat the patient's foot pathology.

Over the past 30+ years since the SRT was first described within the medical literature, an increasing number of researchers have studied the reliability, biomechanics and clinical application of the SRT in various foot pathologies. In 2003, Payne et al. studied the correlation of the SRT to the STJ axis position in 47 subjects (Payne C et al.: Position of the subtalar joint axis and resistance of the rearfoot to supination. JAPMA, 93(2):131-135, 2003). These researchers used the manual STJ axis location test to determine STJ axis location on the plantar foot and found that the SRT positively correlated both to increased body weight and to a more medial STJ axis position (Kirby KA: Methods for determination of positional variations in the subtalar joint axis. JAPMA, 77: 228-234, 1987).

Then, in 2012, Griffiths and McEwan used a new "supination resistance measuring device" that closely reproduced the biomechanics of the manual SRT in a study of 26 subjects. Their supination resistance measurement device was highly correlated to the manual SRT. However, they also found that their instrumented SRT correlated poorly to the Foot Posture Index and correlated weakly to body weight (Griffiths IB, McEwan I: Reliability of a new supination resistance measurement device and validation of the manual supination resistance test. JAPMA, 102(4):278-289, 2012).

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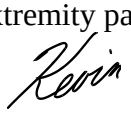
In 2019, the first research paper which studied the correlation of the SRT to gait function was published. McBride et al measured the kinematics and kinetics in 10 healthy adult subjects to determine whether any of the biomechanical parameters of walking gait correlated to the SRT as measured by the Keystone device, a new commercial device specifically designed to measure the forces required to perform the SRT. These researchers found that the SRT during relaxed bipedal standing was inversely related to maximum midfoot pronation moments, maximum midfoot plantarflexion moments, and peak midfoot power generation during walking gait (McBride S et al.: The relationship between supination resistance and the kinetics and kinematics of the foot and ankle during gait. Gait & Posture, 73:239-245, 2019).

The reliability of the Keystone device used for measuring the SRT was also studied in 2022 by Moison et al. The researchers studied 30 adults that had their SRT measured with the Keystone device in two sessions, spaced one week apart. They found that both the intrarater reliability and interrater reliability of the SRT were good and concluded that the Keystone device was a reliable tool that may be used in both clinical and research applications (Moisan G et al.: The Keystone device as a clinical tool for measuring the supination resistance of the foot: A reliability study. Musculoskeletal Care, (3):570-6, 2022).

In the most recent research on the SRT, just published in December 2023, Moisan et al. designed a research study to see if the SRT correlated to individuals with the pathologies of plantar fasciopathy (PF), PTTD and chronic ankle instability (CAI). Fourteen subjects with PF, 14 subjects with PTTD and 14 subjects with CAI were studied using the Keystone device and SRT to determine the amount of force necessary to supinate the STJ. The researchers found that supination resistance was lower for the injured foot for CAI ($p < 0.001$) and greater for PTTD ($p < 0.001$), when compared to the healthy foot. There was no significant between-foot difference observed for PF and controls. In another part of their study, a 10° valgus-inclined surface increased the SRT value and a $10^0$ varus-inclined surface decreased the SRT value for the subjects (Moisan G et al.: Supination resistance variations in foot and ankle musculoskeletal disorders: implications for diagnosis and customised interventions with wedged insoles. J Foot Ankle Res, 6(1):1-10, 2023).

It is important to note here that the results from the most recent 2023 research study by Moisan et al. correlates well with the findings that would be expected using the STJ Axis Location and Rotational Equilibrium (SALRE) Theory of Foot Function (Kirby KA: Subtalar joint axis location and rotational equilibrium theory of foot function. JAPMA, 91:465-488, 2001). In other words, SALRE theory proposes that alterations in STJ axis spatial location alter the STJ pronation and supination moments acting on the foot during weightbearing activities. Thus, a foot with a medially deviated STJ axis would require greater STJ supination moments to supinate the STJ and a foot with laterally deviated STJ axis would require decreased STJ supination moment to supinate the STJ. Since feet with PTTD have been found to have medially deviated STJ axes (Kirby KA: Conservative treatment of posterior tibial dysfunction. Podiatry Management, 19:73-82, 2000) and CAI has been proposed to often result from lateral deviation of the STJ axis (Kirby KA: Biomechanics of the normal and abnormal foot. JAPMA, 90:30-34, 2000), Moisan et al.'s 2023 research results are nicely explained using the biomechanical concepts contained within SALRE theory.

In conclusion, the SRT is a useful clinical test that can be easily performed to help determine the balance of STJ pronation and supination moments acting within the weightbearing foot. Patients requiring a large amount of force to supinate the foot with the SRT will likely require extra pronation-controlling features (e.g., medial heel skives) added into their custom foot orthoses. Patients who require little SRT supination force will not likely require any pronation-controlling features and may, in fact, require supination-controlling features added to their orthoses (e.g., valgus wedges). The podiatrist should be aware of and know how to use clinical tests such as the SRT in order to determine how best to modify custom foot orthoses to improve the comfort and function of their patients with mechanically-based foot and lower extremity pathologies.



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