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Modified Evans technique improves plantar pressure distribution in lateral ankle instability

Modifiye Evans tekniği ile lateral ayak instabilitesine bağlı ayak tabanı basınç dağılımının geliştirilmesi

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Objectives: Efficiency of the modified Evans technique based on clinical and radiological evaluations was determined by plantar pressure measurement.

Patients and methods: Eleven patients (2 females, 9 males; mean age 29 years; range 19 to 39 years) with chronic lateral ankle instability were surgically treated using the modified Evans technique. Plantar pressures of nine patients were measured pre- and post-operatively.

Results: Plantar pressure below the first metatarsal head decreased in seven of the patients after surgery. Furthermore, in all of the patients, the time of initial contact decreased significantly and the pathology returned to normal limits in the postoperative period.

Conclusion: Modified Evans technique, despite its controversial long-term outcomes in lateral ankle instability, decreases first metatarsal head pressure and initial contact time significantly.

Key words: Modified Evans technique; lateral ankle instability; metatarsal head pressure.

Amaç: Modifiye Evans tekniği klinik ve radyolojik verilerin yanısıra ayak tabanı basınç ölçümleri ile değerlendirildi.

Hastalar ve yöntemler: Kronik ayak bileği dış yan bağ instabilitesi olan 11 hasta (2 kadın, 9 erkek; ort. yaş 29; dağılım 19-39) modifiye Evans tekniği kullanılarak tedavi edildi. Dokuz hastanın ameliyat öncesi ve sonrası ayak tabanı basınç ölçümleri gerçekleştirildi.

Bulgular: Hastaların yedisinde birinci metatars başının altındaki basınç cerrahi sonrası azaldı. Ayrıca tüm hastalarda yürüyüşün başlangıç temas süresi belirgin olarak kısaldı ve patolojik durum ameliyat sonrası dönemde normale döndü.

Çıkarımlar: Modifiye Evans tekniği, çelişkili uzun takip sonuçlarına karşın ayak bileği dış yan bağ instabilitelerinde birinci metatars başının altındaki basıncı ve yürüyüşün başlangıç temas süresini belirgin olarak kısaltmaktadır.

Anahtar sözcükler: Modifiye Evans tekniği; lateral ayak bileği instabilitesi; metatars başı basıncı.

Several surgical techniques have been defined for the treatment of lateral ankle instability, mostly focusing on the treatment of a mechanic abnormality or talar instability.[1-7] Anatomic reconstructions aim to either repair or replace the injured ligament directly to provide resistance against anterior translation and inversion without limiting the subtalar and ankle motions.[1-10] Direct repair, as defined by Bromstrom,[4] is not always possible. Other techniques include (a) passing the ligaments through the fibula, (b) strengthening the ligaments by augmenting local tissues or (c) replacing them

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with grafts obtained from the peroneus brevis, the peroneus longus, the peroneal terius, the palmaris longus and the fascia lata.[6,11-23]

Similarly, non-anatomical reconstructions limiting inversion and anterior translation are also widely used. In these techniques, the aim is to prevent the abnormal motion pattern by a vertically placed graft material into the area of instability instead of applying a local anatomical restoration. The most frequently used techniques with the best-known results are those of Watson-Jones,[14] of Chrismann and Snook[20] and of Evans.[12] These techniques significantly change the biomechanics of the ankle and subtalar joint and the pressure generated on the hind-foot, the mid-foot, and the fore-foot. Functional instability of the foot has been attributed to abnormal arthrokinetic reflexes associated with injured ankle ligaments and the loss of the proprioception sense.[7] Aside from mechanical limitations, in patients treated with ligament reconstruction, tenodesis or muscle transfers, the functional stability can be achieved through the restoration of the proprioception sense.[18]

In the Evans procedure,[12] the peroneus brevis muscle is separated from its musculotendinous compound and its proximal is sutured to the peroneus longus. Then, an aperture is created from the postero-superior of the fibula to the lateral malleolar tip. The tendon is then passed from the anterior towards the posterior through this aperture and sutured on itself. This procedure was designed to prevent the talar tilt by reducing foot inversion. The disadvantage of the Evans procedure is its inability to restore the normal anatomical position of the anterior talofibular ligament. Hence, the stability at inversion is restored. The plantar pressure changes after the modified Evans procedure have not been measured. It is hypothesized that the modified Evans procedure will improve plantar pressure balance in lateral ankle instability.

