Isolated Syndesmosis Diastasis: Computed Tomography Scan Assessment With Arthroscopic Correlation

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Purpose: To investigate which method can predict tibiofibular diastasis more accurately among the tibiofibular interval at the ankle joint level or previous parameters taken 1 cm above the joint line. **Methods:** An arthroscopic examination was performed in 78 consecutive patients with anterolateral ankle pain. Four different methods were performed to take measurements of the tibiofibular interval using an axial computed tomography (CT) scan under existing arthroscopic diagnosis. Three previously reported parameters were assessed at 1 cm above the joint level. In the first method, 2 measurements were obtained. The anterior measurement was the closest distance between the anterior border of the fibula and anterior tibial tubercle. The posterior measurement was the closest distance between the medial border of the fibula and posterior tibial tubercle. In the second method, an angle between the fibular axis and the line connecting the anterior and posterior tibial tubercle was measured. In the third method, the nearest distance between the line perpendicular to the line connecting the tubercles at the anterior tubercle of the distal tibia and the anterior-most margin of the fibula was measured. The fourth method, which was developed in this study, measured the narrowest tibiofibular distance at the joint level. Data were analyzed using Student's *t*-test and the receiver operating characteristic curve to make comparisons among 4 CT-based parameters. **Results:** In the comparison between the patients with arthroscopic diastasis and without diastasis, the posterior parameter in the first method and the narrowest tibiofibular distance at the joint level in the fourth method showed a significant difference ($P < .05$) The areas under the receiver operating characteristic curve (AUCs) of the anterior and posterior parameter of the first method were 0.58 (95% confidence interval [CI], 0.43-0.73; $P = .167$) of anterior measurement and 0.6 (95% CI, 0.45-0.75; $P = .029$) of posterior measurement, respectively. The second and third methods presented AUCs of 0.59 (95% CI, 0.44-0.74; $P = .458$) and 0.48 (95% CI, 0.33-0.64; $P = .987$), respectively. The fourth method presented an AUC of 0.86 (95% CI, 0.75-0.94; $P = .000$). When the syndesmosis was measured at the joint level, 2 mm of syndesmosis interval as a cutoff value showed 76% of sensitivity and 81% of specificity. **Conclusions:** Syndesmosis assessment using an axial CT scan at the joint level best correlated with the arthroscopic examination. When there is more than 2 mm of widening in syndesmosis on the axial CT scan at the joint level, there is a high likelihood of diastasis of the distal tibiofibular syndesmosis in patients who are suspicious clinically to have acute or chronic syndesmosis lesion. **Level of Evidence:** Level III, retrospective comparative study.

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When syndesmotic injury is suspected, a clinical examination and radiographic assessment are performed initially. However, injury to the distal tibiofibular syndesmosis is difficult to diagnose because of the limitations of the clinical examination and radiographs. If the syndesmosis is completely disrupted, diastasis can be detected on plain anteroposterior radiographs. More subtle injuries in the syndesmosis, however, often cannot be quantified reliably. In addition, because of the various results of clinical tests for the diagnosis of syndesmotic injury, previous studies have postulated that the final diagnosis of syndesmotic injury should be made by additional diagnostic imaging.[1-5] As a result, computed tomography (CT), magnetic resonance imaging, and

arthroscopy have been used as more accurate diagnostic methods.[4,6-12]

Several parameters on the axial image of the CT scan at the level of 1 cm above the ankle joint have been used for the assessment of the distal tibiofibular relation. Gardner et al.[13] measured the distance between the fibula and the anterior and posterior facets of the incisura. A difference of more than 2 mm between anterior and posterior measurements was considered as the incongruent syndesmosis in ankle fractures. Dikos et al.[6] measured the rotation of the fibula in the syndesmosis by using the angle between a line tangential to the anterior and posterior tibial tubercles and the fibula axis in normal volunteers. Phisitkul et al.[14] developed a new technique of syndesmosis measurement for evaluating the anteroposterior displacement of the fibula in destabilized ankle specimens of cadavers. Although those CT parameters have been shown to be reproducible, they were used for evaluation of normal tibiofibular relation or diastasis in the setting of ankle fractures. In addition, the location of the assessment on the CT image does not coincide with the location of the arthroscopic assessment of diastasis.[4,6,8,13-15]

