J Orthop Sci (2009) 14:699–703
DOI 10.1007/s00776-009-1386-z

JOURNAL OF
ORTHOPAEDIC SCIENCE

Original article

Clinical study of chronic lateral ankle instability: injured ligaments compared with stress X-ray examination

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Abstract
Background. A comparative analysis of ankle stress X-ray findings and the condition of injured ligaments in patients with chronic lateral ankle instability was performed to determine a method of identifying the condition of injured ligaments prior to operation.
Methods. Altogether, 36 males and 80 females were included in the study. The average age at the time of operation was 29.4 years. Anterior drawer distances and talar tilt angles were measured manually. During the operations, the injured ligaments were classified into 25 categories.
Results and Conclusion. The condition of the injured ligaments in patients with a talar tilt angle of more than 15º had injured ligaments that were almost avulsed and degenerated or completely absent.

Introduction

Many surgical procedures have been proposed to treat chronic lateral ankle instability. They can be divided into three general categories: (1) procedures that reconstruct the ligaments using a free or a split tendon graft or an extensor retinaculum or a periosteum;[1–5] (2) procedures that reconstruct ligaments using artificial ligaments;[6] and (3) procedures that repair ligaments directly from remnants without augmentation.[7–12] Recently, many orthopedic surgeons have utilized the Broström procedure, in which the ligament is repaired using a remnant.[7] The Broström procedure and its modifications are useful for repairing chronic lateral ankle instability because they are relatively easy to perform and atraumatic. If the lateral ligamentous structure is insufficient, in situ repair is impossible and augmentation is necessary.[13] Therefore, it is useful if we can determine the condition of an injured ligament preoperatively. The purpose of this study was to compare the findings of stress X-rays and the condition of the injured ligaments at the time of operation to determine whether the condition of the injured ligaments can be determined prior to operation.

Offprint requests to: T. Hashimoto
Received: August 1, 2008 / Accepted: June 29, 2009

Material and methods

Between 1990 and 2007, a total of 122 lateral ankle reconstructions in 116 patients (36 males, 80 females) were included in this study. The average age at the time of operation was 29.4 years (range 13–66 years). In all, 52 operations were for right ankles, 58 for left ankles, and 6 for bilateral ankles. The average interval between injury and operation was 9 years 1 month (range 3 months to 38 years). Anterior drawer distances and talar tilt angles were measured manually without anesthesia. The force that we applied was about 140 N. We inspected it with maximum force, and it was about 140 N when it was measured by spring balance.

Anterior drawer distances were measured by use of lateral stress radiographs, defining the tibiotalar distance with the knees in 90° flexion position and with the ankles in neutral position. Talar tilt angles were measured in the standard manner by defining the angle between the talar dome and tibial plafond with the knees in extension and with the ankles in neutral position. We performed an operative adaptation with the patients who had more than a 10° talar tilt angle and/or an anterior drawer distance of >8 mm. All patients had failed conservative treatment for more than 6 months.

Five categories of ligament condition were established prior to the first case in 1990. During the operation, photographs of injured ligaments were taken. The injured ligament was classified into one of the five categories based on its condition using both the perioperative findings and photographs, as follows (Fig. 1).

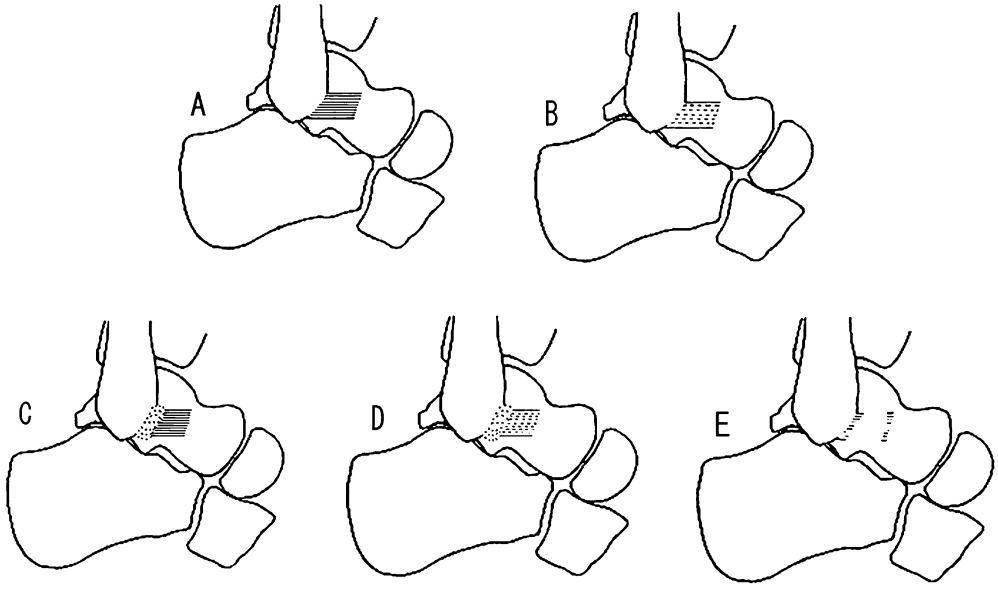

Fig. 1. Classification of the ligaments of chronic lateral ankle instability based on their condition. **A** Near-normal ligament (N). **B** Ligaments degenerated to scar tissue; their fibrous structure has disappeared (SC). **C** Avulsion ruptures at the endpoints (AV). **D** Ligaments have degenerated to scar tissue and are ruptured at the endpoints (AVSC). **E** Ligaments have disappeared (DP)