The present study aims to determine the efficiency of the modified Evans technique based on clinical and radiological evaluations. To this end, the pathophysiology of lateral ankle instability was assessed by plantar pressure measurements.

PATIENTS AND METHODS

Eleven patients (2 females, 9 males; mean age 29 years, range 19 to 39 years) presenting chronic lateral ankle instability at the Gülhane Military Medical Faculty between November 2001 and April 2004 were surgically treated with the modified Evans technique. Preoperatively, all the patients had positive findings in the anterior drawer test and/or the talar tilt test.

All the patients were enrolled in a rehabilitation and proprioception exercise program before surgery. None of them had a history of fracture, osteocondral lesion or previous surgery on their ankles. Talar tilt was evaluated in preoperative direct and stress X-ray. When the tibiotalar angle of 9° was 6° or higher compared to the contralateral normal ankle, the presence of the talar tilt was confirmed. When the talus displaced 3 mm or higher under the tibia in relation when compared to the contralateral normal ankle in the drawer test, the result was considered positive. Magnetic resonance images of eight patients were obtained and the anterior talofibular ligament rupture was confirmed.

The ruptured ligament was reconstructed using the modified Evans technique in all the patients. A "J" shaped incision extending from the lateral malleoli to the base of the 5th metatarsi was made. The sural nerve was explored and protected. Subsequently, the musculotendinous compound was separated. A split obtained from this tendon was sectioned at its proximal end. The tendon was then crossed beneath the extensor retinaculum and transferred to the distal while the extensor retinaculum was protected. The periosteum on the fibula was elevated and an aperture on the anteriposterior plane of the fibula was created using a 3.5 burr. The split tendon was then advanced through this aperture. The tendon was stretched and sutured over itself. Supporting sutures were made in the part of the tendon covering the bone. After the tourniquet was deflated, hemorrhage was checked, and the subcutaneous and the cutaneous tissues were properly closed. Postoperatively, a short-leg plaster was applied and worn for 45 days. On the day when the plaster was removed, the patients began to walk with double crutches. Full weight bearing during gait was allowed on day 60, The patients were asked to abstain from sportive activities and/or heavy physical work for the next three months.

The patients were followed up for 17 weeks (range: 8-26 weeks) for possible postoperative complications. Functional results were obtained based on the scoring system of Karlsson et al.[8] In this

scoring system, absence of symptoms is considered highly favorable. Any loss of motion of five or more compared to the normal contralateral ankle is considered a limitation of the range of motion. The patients were clinically evaluated for edema, sensitivity, persistent pain, and ligamentouslaxity. In all the visits, limitation in range of motion, positive anterior drawer test, persistent pain and any injuries to the ankle were recorded. Postoperative direct and stress radiographs were also obtained.

Plantar pressures of nine of the 11 patients were tested 2.5 months after the surgery in the gait laboratory.

RESULTS

Optimum results were obtained in eight of the ankles (72%), (Table I).[8] Seven ankles were defined as Grade I using the scoring system of Good et al.[13] (Table II).

In the postoperative period, two patients suffered delayed wound healing. In one of these patients, after debridement and primary closing of the wound, complete healing was achieved on postoperative day 20, while the other patient was followed up with antibiotic therapy and dressing for secondary repair due to superficial infection; the wound completely healed on the postoperative day 35 (Table III).

In the first patient, hypoesthesia was detected upon the removal of the plaster, which was attributed to sural nerve neuropraxy. The complaints of the first patient spontaneously resolved in postoperative month three. No recurrence of lateral ankle instability was encountered and none of the patients required any secondary surgical intervention associated with the recurrence of instability. The most common complaint of the patients in this period was persistent pain. Five patients complained of severe pain. Three of these patients reported pain after long walks or sports activities, and two patients reported pain fearing an ankle sprain after walking on bumpy surfaces. After the exercise program, the pain of the three patients completely resolved in the postoperative month six. One patient had slight pain, while the level of pain in one patient did not regress. The pain pathology of this patient is associated with reflex sympathetic dystrophy.

Ankle joint motion limitation was another concern. The patients began range-of-motion exercises on day 21 after the plaster was removed. At the end of the exercise period, the range-of-motion returned to normal in all but one patient: hind-foot aversion remained limited in one of the patients.

