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Advanced conservative treatment of complete acute rupture of the lateral ankle ligaments: Verifying by stabilometry

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ABSTRACT

Background: The aim of this study was to investigate the result of the specific conservative treatment of acute lateral ankle ligaments rupture and verify the effect of this therapy by stabilometry.
Methods: 17 young athletes were examined after acute lateral ankle sprain (grade III). Diagnosis was based on musculoskeletal ultrasound examinations. Pressure plate evaluated postural stability after conservative treatment at regular intervals during 1 year.
Results: There were no significant differences in postural stability in double-leg stance between limbs. In single-leg stance, COP confidence ellipse ($p = 0{,}011$) and COP excursion in sagittal plane ($p = 0{,}000$) were significantly higher for the injured leg when compared with the uninjured leg only one week after removing the cast.
Conclusions: After conservative treatment of grade III injuries with STABHA, immobilization with full weight bearing on the injured leg for 6 weeks and rehabilitation, stabilometry results showed that none of the patients had impaired postural stability or were at risk of functional ankle instability in the monitored period.

1. Introduction

Ankle injuries involving the lateral ankle ligaments are among the most common injuries of the musculoskeletal system. These injuries occur during daily activities as well as in sport. Diagnosis and management of these injuries is an almost daily task for physicians, trainers, and physical therapists. Nevertheless, outcomes are often unsatisfactory and experts' opinions on suitable treatment differ.

Ankle ligament injuries are collectively known as ankle sprains, which refer to the mechanism of the injury rather than the degree of the injury. An ankle sprain diagnosis that does not take into account the severity of the injury can lead to treatment protocols with insufficient immobilization and subsequent inadequate individual rehabilitation. The injuries are often disparaged by the patients, athletes in particular.

The lateral ankle ligament complex consists of three ligaments: the anterior talofibular ligament (ATFL), the posterior talofibular ligament (PTFL), and the calcaneofibular ligament (CFL) [1,2].

One main function of these ligaments is mechanical stabilization of ankle joints (talocrural and subtalar). Another important function of these ligaments is their role in joint proprioception. Histological studies show that the ligaments contain mechanoreceptors that have nerve endings: Pacinian corpules, Golgi tendon organs, and Ruffini endings. They provide kinesthesia and statesthesia, causing activation or inhibition of muscular activities. When ligaments are strained, they invoke neurological feedback signals that then activate muscular contraction [3,4].

Ankle sprains are classified into three grades. In grade I, the ligament is stretched without tearing; in grade II, the ligament is partially torn and has minimal laxity, in grade III, there is complete rupture of the ligament with instability of the joint [5]. Severity of secondary changes (e.g. swelling, hemorrhage), however, often does not correspond to the grade of injury.

Various diagnostic procedures have been used to determine and assess ligament injury (ultrasonography, radiography, magnetic resonance imaging). Ultrasonography has been shown to be a useful diagnostic modality for ankle injuries given the superficial

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nature of the ankle soft tissues and the ability to perform dynamic stress tests (e.g., anterior drawer test, talar tilt test) [6].

Although ruptures of the lateral ankle ligaments occur often, treatment selection remains controversial. Management strategies for acute ruptures of lateral ankle ligaments can be divided into immobilization, surgical treatment, and functional treatment.

In the acute phase, ankle sprains are associated with pain and loss of function. The main treatment goal during this phase is to control pain and swelling. The optimal treatment remains protection, rest, ice, compression, and elevation (PRICE). Hyaluronic acid is a new therapeutic method in ankle sprain injuries.

Biological ligament healing can be divided into three different phases: (1) inflammatory phase (until 10 days after trauma), (2) the proliferation phase (4th–8th week) and (3) the remodeling or maturation phase (until 1 year after trauma). The duration of the different phases may individually vary. During the proliferation phase, the tissue responds with vascular ingrowth, fibroblast proliferation and new collagen formation. Protection of inversion is important during this phase of healing to prevent excess formation of weaker type III collagen formation that can contribute to chronic elongation of the ligament [7].

Incomplete healing of the ligament tissue results in ligament laxity, predisposing the joint to further injury. This cycle of ligament injury and subsequent laxity causes joint instability, which then leads to chronic pain, diminished function, and, ultimately, to osteoarthritis of the affected joint [4,8]. Correct treatment in the acute phase is important to prevent both the persistence of symptoms and the development of chronic ankle instability.