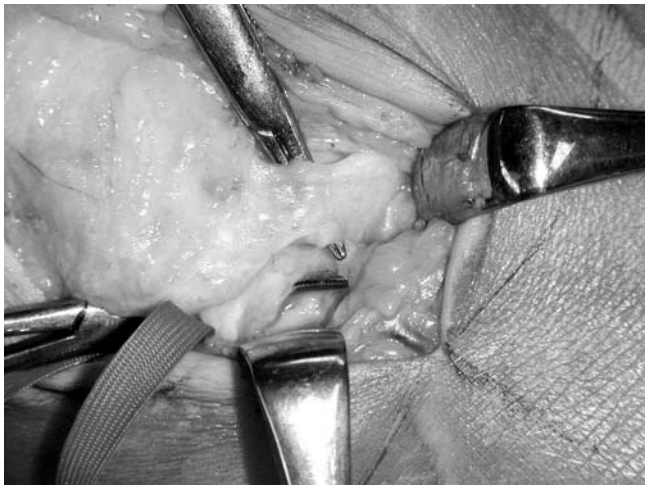

Fig. 2. Ligaments degenerated into scar tissue, and the fibrous structure has disappeared (SC)

Fig. 3. Avulsion rupture at the endpoints (AV). It has the structure of a tendon

1. N — near-normal ligament
2. SC — ligaments degenerated to scar tissue; fibrous structure has disappeared (Fig. 2)
3. AV — avulsion ruptures at the endpoints (Fig. 3)
4. AVSC — ligaments degenerated to scar tissue, ruptured at endpoints (Fig. 4)
5. DP — ligaments have disappeared (Fig. 5)

The classification was undertaken by several doctors. We tried to lift a remnant by a forceps and classified it as AV when an insertion was unstable. We observed a remnant and classified it as SC when the fiber structure disappeared. We divided the anterior talofibular ligament (ATFL) and the calcaneofibular ligament (CFL) into 25 combinations as follows: (N, N), (N, SC), (N, AV), (N, AVSC), (N, DP), (SC, N), (SC, SC), (SC, AV), (SC, AVSC), (SC, DP), (AV, N), (AV, SC), (AV, AV), (AV, AVSC), (AV, DP), (AVSC, N), (AVSC, SC), (AVSC, AV), (AVSC, AVSC), (AVSC, DP), (DP, N), (DP, SC), (DP, AV), (DP, AVSC), (DP, DP). For instance, (N, N) indicated that the condition of ATFL was N and CFL was N.

Ligament reconstruction using a free tendon graft was done in 70 of 122 ankles. The operation was performed with the patient on his or her side under general or spinal anesthesia with a thigh tourniquet. Holes were drilled on the original insertions of the ATFL at the fibula and talus and of the CFL at the fibula and calcaneus. The split portion of the peroneus brevis tendon was pulled through these holes. Reinforcement by a periosteal flap and retinaculum was not performed. A modified Chrisman-Snook procedure was done in 42 of

Fig. 4. Ligament degenerated into scar tissue and ruptured at the endpoints (AVSC)

Fig. 5. Ligaments have disappeared (DP)

122 ankles, and the Broström procedure was done in 5 of 122. Ligament reconstruction using artificial ligament was done in 5 of 122 ankles. The results of the stress X-rays and the injured ligaments classifications were then evaluated.

This study was approved by the institutional review board of Keio University, Tsukigase Rehabilitation Center and met all guidelines for the ethical conduct of studies as delineated in the Declaration of Helsinki. All subjects were informed that data from this study would be submitted for publication and gave their consent.

The Pearson chi-squared test was used to test for differences between scores in the two groups. Differences were considered to be significant with $P < 0.05$.

Results

The number of ATFLs in the injured ligament classification was as follows: N = 2, SC = 71, AV = 5, AVSC = 30 and DP = 14. The number of CFLs was N = 8, SC = 23, AV = 63, AVSC = 21, and DP = 7. The number of ATFLs and CFLs in combination according to the injured ligament classification was as follows: (N, N) = 0, (N, SC) = 0, (N, AV) = 1, (N, AVSC) = 1, (N, DP) = 0, (SC, N) = 6, (SC, SC) = 18, (SC, AV) = 38, (SC, AVSC) = 7, (SC, DP) = 2, (AV, N) = 0, (AV, SC) = 1, (AV, AV) = 3, (AV, AVSC) = 1, (AV, DP) = 0, (AVSC, N) = 1, (AVSC, SC) = 3, (AVSC, AV) = 16, (AVSC, AVSC) = 9, (AVSC, DP) = 1, (DP, N) = 1, (DP, SC) = 1, (DP, AV) = 5, (DP, AVSC) = 3, (DP, DP) = 4.

