ATFL and ATiFL rupture have different mechanisms in ankle instability
+1Suzuki, D; 2Teramoto, A; 1Kamiya, T 1Chikenji, T and 1Fujimiya, M
+Sapporo Medical University, Sapporo, Japan, 2Kushiro Red Cross Hospital, Kushiro, Japan
daisuke@sapmed.ac.jp

ABSTRACT INTRODUCTION:
Anterior talofibular ligament (ATFL) was frequently injured by sports and recreational activities. On the other hand, anterior tibiofibular ligament (ATiFL) injury, which was less frequently than ATFL injury, was often overlooked or misdiagnosed for ATFL injury, by follow reasons; those two ligaments were nearly positioned each other, and observed increase of talar tilt angle (TTA) in both case. We tried to clarify the differences of instability mechanism between ATFL and ATiFL injury by making ligament rupture models.

MATERIALS AND METHODS:
Thirteen fresh frozen cadaveric legs were used; those are donated to Sapporo Medical University. The mean of age was 79.4 years old (range, 67-88 y.o.). Six legs (4 male, 2 female) were used as ATFL or lateral ligament injury model (LLIM) and the other seven legs (6 male, 1 female) are used as ATFL or syndesmosis injury model (SIM). Each model was made by cut ATFL or ATiFL. The leg was fixed on wooden jig and attached three electromagnetic sensors (3 Space Fastrack; Polhemus, USA) on the tibia, fibula and talus (Figure 1). Some anatomical points were also marked on the tibia, fibula and talus to calculate distances and angles for each anatomical point. These points are tracking each movement of the sensor following the bone attached. The data of each anatomical point were converted three dimensional coordinates by Medis-3D software (Medisence, Japan).

The medial (inversion) and lateral (eversion) traction force of 19.6N, and internal and external rotation torque of 2Nm were applied to each leg without cutting ligament. Next, LLIM and SIM were made and the same experimental procedures were done. Statistical analyses were used paired T-test and the level of significance was set at 5%.

RESULTS:
Both LLIM and SIM, TTA was significantly increased 8.38±4.05°and 12.55±4.87° during inversion, respectively (Figure 2). LLIM showed increase of talocrural instability, when inversion force or internal rotation torque were applied. On the other hand, SIM was not showed instabilities during internal rotation, while during inversion or external rotation, the increase of tibio-fibular instability, such as shaft angle between tibia and fibula, and diastasis between lateral and medial malleolus was observed (Fig 2).

Interestingly, the subtalar rotation was significantly decreased from 4.12±2.07° to 2.81±2.00° during internal rotation in LLIM, instead that the talocrural rotation was significantly increased. This paradoxical motion was not observed in SIM.

DISCUSSION:
TTA angle was increased both LLIM and SIM, but their mechanism was quite different. The increase TTA in LLIM is attributed to the rupture of ATFL itself (Cox & Hewes 1979), while in SIM, it is attributed to the diastasis between the medial and lateral malleolus (Teramoto et al 2008). The SIM showed not only the diastasis, but also increase tibio-fibular instability during inversion or external rotation. At the same time, the prominent instabilities were not observed during internal rotation. It is likely that ATFL hold the excess of internal rotation in talocrural joint.

The LLIM showed talocrural instability, increase of TTA and talocrural rotation during inversion and internal rotation, respectively. It suggests ATFL transmit the crural movement to the talus. It is, therefore, the paradoxical motion or decreased movement of subtalar rotation was arose by the compensation of talocrural rotation, because the gross rotation was not changed before and after ATFL cutting. There are no significant instabilities during external rotation, because the mortise formed by the distal tibia and fibula was held the talus tightly.

The results show that the instabilities of LLIM mainly arose in talocrural joint, that is, the instabilities were generated between the tibio-fibular unit and talo-calcaneal unit (Figure 3). On the other hand, instabilities of SIM mainly arose in related tibio-fibular movement, that is, instabilities were generated between the tibia and fibula-talo-calcaneal unit (Figure 3). This schema makes the discrimination of ATFL and ATiFL rupture easier, and enable immediate and adequate treatments.

REFERENCES:

Figure 1(left). Diagram of measurement system.
Figure 2(right). Inversion instability. TTA, talar tilt angle; diastasis, between medial and lateral malleolus.

Figure 3. The instability mechanism during inversion. A. neutral position of the crus; B. normal inversion by the subtalar joint movement; C. LLIM or ATFL injured model. The instability is generated between the tibio-fibular unit and talo-calcaneal unit (dark grey) as known as talocrural instability (arrows). D. SIM or ATiFL injured model. The instability is generated between tibia and fibula-talo-calcaneal unit (dark grey) such as the diastasis (arrows).