

STUDY COPY WITH SELECTED RESULTS

STABILIZATION OF THE ANKLE JOINT DURING SIMULATED SUPINATION BY MEANS OF THE ANKLE ORTHOSES MalleoLoc® L AND MalleoLoc® L3

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DISCUSSION

The analysis of numerous clinical and biomechanical studies reveals two basic principles of joint stabilization: active (the neuromuscular system) and passive (ligaments, joint contact, and joint capsule) functional joint stabilization. The two different stabilization mechanisms can replace each other as well as complement each other depending on the corresponding present needs [7].

This study examines the function of the MalleoLoc L and L3 during simulated ankle supination, taking into account a dynamic injury scenario. The simulated movements, similar to ankle sprains, in a functional setting are close to the conditions prevailing during everyday activities and sporting activities. A previous study already showed that ankle orthoses (e.g. MalleoLoc from Bauerfeind AG) have a stabilizing effect on the ankle joint by limiting the extent of supination [3]. The current results also suggest that the stabilization of the ankle joint by means of orthoses is possible in those functional dynamic situations. In particular, the MalleoLoc L3 reduced both the maximum joint displacement as well as the maximum speed of joint displacement with respect to injury-related ankle inversion and internal rotation.

Since supination traumas occur at approx. 50–150 ms after a foot's contact with the ground, rapid and effective protection is crucial.

The data from this study prove that, especially at this stage, the ankle orthoses already effectively counteract supination. In addition to purely mechanical stabilization, ankle orthoses also seem to provide neuromuscular stabilization for the ankle by increasing pronation while the foot is in contact with the floor and laterally shifting the center of pressure (COP), further promoting the tendency towards pronation [8].

In a study population in the U.S. (794,340 patients, according to the ICD-9 code in the U.S. Public Health Service), only 9% of the affected patients received an orthopedic aid after suffering from supination trauma [1]. However, several studies have shown that early functional treatment, including ankle orthoses, is superior to conservative therapy requiring immobilization. The parameters used as a benchmark are ROM, "return to sport", "return to work", permanent swelling, objective stability, and patient satisfaction [4,5]. Additionally, ankle orthoses can be used effectively for secondary prevention [9]. This study also shows that, during an induced supination movement, the MalleoLoc L3 and the MalleoLoc L orthoses limit the inversion and internal rotation of the foot substantially when walking, counteracting damage caused by ankle sprains.

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BACKGROUND

In-depth knowledge of the functional stabilization of the ankle joint is a prerequisite for developing prevention measures against typical injuries to the ankle. Neuromuscular, ligamentous, and osseous mechanisms regarding the stability of the ankle joint are of particular interest here.

Studies show that supination trauma is associated with excessive inversion of the ankle in combination with pronounced internal rotation of the ankle [2,6]. Therefore, the objective of this study was to examine the effect of orthoses on the control of the ankle during walking while simultaneously provoking supination. Specifically, the study intended to investigate extent to which the ankle joint is stabilized using the newly developed MalleoLoc L and MalleoLoc L3.

STUDY DESIGN

A controlled laboratory study

METHODS

Sample:	n = 20 subjects, Age: 22.3 ± 2.8 years, 13 women and 7 men
Test orthoses:	MalleoLoc L / L3 (Bauerfeind), Malleo Dynastab Boa (Thuasne)
Measurement systems:	3D motion analysis (Vicon MX)
Test method:	By means of a specially designed platform, the ankle's supination movement that is characteristic of a lateral ankle injury was imitated. As such, the subjects stood or walked barefoot on the platform, which could abruptly be tilted to result in 24° inversion and 15° plantar flexion. In addition, the subjective feeling of stability with and without shoes when walking and during "agility tests" was recorded.
Inclusion criteria:	Athletic, active persons aged 18–35 years Verified unilateral, chronic ankle instability based on the Cumberland Ankle Instability Tool (CAIT score ≤ 25) Prior history of recurring ankle traumas

RESULTS

Inversion:

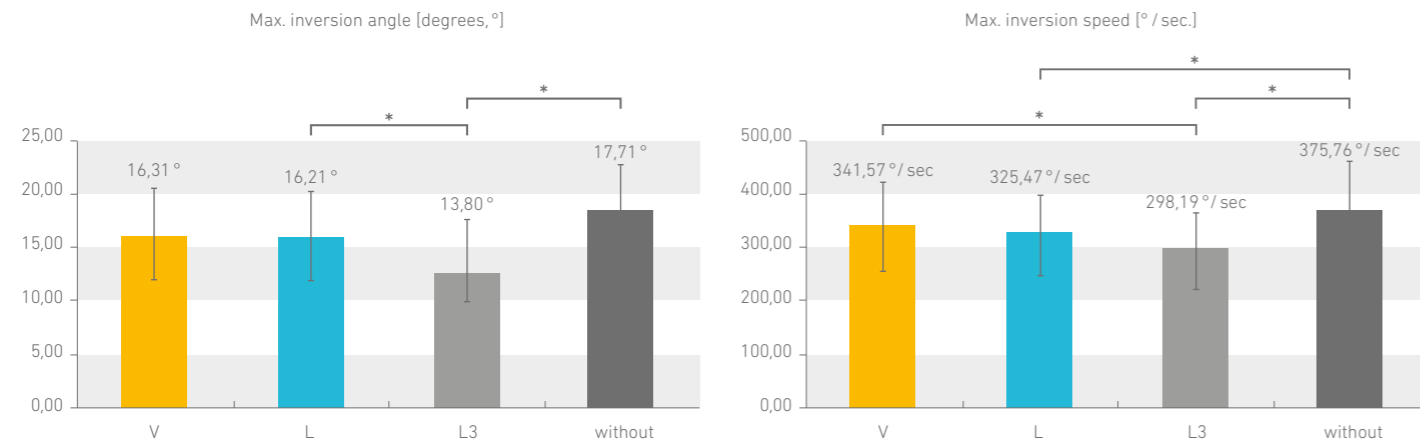


Fig. 1: Measurement of the max. inversion angle (left) and the max. inversion speed (right) of the ankle joint with previously announced supination induction via a trapdoor (causing 24° inversion and 15° plantar flexion) when walking on a platform. [C = comparator orthosis; L = MalleoLoc L; L3 = MalleoLoc L3; without = barefoot]

Inversion is one of the characteristic rotations of the ankle joint when there has been an injury to the lateral capsular ligament structures. When wearing the MalleoLoc L3 while walking on the tilting platform was tested, the results showed a reduced max. inversion angle (-22.1%) and a reduced inversion speed (-20.6%) compared to when no orthoses were worn. When wearing the MalleoLoc L while walking was tested, the results also showed a significantly reduced inversion speed (-13.4%) compared to when no orthoses were worn. The reference orthosis showed no significant reduction in the inversion angle and inversion

speed compared to the condition in which no orthoses were worn. In a direct comparison between the MalleoLoc L3 and the MalleoLoc L, the MalleoLoc L3 reduced the inversion angle and the inversion speed more than the MalleoLoc L. Similar results were observed during the simulation of the twisting of the ankle joint while in a standing position. Through the use of the MalleoLoc L3, the max. inversion angle and the max. inversion speed was reduced by 33.7% and 13.2%, respectively. The use of the MalleoLoc L also resulted in a reduction of the max. inversion angle by 11.6%, similar to the reference orthosis (not shown).