The average anterior drawer distance was 6.7 mm (range 2–14 mm), and the average talar tilt angle was 13.7° (range 6°–32°) prior to surgery. The average anterior drawer distances of ATFLs and CFLs in combination according to the injured ligament classification are shown in Table 1. The average anterior distance of the injured ligaments for AVSC and/or DP classified as (AVSC, AVSC), (AVSC, DP), (DP, AVSC), or (DP, DP) was 7.8 ± 1.9 mm. This was significantly higher than that of the others (6.6 ± 2.3 mm) ($P = 0.027$). The average talar tilt angle of the combined ATFLs and CFLs according to the injured ligament classification also is shown in Table 1. The average talar tilt angle of either the AVSC or DP condition, including (AVSC, AVSC), (AVSC, DP), (DP, AVSC), or (DP, DP) was 19.2° ± 6.3°. It was significantly larger than that of the others (12.8° ± 3.8°) ($P = 0.0007$).

The condition of the ATFL and/or the CFL in patients with a talar tilt angle of ≥15° was almost always AVSC and/or DP (28/36, 77.8%). In contrast, the condition of the ligaments in patients with a talar tilt angle of <15° was almost always N, SC, or AV (27/86, 68.6%). When we tried to review cases in which the anterior drawer distance was ≥10 mm, there were six cases in which the ATFL was AVSC and/or DP, whereas there were only three cases in which the ATFL was N and/or SC and/or AV.

Discussion

Recently, the importance of diagnosing and treating patients with ruptured lateral collateral ankle ligaments has increased as a result of the increasing number of participants in sports activities, such as football, in Japan.[14]

Many surgical procedures for the treatment of chronic lateral ankle instability have been published, but no single procedure is able to manage all situations with the ligaments. Direct repair is an excellent operation

Table 1. Results of ankle stress radiographs prior to operation

Condition of injured ATFL	Condition of injured CFL	Anterior drawer distance (mm)	Talar tilt angle (°)	No. of cases
N	N			0
N	SC			0
N	AV	7	14	1
N	AVSC	5	10	1
N	DP			0
SC	N	6.5	9.7	6
SC	SC	6.4	10.3	18
SC	AV	6.2	12.2	38
SC	AVSC	7.1	14.6	7
SC	DP	6.5	17	2
AV	N			0
AV	SC	6	15	1
AV	AV	6	12	3
AV	AVSC	9	10	1
AV	DP			0
AVSC	N	8	12	1
AVSC	SC	8.2	18.3	3
AVSC	AV	6.6	14.6	16
AVSC	AVSC	7.8	15	9
AVSC	DP	8	32	1
DP	N	6	10	1
DP	SC	5	14	1
DP	AV	7.8	17.8	5
DP	AVSC	6.7	18.3	3
DP	DP	8.6	26	4

ATFL, anterior talofibular ligament; CFL, calcaneofibular ligament; N, near-normal ligament; SC, ligaments degenerated to scar tissue, fibrous structure has disappeared; AV, avulsion ruptures at the endpoints; AVSC, ligaments degenerated to scar tissue, ruptured at endpoints; DP, ligaments have disappeared

because it is simple, and complications are rare. However, a direct in situ repair requires the presence of adequate ligamentous tissue.[15] When the lateral ligamentous structure is insufficient, in situ repair is impossible and augmentation is necessary.[13] Therefore, it is useful if we can determine the condition of a ligament before an operation when we are deciding on the operative method. Magnetic resonance imaging (MRI)[16] and arthrography,[17] in addition to stress X-ray examinations, are reported to be methods to determine the condition of a ligament. MRI examination is expensive, and it is difficult to quantify the degree of ligament injury. Arthrography examination is invasive and also difficult to quantify the injury. In comparison with these examinations, we think that the stress X-ray examination is superior in a certain respect in that it is noninvasive and can quantify the damage.

In our series, 55 of 122 (45%) feet were classified as AVSC or DP of either the ATFL or CFL. It is useful in an operation if we can determine the condition of an injured ligament preoperatively. The purpose of this study was to determine a method for identifying the condition of injured ligaments prior to surgery using ankle stress X-ray examinations.

As for the ankle stress X-ray examination, there is one report that says it is not useful as a diagnostic procedure for chronic ankle instability[18]; however, there are many reports that it is indeed useful.[19,20] The examination has the weak point that it does not reflect only ligament injury but also reflect the bone configuration of the ankle[21] and the influence of capsule laceration.[22] Instrumentation methods of the anterior drawer test are various, and there is unevenness of data by instrumentation methods.[23] These problems should be resolved in the future.

Conclusion

The results of this study shows that a talar tilt angle of ≥15º is nearly always associated with either ATFL and/or CFL belonging to the AVSC and/or DP category (28/36, 77.8%).

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