Comparison Between the Simultaneous Reconstructions of the Anterior Talofibular Ligament and Calcaneofibular Ligament and the Single Reconstruction of the Anterior Talofibular Ligament for the Treatment of Chronic Lateral Ankle Instability

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Abbreviations:

ATFL, anterior talofibular ligament

CFL, calcaneofibular ligament

CLAI, chronic lateral ankle instability

TTA, talar tilt angle

TAD, Talar anterior drawer distance

JSSF, Japanese Society for Surgery of the Foot

Abstract

This study aimed to evaluate the procedures of reconstruction surgery for chronic lateral ankle instability. We compared single anterior talofibular ligament reconstruction to simultaneous reconstructions of the anterior talofibular and calcaneofibular ligaments. From 2015 to 2019, 14 consecutive patients diagnosed with chronic lateral ankle instability underwent arthroscopic anterior talofibular ligament reconstruction with or without calcaneofibular ligament reconstruction after conservative treatment. Seven patients underwent single anterior talofibular ligament reconstruction (group AT), and seven patients underwent simultaneous reconstructions of the anterior talofibular ligament and calcaneofibular ligament (group AC). The Japanese Society for Surgery of the Foot scale scores and Karlsson scores significantly improved in all patients one year postoperatively. The radiographic measurement of the talar tilt angle and the talar anterior drawer distance at one year after surgery were also significantly improved compared to preoperative values. The postoperative talar tilt angle was significantly greater in group AT (median 6°, range 3° to 7°) than that in group AC (median 3°, range 2° to 5°; p=0.038). The postoperative talar anterior drawer distance, Japanese Society for Surgery of the Foot scale score, and Karlsson score were not significantly different between the two groups.

We found that although the clinical outcomes after the anterior talofibular ligament reconstruction with or without the calcaneofibular ligament reconstruction for chronic lateral ankle instability were

good, instability of the talar tilt angle at one year postoperatively in patients who underwent single anterior talofibular ligament reconstruction was greater than that in patients who underwent simultaneous anterior talofibular and calcaneofibular ligament reconstructions.

Level of Clinical Evidence: Level 4, case control study

Keywords: anterior talofibular ligament, calcaneofibular ligament, chronic lateral ankle instability, reconstruction

Introduction

Ankle sprains are common in sports activities, and often involve ankle lateral ligament complex injuries (1-4). The anterior talofibular ligament (ATFL) and the calcaneofibular ligament (CFL) are damaged in severe ankle sprains. The ATFL is the most frequently injured ligament in ankle sprains (2). In epidemiologic surveys, ATFL injuries occurred in 85% and CFL injuries occurred in 35% of all lateral ankle ligament injuries due to ankle sprain (5). Conservative therapy is the first line treatment for ankle sprains in the acute phase, and more than 80% of patients can return to sports activities (6). However, chronic lateral ankle instability (CLAI) develops in 5 to 20% of patients with ankle sprains despite adequate conservative treatment (6,7).

The Broström technique is the most popular procedure used for repairing a ruptured ATFL (8). Gould et al. reported the augmentation method with the inferior extensor retinaculum (9), and Karlsson et al. showed the method of suturing and reattaching the ATFL using drill holes of the lateral malleolus (10). However, patients with ankle sprains who are not treated in a timely manner may experience residual ankle instability, as outcomes of repair surgeries depend on the quality of the remnant ATFL. In patients who are not treated promptly, a ligament reconstruction method using a free tendon is indicated. Several open reconstruction techniques designed to replace absent or incompetent ATFLs and CFLs have been reported (11-18). Recently, minimally invasive reconstruction surgeries of the ATFL and CFL have been performed percutaneously or with arthroscopy (19-23). When patients have

positive physical examinations of anterior drawer and varus stress tests, and exhibit greater radiographic talar tilt angle (TTA) and talar anterior drawer distance (TAD), ATFL and CFL reconstruction surgery might be performed. However, whether CFL reconstruction is necessary in addition to ATFL reconstruction remains controversial (4).

The purpose of this study was to compare the postoperative lateral ankle instability and clinical outcomes between patients with CLAI who underwent simultaneous reconstructions of ATFL and CFL and patients who underwent single ATFL reconstruction. We hypothesized that patients who underwent simultaneous reconstructions of the ATFL and CFL would have better results than patients who underwent single reconstruction of the ATFL. Therefore, we retrospectively analyzed the outcomes of reconstructive surgeries to determine whether the simultaneous reconstructions of the ATFL and CFL provided advantages to the single reconstruction of the ATFL in radiographic instability and clinical outcomes.