Chronic ankle instability can be subdivided into mechanical and functional instability. Mechanical instability is caused by post-traumatic ligament laxity and characterized by ankle joint mobility beyond normal range of motion, which is identified by positive anterior drawer test, talar tilt test, or both tests [2,9]. Functional instability refers to repeated sprains and/or the feeling of the ankle "giving way" [10,11]. Factors suggested as causes of this disability include mechanical instability of the talocrural joint, impaired proprioception, and incoordination of dynamic stabilizers of the ankle (peroneal muscles). One manifestation of incomplete healing and functional instability is change in postural stability after these injuries in double- and single-leg stance [12,13]. Stabilometry is an objective method for the quantitative study of postural equilibrium and has previously been shown to correlate to functional instability of the ankle joint [14].

The goal of this study was to investigate the results of a specific conservative treatment of acute lateral ankle ligament rupture and to verify the effectiveness of this therapy by stabilometry.

2. Materials and methods

After obtaining institutional review board approval, a prospective study was conducted of patients who experienced acute lateral ankle sprain (grade III) between 2013 and 2015.

All subjects signed an informed consent before being enrolled in the study.

Thirty-five patients whose symptoms indicated potential grade III ankle ligament injury (complete rupture of ATFL and CFL) were physically examined by a senior sports orthopedic surgeon. Exclusion criteria for this study consisted of the following: previous ankle injury, systemic or generalized disorder affecting the locomotor system, constitutional ligamentous laxity, fracture, or syndesmosis injuries. Inclusion criteria were acute lateral ankle sprain (grade III) confirmed via ultrasonography and minimum sports participation of 60 min, 4 times per week. Eighteen patients were excluded from the study. Seventeen of the 35 young athletes who were examined were eligible to be included in this study. Basic characteristics of patients are shown in Table 1. Sports played by these athletes included football (n = 6), volleyball (n = 5), gymnastics (n = 3), and running (n = 3).

After clinical examination and within 48 h after the injury, ultrasonography was used to examine the injured and uninjured (contralateral) ankle of each patient. The ankles were examined in held-forced positions (anterior drawer test) under local anesthesia. Administering local anesthesia is important to reduce pain and relax the muscles. Musculoskeletal ultrasound scans were obtained in dorsal and ventrolateral cuts for the injured ankle and the uninjured (contralateral) ankle. The distance between the posterior rim of the tibia and talus was measured for each ankle. Then the distance was measured between the apex fibula and the edge of the calcaneus for each ankle. Ventrolateral cuts were obtained to evaluate the instability of the talocrural and subtalar joints (Figs. 1 and 2). To diagnose the ligament tear as being a complete tear, the difference between the injured and uninjured ankle had to be greater than 3 mm in both the dorsal and ventrolateral cuts (Ernst and Hrazdira approach to identify talocrural and subtalar instability [15,16]).

The first step of the treatment was performing an administration of hyaluronic acid (Soft Tissue Adapted Biocompatible Hyaluronic Acid [STABHA]) under ultrasound control directly to the region of the injured ligaments according to aseptic rules. Then all injured ankles were immobilized with rigid ankle plaster walking casts for 6 weeks (Fig. 3). Before cast application, synthetic wadding was placed from the distal third of the tibia to the middle of the metatarsal bones. The wadding was properly formed, especially above the talocrural joint and arch of the foot. Full weight-bearing was allowed. After 6 weeks, the cast was removed and patients began a 3-week individual rehabilitation program with neuromuscular training. Early functional rehabilitation of the ankle included range-of-motion (ROM) exercises, isometric and isotonic strength-training exercises, and proprioception-training exercises. The active ankle range of motion (ROM) was measured before and after rehabilitation (plantar and dorsal flexion in the sitting position with the knee flexed to 90°) (Table 2). To measure ROM was used a goniometer. During the final stages of rehabilitation, the focus shifted to sport-specific activities to prepare the athlete for return to sport. All participants returned to full sports activities 8 weeks after initial acute injury.

The changes in postural stability after conservative treatment in double- and single-leg stance were investigated at 6 weeks (day of cast removal), 7 weeks (1 week after cast removal), 3 months, 6 months, and 1 year after the acute injury for both the injured and uninjured ankle by stabilometry. The difference between the injured and uninjured leg was measured by FootWorkPro forceplate (49 by 64.5 cm) (AmCube UK, Ascot, United Kingdom).

Table 1
Basic characteristics of patients.

	Sex	Mean age ± SD (years)	Mean height ± SD (cm)	Mean weight ± SD (kg)
Acute ankle injury (Grade III)	Men (n = 8)	27.0 ± 6.9	192.9 ± 4.9	89.9 ± 9.8
	Women (n = 9)	23.4 ± 6.2	167.7 ± 8.6	59.8 ± 9.2
	Group (n = 17)	25.1 ± 6.8	179.5 ± 14.5	73.9 ± 17.8

SD, standard deviation.

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