No radiological and physical findings of instability were determined on day 60. In seven of the nine patients, plantar pressure increase beneath the first metatarsal head returned to normal (Figures 1a, b, 2a, b). In two patients, no plantar pressure increase beneath the first metatarsal head was detected preoperatively. The patients' complaints resolved completely. Time of initial contact decreased significantly in all the patients after the surgery.

DISCUSSION

In the treatment of lateral ankle instability, nonanatomical reconstructions as well as anatomical reconstructions have been used to limit inversion and anterior translation. These procedures aim to prevent abnormal patterns of motion by placing the graft material vertically in the area of

TABLE I

Evaluation of the patients according to the Karlsson[20] scoring system

Grade	n
Excellent	8
Good	2
Moderate	1
Poor	–

TABLE II

Evaluation of the patients according to scoring system Good et al.[10]

Grade	n
1	7
2	3
3	1
4	–

TABLE III

Summary of complications

Persistent pain	1
ROM restriction	1
Local nerve damage	1
Wound problem	2
Reflex sympathetic dystrophy	1

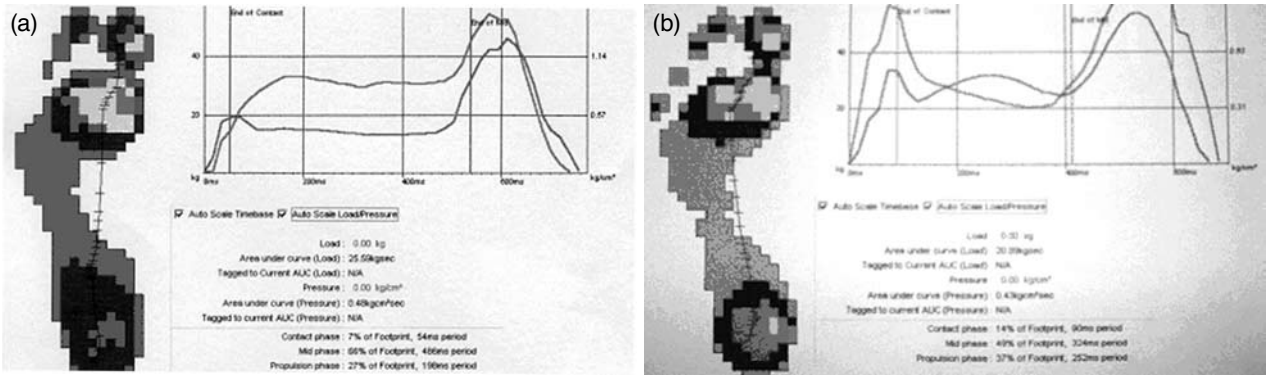

Figure. 1 (a) Increased pressure at first metatarsal head and medial plantar surface and shortening of the initial contact phase in the preoperative plantar pressure measurement of a 22-year-old male patient. **(b)** Postoperatively, the first metatarsal head pressure is normal and an increased initial contact phase is recorded.

instability rather than performing a local anatomical reconstruction.[11,12,14,16-22] The most common ones with the best known results are the techniques of Watson-Jones, Chrismann and Snook and Evans, which significantly alter the biomechanics of the ankle and subtalar joint as well as the pressures of hindfoot, midfoot, and forefoot.[12,14,20] Functional instability of the ankle has been accounted for by abnormal arthrokinetic reflexes and the loss of proprioception sense due to injured ankle ligaments. Excluding the mechanical limitations experienced by patients treated with ligament reconstruction and tenodesis or muscle transfer techniques, through restoration of proprioception sense and arthrokinetic reflexes functional stability can be achieved.[2-4,13]

The primary aim of the treatment for lateral ankle instability is to eliminate the uncomfortable feeling associated with recurrent sprains. Many authors have reported short-term successful results after tenodesis. For example, Rosenbaum et al.[19] compared the anatomical reconstruction and Evans tenodesis techniques clinically and functionally and reported successful results with both techniques in the postoperative first year. On the other hand, Kaikkonen et al.[7] reported development of ligamentous laxity, significant limitation of the ankle motion and severe edema within five years of tenodesis. In another longterm follow-up study conducted by Barnum et al.[10] on 20 patients, a success rate of 85% was achieved; however, no clinical evaluation was performed, and no questionnaire was used. Some long-term clinical evaluation studies[21] have reported poor results of tenodeses. Van der Rijt and Evans were the first researchers to report poor long-term results.[12,21] In nine patients followed-up for 22 years, they found that the successful results obtained in the first few years following the tenodesis procedure changed after 7-10 years. The most important reason for this change in the clinically successful short-term results is the insufficiently stretched ligament, which has been shown in clinical and laboratory