Patients and methods

The current research was performed retrospectively as a case control study. From April 2015 to March 2019, consecutive patients who underwent arthroscopic reconstruction surgery of the ATFL with or without reconstruction of the CFL for CLAI were included in this study. All patients waited at

least one year after the initial ankle sprain before surgery and had been active in sports between the time of injury and the time of surgery. A preoperative diagnosis of CLAI was made based on symptoms of instability, clinical examinations including the anterior drawer and varus stress tests (5,6), and stress radiography and magnetic resonance imaging results. Fourteen patients (6 men, 8 women) with a median age of 35.3 (range 26 to 53) years were analyzed in this study to determine the differences in the outcomes of simultaneous ATFL and CFL reconstruction and single ATFL reconstruction (Table 1). For all patients diagnosed with CLAI, one senior orthopedic surgeon (M.H.) evaluated clinical and stress radiograph examinations, surgical procedures, and analysis of data described below.

Surgical techniques and postoperative procedures

In almost patients, single reconstruction surgeries of the ATFL with arthroscopy were performed from April 2015 to August 2017, and arthroscopic reconstructions of the ATFL and CFL have been performed since then regardless of ankle instability.

An arthroscopic examination was performed to evaluate articular cartilage injuries of the tibia and talus at first. When cartilage damage was present, debridement and micro-fracture procedures were performed regardless of the size of the cartilage lesion.

Simultaneous ATFL and CFL reconstruction and single ATFL reconstruction were performed with arthroscopy according to the techniques described by Takao et al. (18,24). Briefly, a gracilis tendon of

91 the ipsilateral knee was harvested and a graft for the single ATFL (Fig. 1A) or the ATFL and CFL
92 complex (Fig. 2A) was created. Bone tunnels with a depth of 20 to 25 mm were created in the fibula,
93 talus, and calcaneus, then the graft was inserted to bone tunnels and fixed with interference screws
94 with a diameter of 5 or 6 mm (Fig. 1B, 2B).
95 The postoperative procedure included immobilization with a plaster slab. Patients were encouraged to
96 perform non-weight-bearing gait for two weeks after surgery. At three weeks postoperatively, range of
97 motion exercises and weight-bearing gait were allowed if there was no articular cartilage injury. When
98 articular cartilage damage was observed, weight-bearing gait was only started at five weeks
99 postoperatively. An elastic ankle support brace was used for six months after removal of the plaster
100 slab in all patients.
101
102 *Clinical and radiographic assessments*
103 Clinical and radiographic assessments were performed as previously described (25). Stress
104 radiography, including the assessment of varus and anterior drawer stress, was performed with the
105 Telos Stress Device (Aimedic MMT, Japan). TTA was defined as the angle between the tibial plafond
106 and the talus in the frontal view, and TAD was defined as the distance between the posterior horn of
107 the tibial plafond and the talus dome in the lateral view. CLAI was diagnosed and reconstruction
108 surgery was considered in patients with a TTA >5°, and a TAD of >5 mm. Clinical scores were

evaluated using the Karlsson scoring scale (26) and the Japanese Society for Surgery of the Foot (JSSF) ankle-hindfoot scale (27,28). All patients underwent clinical and radiographic examinations preoperatively and at one year after surgery.

Statistical analysis

Patients were divided into two groups according to whether they had simultaneous reconstructions of the ATFL and CFL (Group AC) or a single ATFL reconstruction (Group AT). The Mann-Whitney U test was used to compare patients' demographic data, radiographic examinations including TTA and TAD, and clinical outcomes including JSSF scale scores and Karlsson scores between the groups. In each group, postoperative data was statistically compared to preoperative data using the Wilcoxon signed-rank test. SPSS version 25 (IBM Corporation, Armonk, New York, USA) was used for statistical analysis. A p-value of 0.05 was considered statistically significant.