Internal rotation

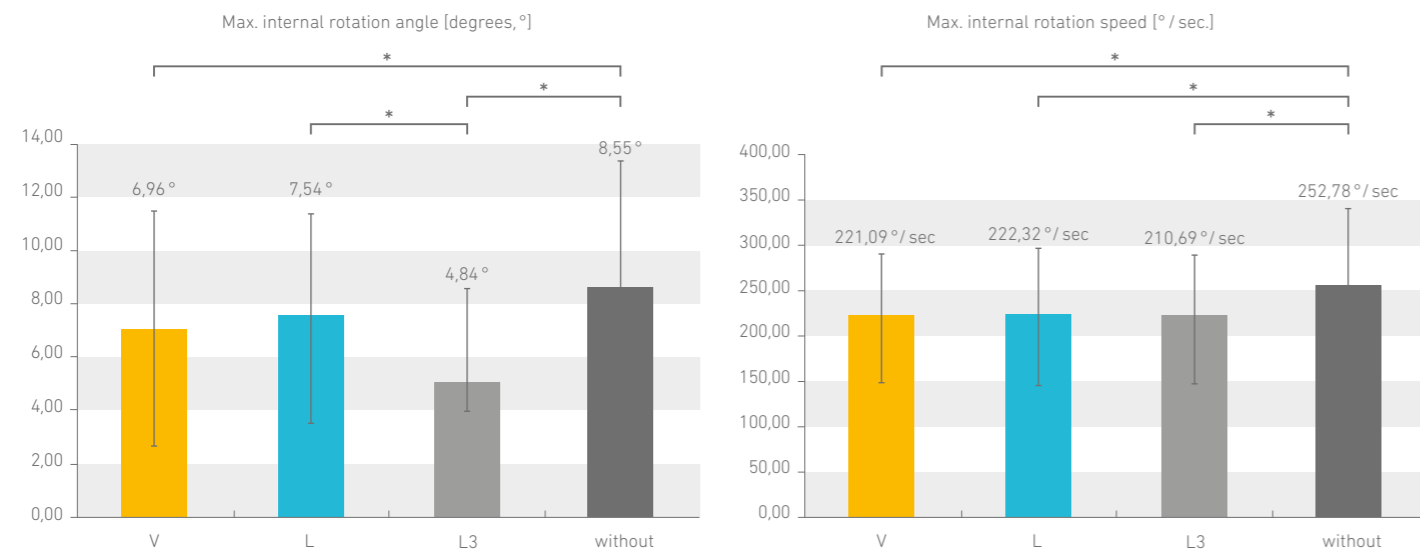


Fig. 2: Measurement of the max. internal rotation angle and the max. internal rotation speed of the ankle joint with previously announced supination induction via a trapdoor (causing 24° inversion and 15° plantar flexion) when walking on a platform. [C = comparator orthosis; L = MalleoLoc L; L3 = MalleoLoc L3; without = barefoot]

A second important subcomponent of the injury mechanism is internal rotation. The MalleoLoc L3 limited the max. internal rotation angle by 43.5%, while the MalleoLoc L caused no change in the max. internal rotation angle.

The reference orthosis significantly reduced the angle by -18.7%. All three orthoses stabilized the ankle, leading to a significant reduction of the max. internal rotation speed (C: -12.1%, L: -12.1%, L3: -13.1%).

