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## Original article

## The anterolateral ligament in a Japanese population: Study on prevalence and morphology

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## ABSTRACT

**Background:** The anterolateral ligament of the knee (ALL) has been attracting research attention as the ligament related to the Segond fracture. In this study, we investigated the prevalence and morphological variation of the ALL and developed a classification for the ALL in Japanese people.

**Methods:** A total of 94 knees of 54 room cadavers of Japanese people were examined (24 male, 30 female; age range 70–103 years; average age: 85.6 years). Knees with damaged ligaments, such as ACL rupture, and with bony abnormalities were excluded. The ALL-like structure was classified based on orientation and shape of the structures.

**Results:** The fibrous structure independent from the knee joint capsule in the anterolateral part of the knee was present in 35 knees out of 94 knees (37.2%). This structure was classified into two types, based on thickness: type I is for the strong ligamentous structures of more than 1 mm in thickness; and type II is for weak aponeurotic structures of equal or less than 1 mm thickness. Here we regard the anterolateral ligament (ALL) as the type I and the type II is termed anterolateral ligamentous tissue (ALLT). Type I was seen in 19 of 35 knees (54.3%), and type II was seen in 16 of 35 knees (45.7%).

**Conclusions:** This study described the fibrous structure of the anterolateral portion of the knee, and classified the ligamentous structure into type I (ALL) and thin aponeurotic type II (ALLT). The prevalence of the ALL in Japanese people was approximately 20% and was significantly lower than in previous studies, which were reported values from 50% to 100%.

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## 1. Introduction

In recent years, Claes et al. [1] reported a ligament that ran bilaterally from the lateral femoral epicondyle to the anterolateral aspect of the proximal tibia and was partially connected to the lateral meniscus (LM). They named this ligament the anterolateral ligament (ALL). The ALL has been found in approximately 97% of subjects, and it was found to have an obviously different attachment site from that

of the iliotibial band (ITB). The ALL was attached to the anterolateral aspect of the proximal tibia, between the middle of Gerdy's tubercle and the fibular head. Claes et al. [2] concluded that the ALL was the ligament that was the cause of the Segond fracture because this site corresponds precisely to the site of the Segond fracture [3]. Several studies have reported that the frequency of occurrence of Segond fracture is extremely different between the Westerners and Japanese people [4–8]. Therefore, it was thought that the prevalence of ALL also extremely different in Japanese.

The purpose of this study is to examine prevalence and morphological variations of the ALL in Asian populations including Japanese people.

## 2. Materials and methods

A total of 94 knees of 54 room cadavers (24 male, 30 female; age range 70–103 years; average age: 85.6 years) that were donated to

**Abbreviations:** ALL, anterolateral ligament of the knee; ALLT, anterolateral ligamentous tissue; ACL, anterior cruciate ligament; LM, lateral meniscus; ITB, iliotibial band; LCL, lateral collateral ligament; MCL, medial collateral ligament; MM, medial meniscus.

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Sapporo Medical University from January, 2014 to July, 2015 were examined (Table 1). All were of Japanese origin. Exclusion criteria were damaged knee ligaments, such as ACL rupture, and osteological knee abnormalities.

The ALL was dissected according to the method of Claes et al. [1] and Seebacher et al. [9]. The skin around the knee and the subcutaneous tissue were removed, the lateral femoral epicondyle of the femur was exposed, and the ITB, patellar tendon, and biceps femoris tendon were resected. When the orientation of the deep layer of the ITB was close to the ALL, the ITB was carefully removed from the ALL. The ALL and joint capsule were separated by removing the connective tissue. Here, we defined the ALL as the fiber from the lateral epicondyle to anterolateral aspect of the tibia, completely separated from knee capsule. After the ALL was completely exposed, the structure of the ALL was examined. The ALL frequently gives off a connection band to the LM. Therefore, the connection band between the ALL and LM was examined, and the relationship between the occurrence of LM injuries and the presence of the connection band was evaluated.

Approval for this work was obtained from the Human Ethics Committee of the Sapporo Medical University School of Medicine.