Results

Seven patients underwent single ATFL reconstruction, and seven patients underwent simultaneous reconstructions of the ATFL and CFL. The JSSF scale sores and Karlsson scores were improved in all

patients. Table 2 shows patients' demographic data, radiographic examination results, and clinical outcomes in two groups. The postoperative TTA, TAD, JSSF scale scores, and Karlsson scores were significantly improved compared to preoperative values in group AT (p=0.028, 0.018, 0.017, 0.018, respectively). In group AC, postoperative TTA, TAD, JSSF scale scores, and Karlsson scores were also significantly improved compared to preoperative values (p=0.018, 0.016, 0.018, 0.018, respectively). There were no significant differences in age and preoperative data between the groups. The postoperative TTA in group AT (median 6°, range 3° to 7°) was significantly greater than that in group AC (median 3°, range 2° to 5°) (p=0.038). The postoperative TAD, JSSF scale score and Karlsson score were not significantly different between the groups.

Discussion

The most important finding of this study was that TTA instability at one year after surgery in patients who underwent single ATFL reconstruction for CLAI was greater than that in patients who underwent simultaneous reconstructions of the ATFL and CFL.

In this study, the JSSF scale scores and Karlsson scores were improved in all patients after arthroscopic surgery; thus, the arthroscopic procedure was considered sufficiently useful for treating

145 CLAI. However, to our knowledge, there are no reports of TTA or TAD worsening chronically after
146 reconstruction surgery. In addition, this is the first report comparing the outcomes of single ATFL
147 reconstruction and the simultaneous reconstructions of the ATFL and CFL.
148 Several studies have reported that an open procedure for reconstruction surgeries of the ATFL and
149 CFL yielded favorable long-term outcomes (13,15,16,29-31). However, only a few reports on the
150 short-term clinical results of arthroscopic reconstructions of the ATFL and CFL have been published
151 (20,32,33). Dierckman and Ferkel reported that approximately 20% of patients with CLAI were not
152 suitable candidates for anatomic repair, and instead required anatomic reconstruction with a graft (30).
153 ATFL reconstruction with or without CFL reconstruction is indicated in patients who have a relatively
154 large TTA (as confirmed by fluoroscopy during surgery) or significant general joint laxity. CFL
155 reconstruction is considered to be necessary in patients who have fragile remnant of the CFL.
156 Furthermore, in single reconstruction of the ATFL, the CFL remnant might be damaged when a fibular
157 tunnel is made nearby. This may explain why the TTA was found to be larger in patients who
158 underwent single ATFL reconstruction (group AT) than in patients who underwent simultaneous ATFL
159 and CFL reconstructions (group AC) at one year postoperatively in this study. According to Matsui et
160 al., for patients with a sufficient remnant of the CFL, the fibular tunnel for the ATFL's superior limb
161 should be created proximal to the fibular obscure tubercle, as the center of the ATFL origin on the
162 fibula is located 3.7 (range, 0 to 6.7) mm proximal to the fibular obscure tubercle (34). However, it

was difficult to evaluate the quality of the CFL remnant with preoperative magnetic resonance imaging or intra-operative arthroscopic findings. If the quality of the CFL remnant is unknown, it is preferable to reconstruct the CFL as well as the ATFL. Alternatively, when single ATFL reconstruction is performed, the bone tunnel at a fibular site must be made to not interfere with the CFL remnant.

There are several limitations to this study. First, the sample size was small. Large-scale studies should be performed in the future to validate our findings. Second, the quality of the CFL remnant could not be investigated because of the lack of advanced imaging to better define ligament pathology. Selective single reconstruction of the ATFL may be possible if a preoperative or intra-operative procedure for evaluating the quality of the CFL remnant is established. Despite these limitations, we believe that the results of this study are useful for the future development of prospective cohort studies and randomized controlled trials that focus on the necessity of CFL reconstruction.

In conclusion, the clinical scores after arthroscopic reconstruction of the ATFL with or without CFL reconstruction for CLAI were favorable. We found that patients who underwent single reconstruction of the ATFL had greater TTA instability at one year postoperatively than patients who underwent simultaneous reconstructions of the ATFL and CFL. Further studies that include the preoperative or intraoperative evaluation of the quality of the remnant CFL and the possibility of selective single ATFL reconstruction are needed.

Authors' contributions: M. H. acquired and analyzed the data and wrote the manuscript. K. H. designed the study and checked the manuscript. Y. M. advised on the study and approved the submission.

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Figure Legend

Figure 1: A graft phot and drawing for single anterior talofibular ligament (ATFL) reconstruction procedure.