Sense of stability

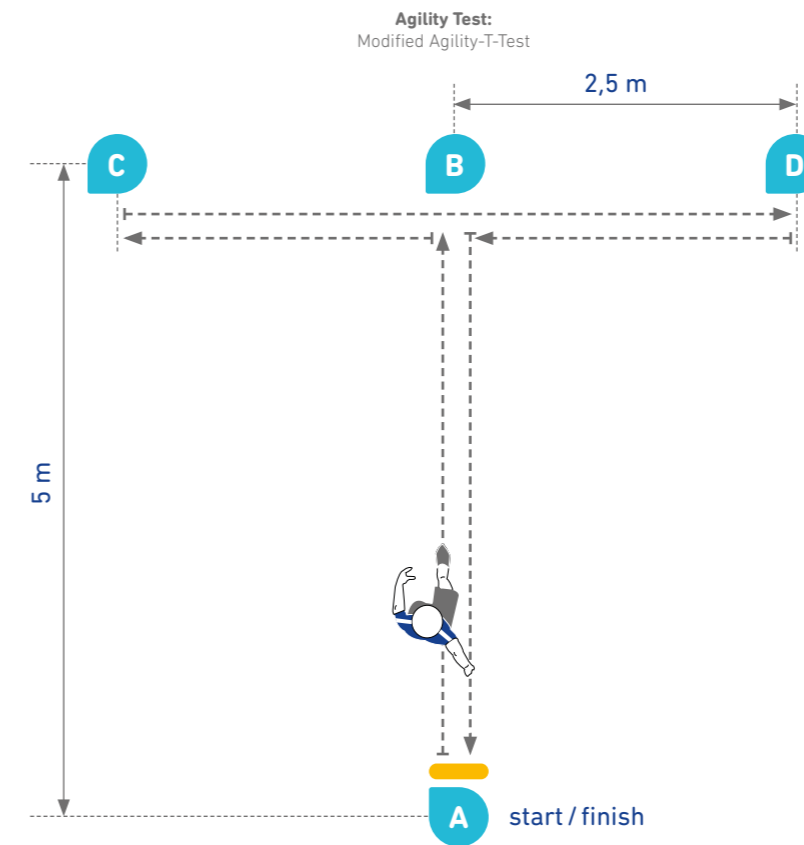


Fig. 3: Description of the agility test: fast walking on level ground with changes of direction to form a T shape.

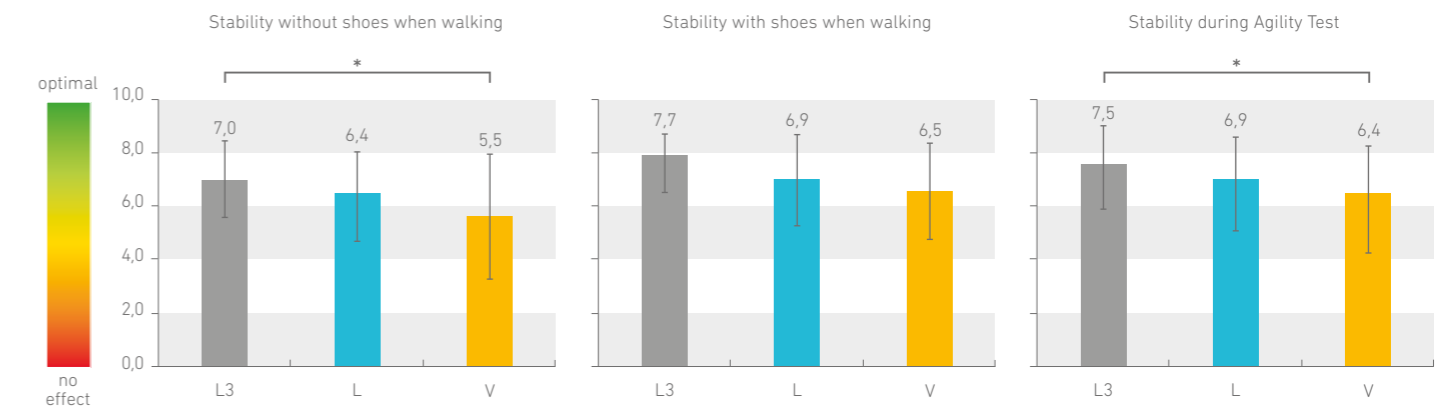


Fig. 4: Measurement of the sense of stability when walking in a straight line with and without shoes as well as when walking with shoes during the agility tests [C = comparator orthosis; L = MalleoLoc L; L3 = MalleoLoc L3]

In addition to the objective measurement of stabilization, the subjective sense of stability is a prerequisite for the patient to safely transition back to normal mobility. When the orthoses were worn without shoes during walking, the MalleoLoc L3 was subjectively more stable than the reference orthosis. The MalleoLoc L achieved moderate stability characteristics and was reported to be between the MalleoLoc L3 and the reference orthosis.

When wearing shoes, all three orthoses showed comparable values regarding subjective stabilization. In the "agility test", the ankle is more heavily loaded than during normal walking due to the required changes of direction. Here (Fig. 3), the MalleoLoc L3 was perceived to have more of a stabilizing effect than the reference orthosis. Again, the MalleoLoc L tended to be between the reference orthosis and the MalleoLoc L3 in terms of the subjective sense of the level of stabilization (Fig. 4).