### 3. Results

#### 3.1. The fibrous structure in the anterolateral part of the knee

In the anatomical investigation, the ALL-like fibrous structure different from the lateral collateral ligament (LCL) and the ITB was seen in 35 knees out of 94 knees (37.2%). The ALL-like fibrous structure was distinguished from the joint capsule of the knee by its macroscopic finding of cord-like or aponeurotic structure. This ALL-like fibrous structure was connected around the lateral epicondyle of the femur and the anterolateral aspect of the tibia. The fibrous structure frequently gives off a connection band attached to the LM (20/35, 57.1%).

The orientation and shape of the fibrous structure showed various morphologies. Hence, the fibrous structure in the anterolateral part of the knees was classified into two types based on thickness at the midsubstance. The type I is for the structures of more than 1 mm in thickness with a ligamentous structure while

**Table 1**  
Subject characteristics.

	Male	Female	Total
Number of subject	24	30	54
Number of knee	45	49	94
right/left	21/24	22/27	43/51
Age (range)	83.2 (71–97)	87.6 (70–103)	85.6 (70–103)

**Table 2**  
Classification of anterolateral ligament (type I) and ligamentous tissue (type II).

	Morphology and thickness mm	Femoral attachment	Tibial attachment	Frequency
Type I a	Ligamentous 1.3–3.2	Overlapped LCL attachment site	Anterolateral aspect of tibial plateau	13.8% (13/94)
Type I b	Ligamentous 1.2–2.2	Posterior to LCL attachment site	Anterolateral aspect of tibial plateau	3.2% (3/94)
Type I c	Ligamentous 1.6–2	Anterior to LCL attachment site	Anterolateral aspect of tibial plateau	3.2% (3/94)
Type II a	Aponeurotic 0.45–1	Anterior to posterior of LCL attachment site	Anterolateral aspect of tibial plateau	10.6% (10/94)
Type II b	Aponeurotic 0.7–0.9	Anterior to posterior of LCL attachment site	Lateral aspect of tibial plateau (near fibular head)	6.4% (6/94)

LCL: Lateral collateral ligament.

the type II is for those of thin equal or less than 1 mm thickness with aponeurotic structure. Furthermore, Type I and Type II was classified into subtype based on orientation (Table 2). The types I and II indicate the ALL and anterolateral ligamentous tissue (ALLT), respectively.

#### 3.2. The morphology of the ALL (type I fibrous structure)

The ALL (type I) was seen in 19 of 94 knees (20.2%), of which 5 knees (26.3%) were from males, and the other 14 knees (73.7%) were from females (Table 3).

The ALL was attached to the anterolateral aspect of the tibial plateau between Gerdy's tubercle and the fibular head, the exact location of the Segond fracture [2]. It was found that the ALL tended to be taut in the knee extension and slack in the knee flexion (Fig. 1AB). This tensioning pattern of the ALL is similar to that of the ACL.

The ALL was classified into three subtypes by its orientation. Type Ia ALL had the attachment site superficial to the femoral attachment site of the LCL (Fig. 2A) and made a V-shape with the LCL. The type Ia ALL showed the typical morphology of the ALL, which Claes et al. [1] described. Type Ib ALL had the femoral attachment site posterior to the femoral attachment site of the LCL, and the fibers of the type Ib ALL ran superficial to the LCL at the midsubstance. The type Ib ALL made an X-shape with the LCL and was often thinner than the type Ia ALL (Fig. 2B). Type Ic ALL had the attachment site anterior to the femoral attachment site of the LCL and posterior to the origin of the popliteus. The type Ic ALL also made a V-shape with the LCL, but the femoral attachment site of the type Ic ALL was deeper to the LCL attachment site (Fig. 2C).

All types of ALL were extracapsular ligaments and separated from the knee capsule. The femoral attachment of the ALL was mostly on the LCL attachment or posterior to the LCL attachment. The connection band was present in 17 ALLs out of 19 ALLs, but was not as strong as the case mentioned Claes et al. [1] (Fig. 3). Abundance of the connection band was not related to the subtypes.

**Table 3**  
Prevalence of fibrous structure in anterolateral part of the knee.

Type		Male	Female	Total
I (ALL)	Number of subjects	3	9	12
	Number of knees (right/left)	5 3/2	14 6/8	19 9/10
	Number of both knees	2	5	7
II (ALLT)	Number of subjects	8	5	13
	Number of knee right/left	10 3/7	6 1/5	16 4/12
	Number of both knees	2	1	3

ALL: Anterolateral ligament, ALLT: Anterolateral ligamentous tissue.

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