(A) Single ATFL grafts were made from the gracilis tendon harvested from the ipsilateral pes anserinus, and were prepared as folded two-strand grafts. Both ends of the graft have a 15 mm portion to be inserted into the bone tunnels. The center of the graft spanned 15 to 20 mm. (B) Single ATFL graft (arrow head) were inserted into fibular and talar bone tunnels (broken line), then were fixed with a bioabsorbable interference screw (arrow) in both tunnels.

Figure 2: A graft phot and drawing for simultaneous anterior talofibular ligament (ATFL) and calcaneofibular ligament (CFL) reconstruction procedure.

(A) ATFL grafts were also prepared as two-strand grafts and CFL grafts were prepared as one-strand or two-strand grafts depending on gracilis length. The three ends of the graft have 15 mm portions to be inserted into the bone tunnels. The ATFL portion of the graft (right side) spanned 15 to 20 mm and the CFL portion of the graft (left side) spanned 25 to 30 mm. (B) ATFL and CFL grafts (arrow head) were inserted into bone tunnels (broken line), then were fixed with a bioabsorbable interference screw (arrow) in each tunnel.

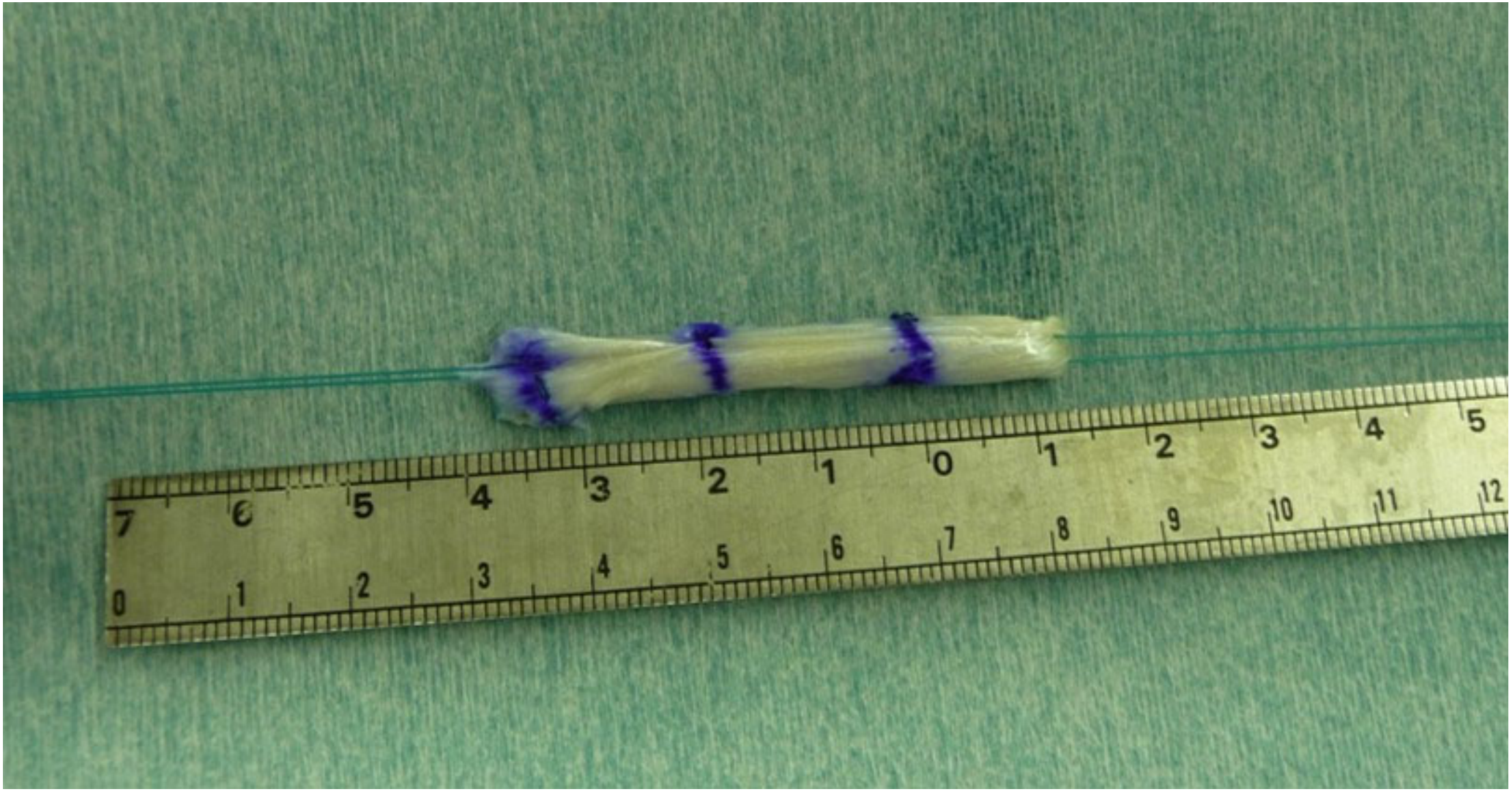

Figure 1A

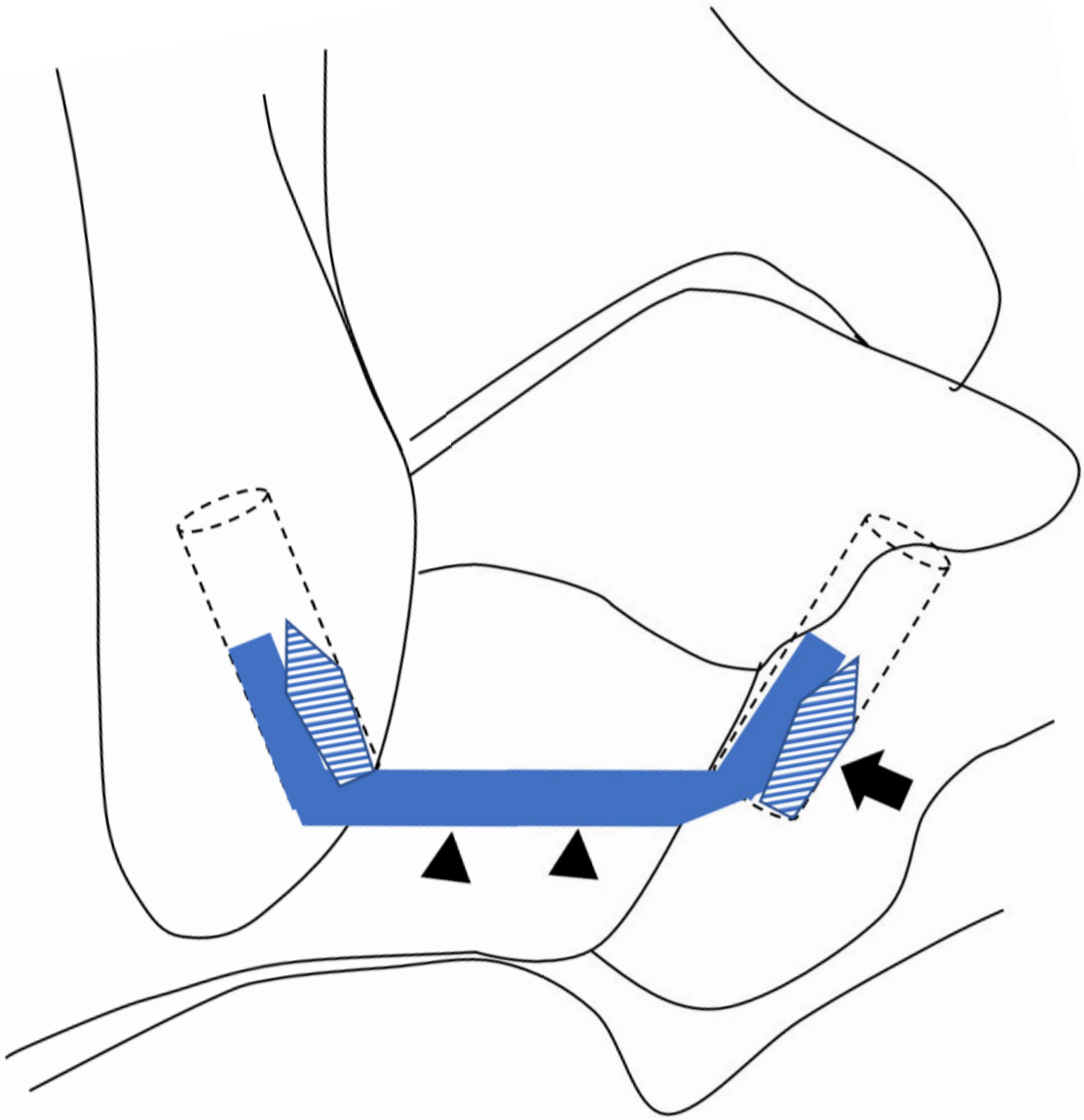

Figure 1B


JAPAN
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Figure 2A

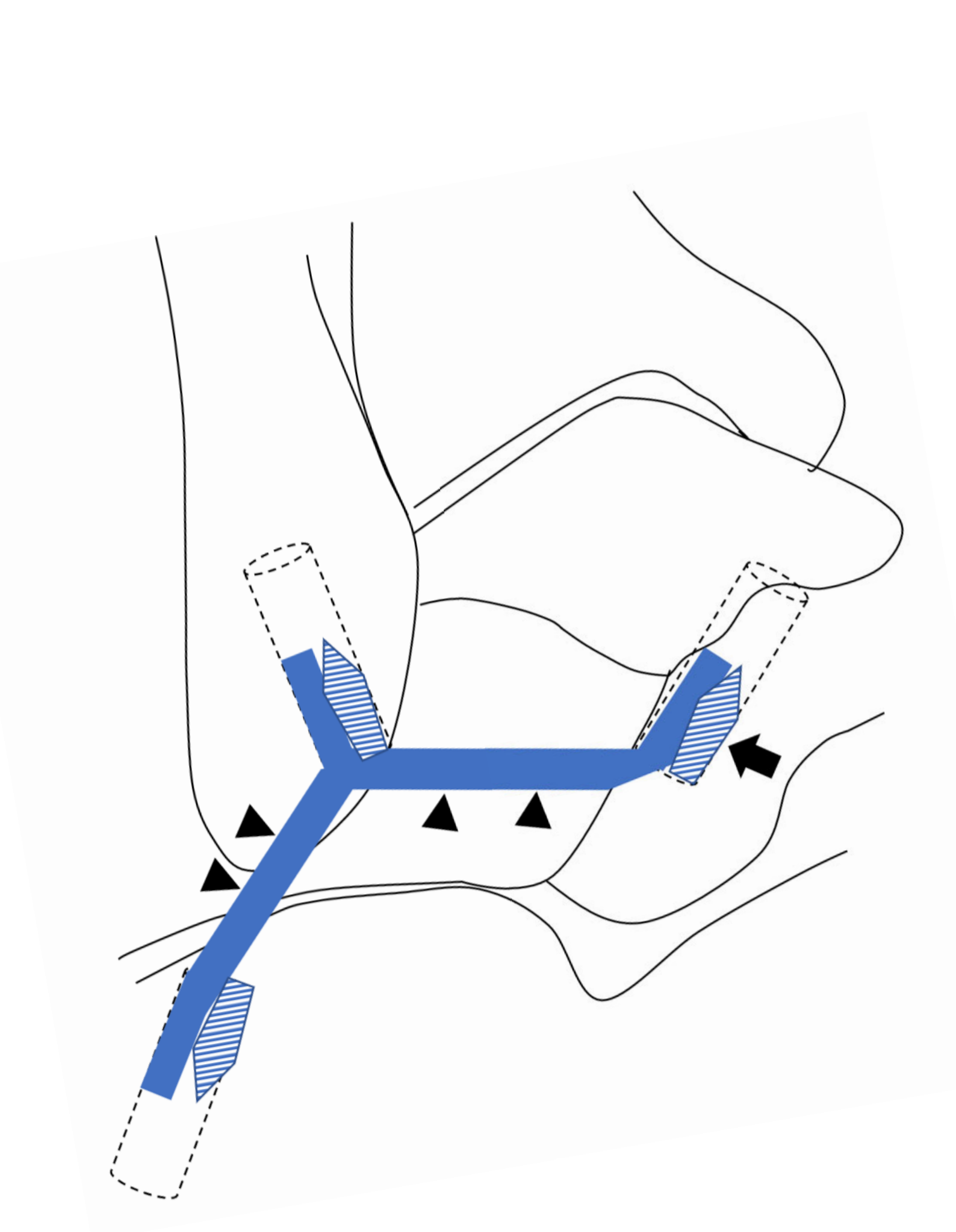

Figure 2B