OBJECTIVES

- Higher-energy ankle syndesmosis injuries are particularly morbid and can be a cause of persistent disability in young patients. However, the radiographic diagnosis of syndesmotic disruptions in pediatric populations is challenging.

- Existing literature has described several imaging characteristics that can be used to delineate ankle syndesmosis injuries in adults: increased tibiofibular clear space (TFCS), decreased tibiofibular (TF) overlap, enlarged medial clear space (MCS). No study has investigated the utility of these parameters in the assessment of pediatric ankle injuries. Due to age-related ossification changes during skeletal growth, indices that have been validated through osseous measurements of the tibia, fibula, and talus in adults may not be applicable to children.

- The purpose of this study was thus to:
  1. Determine the interrater reliability of common radiographic measures of syndesmosis and deltoid ligament competency for pediatric patients
  2. Establish age-based normative values of these measures in children

- Understanding normative values of commonly used ankle indices in children and adolescents would help guide treatment as well as the intraoperative evaluation of surgical reduction.

Discussion

- While investigations in the adult literature have suggested the potential utility of the MCS and MCS/SCS ratio, our data demonstrate that insufficient ossification of the medial malleolus limits their value in children. By contrast, TF overlap changed predictably in a linear fashion through skeletal development and was characterized by excellent interrater reliability.

- Increasingly sophisticated advancements in non-invasive diagnostic imaging techniques are allowing for better characterization of the ankle syndesmosis in adults. Nault et al. reported descriptions of several syndesmotic measurements on axial computed tomography, noting their potential utility in achieving reduction of the syndesmosis. However, although axial imaging may be easily performed in the outpatient setting, it is not always readily available intraoperatively, and the variable ossification of the distal tibia and fibula in children make CT scans of unknown utility.

- The temporal relationship between ossification of the medial malleolus and pediatric development has previously been reported. LaMont et al. described the development of secondary ossification centers as part of the changes in the ossification of the medial malleolus, reporting their presence between 6 and 9 years of age, with earlier visualization in females. Our findings confirm those of previous studies, indicating nearly complete development of the medial malleolus by ages 10-12 with a greater proportion of females than males who presented with a developed medial malleolus.

- It has been shown in previous studies that several of the indices measured in the current study, including TF overlap and MCS, change significantly with radiographic axial rotation. An understanding of high quality, reproducible radiographic technique is paramount to measuring these syndesmotic indices. The current study evaluated images obtained in the clinical setting, which provide a true measure of the interrater reliability and normative values in the context of real-world imaging.

METHODS

- Consecutive patient radiographs from a level-I pediatric trauma center were identified and used to create an age and sex-balanced cohort.

- Subjects between 2 and 18 years of age were randomly selected from a pool of patients who had a complete three-view radiographic ankle series (AP, lateral, and mortise) and a final diagnosis without bony or ligamentous injury. Eight age and sex-balanced groups were created for analysis.

- Three independent raters evaluated all radiographs and recorded radiographic indices commonly used in ankle trauma evaluation: width of the medial clear space (MCS) and superior clear space (SCS), tibiofibular clear space (TFCS), tibiofibular overlap (TF), and MCS/SCS ratios (Fig. 1).

- Interrater reliability was calculated using the intraclass correlation coefficient (ICC); means and standard deviations were used to report age-group normative values.

RESULTS

- 282 patients (mean age 9.61±4.6 years) were analyzed

- SCS and TF were characterized by excellent interrater reliability (ICC=0.915 and ICC=0.964, respectively). MCS and TFCS resulted in substantial agreement (ICC=0.856 and ICC=0.835, respectively) while the MCS/SCS ratio had moderate agreement (ICC=0.418).

- The MCS could not be reliably measured until age 8 due to insufficient ossification of the medial malleolus.

- TF demonstrated a linear increase over time, ranging from 1.4mm at 2-4 years old to 6.7mm for children aged 16-18 (R²=0.995). Normative values varied by age and sex.

- No patients had a sufficiently developed medial malleolus before age 6 and the MCS could be measured in all children over 12 years. For groups between ages 6 and 12 years old, there tended to be a greater proportion of females than males who presented with a developed medial malleolus.

REFERENCES