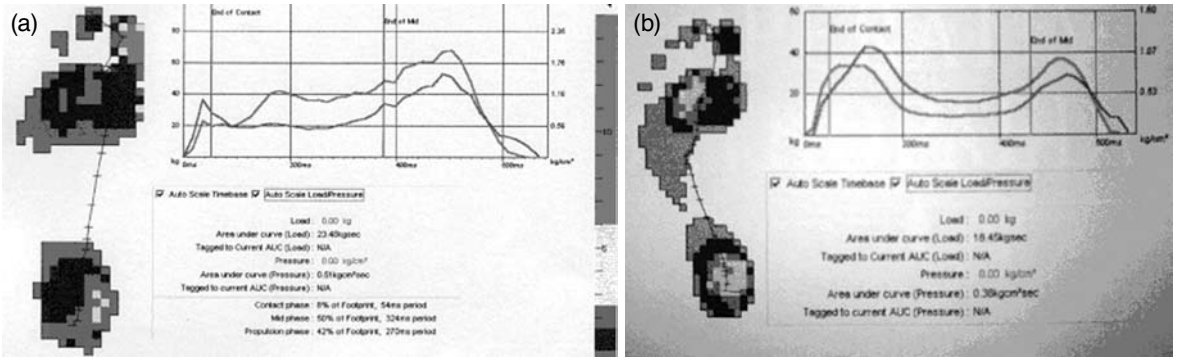

Figure. 2 (a) Increased pressure at the base of the first metatarsal head and medial plantar surface and shortening of the initial contact phase in preoperative plantar pressure measurement of a 29-year-old male patient is observed. **(b)** Postoperatively, the first metatarsal head pressure returned to normal.

studies.[19] In a study by Karlsson et al.,[15] ligament laxity was directly correlated with poor clinical results and the anterior talar translation was more pronounced than the talar tilt. Orava et al.[9] reported radiological evidence of 54% of anterior talar translation in the patients that underwent Evans tenodesis. This may be accounted for by the attempts of Evans tenodesis to construct a structure that could perform the function of anterior tibiofibular and calcaneofibular ligaments but not their anatomical reconstruction. Thus, naturally the talus ankle may have subluxation in the plantar position. The limitations of our study were the small number of patients, lack of a control group and lack of measurements of muscle strength and proprioception. However, the study presents important findings because the patients were evaluated by using plantar pressure measurements. Plantar pressure increase beneath the first metatarsal head returned to normal; this is particularly important to normalize the abnormal contact of the foot that developed preoperatively and secondary to instability. By restoring the lateral stability, excess burden on the 1st metatarsophalangeal joint is distributed and the time of initial contact is reduced.

In patients with lateral ankle instability, the success rate of surgery, regardless of the technique used, has been reported to be nearly 80-95% if the indication is correctly taken.[11-13,16-22] Although complications are rare, when they arise, they may lead to serious problems. Early complications are usually in the form of delayed wound healing, infection or sural nerve damage. Although recurrent instability is associated with new trauma, they may be rarely due to improper surgical interventions that do not provide sufficient stability. Recurrent instability will be inevitable for patients in whom possible joint laxity or cavovarus deformity is overlooked. The particular residual ankle insufficiency encountered in tenodesis procedures is the loss of the ankle motion and the subtalar motion. Long-term complications like degenerative joint damage have been well-defined.[12,13,16-24] However, it is not clear whether the etiology is related to recurrent trauma sequela due to loss of the proprioception sense or abnormal weight distribution after reconstruction.

The clinical results of this study based on Evans technique cannot be generalized because of the limited number of patients and the short-term follow-up. Nevertheless, our clinical evaluations and the results of our laboratory studies have shown a short-term success rate of 72%. Increased plantar pressures on the medial side of the foot and a shorter initial contact time after surgery are obvious findings of the study.

In conclusion, we believe, in type III ligament injuries of the ankle with no possibility of anatomical reconstruction, the modified Evans technique is superior to other tenodesis techniques because of its easy application. This technique decreases pressure beneath the head of the first metatarsal and shortens initial contact time significantly.

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