Arthroscopy has been known as the most reliable method for the diagnosis of the syndesmotic pathology.[9,11,12,16,17] An arthroscopic examination of the syndesmosis is conducted at the ankle joint level under direct vision. The diastasis of the syndesmosis is usually confirmed under the arthroscopic examination when the tibia and the fibula are separated more than 2 mm under external rotation stress to the ankle joint.[9,12,17-19]

To assess the validity of the previously reported CT parameters for the diagnosis of diastasis in the distal tibiofibular syndesmosis, we planned to correlate the parameters to the arthroscopic examination. In addition, a new CT parameter at the level of the ankle joint was introduced, which is the location of the arthroscopic assessment of diastasis, because to date, there has been a discrepancy of the measuring location between the CT and arthroscopic examination.

The aim of this study was to investigate which method can predict tibiofibular diastasis more accurately among the tibiofibular interval at the ankle joint level or previous parameters taken 1 cm above the joint line. The hypothesis of this study was that the diastasis would be more accurately diagnosed by the tibiofibular interval at the level of the ankle joint than various parameters at the level of 1 cm above the ankle joint.

Methods

Patients who underwent an arthroscopic examination for the syndesmosis from May 2010 to December 2014 were retrospectively identified using a prospectively collected patient database. The study was approved by the institutional review board. The inclusion criteria were (1) anterolateral ankle pain around the syndesmosis, (2) a history of acute or chronic sprain with or without repetitive episodes, and (3) preoperative and postoperative CT scan data on syndesmosis. The exclusion criteria were (1) deltoid ligament injury, (2) a history of fracture around the ankle joint, and (3) a history of infection, and inflammatory or neuropathic arthropathies in the ankle joint. All patients had anterolateral ankle pain around the syndesmosis, but often could not be exactly localized by themselves. Even in stress tests, magnetic resonance imaging images in some of the patients and radiologic images could not confirm the injury of syndesmosis; if the patients had pain around the syndesmosis and syndesmotic injury was suspected in relation to the physical examination and the mechanism of injury, we performed the arthroscopic examination for subtle injury or instability. We excluded patients with deltoid ligament injury and fractures around the ankle joint to investigate homogeneous cases with minimal degree of diastasis that is suspected to be caused by ligamentous injury only.

CT Assessment

In this study, 4 different methods were performed to take measurements of the distal tibiofibular interval using an axial image of the non-weightbearing CT scan. Before the CT measurements, 3 different observers (T-K.A., S-M.C., J-Y.K.) who were blinded to the arthroscopic results predetermined the sections of the axial CT scan to be measured by mutual agreement. Then, each of the observers reviewed the axial CT scans in duplicate with randomly selected patients' list, after a planned delay of at least 1 month. All axial CT scans were taken parallel to the tibial plafond with 2 mm of interslice gap in the neutral ankle position. Three previously reported parameters were supposed to be measured at 1 cm above the tibial plafond, but actual measurements were performed at 8 to 10 mm proximal to the tibial plafond due to the interslice gap. All measurements were performed using a picture archiving and communication system (Maroview, Marosis, Seoul, Republic of Korea) digitally. The degree of accuracy was 0.01 mm, but we allowed 0.1 mm of accuracy with rounding off the numbers. The first method, used by Gardner et al.[13] and Elgafy et al.,[20] obtained 2 measurements. The anterior measurement (a) was the closest distance between the anterior border of the fibula and the anterior tibial tubercle. The posterior measurement (b) was the closest distance between the medial border of the fibula and the posterior tibial tubercle. The second method, described by Dikos et al.,[6] measured an angle (θ) between the fibular axis and the line connecting the anterior and posterior tibial tubercle. The third method, described by Phisitkul et al., measured the nearest distance (c) between the line perpendicular to the line connecting the tubercles at the anterior tubercle of the distal tibia and anterior-most