INTRODUCTION:
Articular degeneration with ankle osteoarthritis often involves anteriorly or posteriorly dislocated talon dome position under the tibia, which is possibly implicated with an accelerated rate of degeneration or premature implant failure of total ankle replacement. With most severe cases of arthritis and/or with use of implants, the standard articular radiographic landmarks of the ankle are usually obscured.

In a previous cadaver experiment [1], several candidate measures that quantify antero-posterior (AP) tibial-talar alignment without using ankle articular landmarks were tested for reproducibility with perturbations of ankle positioning on radiographs. The results demonstrated the best reproducibility with the tibial axis-talar ratio (T-T ratio; a ratio that the mid-longitudinal axis of the tibia shaft bisects the longitudinal horizontal segments of the talus, Fig. 1a).

In this study, the AP tibial-talar alignment was quantified by this new measure, on clinical radiographs of both normal ankles and severely degenerated ankles, to explore reproducibility of measurement. In addition, to assess if this new measure appropriately described the AP position of the talus under the tibia, on normal ankles, the positional relationship of the talus dome relative to the mid-longitudinal tibial axis (T-D distance, Fig. 1b) was also measured.

METHODS:
Sixty-eight lateral standing ankle radiographs were collected in our foot and ankle clinic. Each radiograph captured one of two groups of ankles; 1) 33 ankles without articular degeneration (non-OA ankles) from 27 patients (17 females, 8 males, and 2 unknown; age 15 – 78), and 2) 35 ankles with severe articular degeneration (OA ankles) from 35 patients who underwent total ankle replacement or ankle fusion (21 female and 14 male; age 45-82). Every radiograph included at least 10 cm of the tibial shaft and clear demarcation of the floor line.

The posterior talar point (point A in Fig.1) was identified as the intersection between the posterior subtalar surface and the posterior-superior calcaneal cortex. A line was drawn through point A parallel to the floor. Point B is the vertical projection of the most anterior aspect of the talus onto this line; length of line AB is defined as the talar length. The distal tibia axis (DTA) was defined as a line through two tibia shaft bisection points 5 and 10 cm above the ankle. The intersection of the DTA with line AB was identified as points C. The contour of the talus dome was identified as the arc though three points (anterior, middle, and posterior) on the central groove contour, and the center of the arc was defined as the talar dome center point D.

The non-OA ankles were measured for both the T-T ratio (Fig.1a) and the T-D distance normalized to the talar length AB (Fig.1b). The OA ankles were measured only the T-T ratio. When point C was posterior to the point A or point D was posterior to the DTA, the measure was recorded as a negative value.

All radiographs were measured by two trained observers. Each observer performed every measurement twice; the agreement between the first and second measurements was evaluated by linear regression for intra-observer reproducibility, and the absolute difference between measurements was recorded as the intra-observer error. The mean value across measurements was used in similar analysis across observers, for inter-observer reproducibility. Reproducibility was evaluated separately for each group of ankles.

The value averaged across observers was recorded as the final measure, and the correlation between the T-T ratio and T-D distance on non-OA ankles was then evaluated by linear regression.

RESULTS:
The T-T ratio on non-OA ankles averaged 34.8 ± 3.6 % (mean ± standard deviation). On OA ankles, three of the 35 radiographs were not measurable due to unidentified landmarks (2 with subtalar fusion and 1 with severe tibial shaft deformity). On the remaining 32 radiographs, the T-T ratio averaged 37.1 ± 11.6 %, where the measure with OA ankles was distributed more widely than with non-OA ankles (Fig. 2).

For either intra- or inter- observer reproducibility, R-square values were higher than 0.8 with non-OA ankles, and higher than 0.9 with OA ankles. In every case, intra- or inter- observer error averaged around 2 % (Table 1).

The T-T ratio showed a significant correlation with the T-D distance (Fig. 3; regression coefficient = -0.90, R-square = 0.59).

DISCUSSION:
The T-T ratio measurement on clinical radiographs showed meaningful reproducibility regardless of articular degeneration. The reduced R-square values with non-OA ankles were probably resulting from the relatively narrow distribution of T-T ratio. The correlation between the T-T ratio and T-D distance on non-OA ankles supports the ability of the T-T ratio to represent AP orientation of the talus under the tibia. This new measure appears to be a reliable measure for assessing AP tibial-talar alignment without relying on radiographic landmarks based on ankle articulation.

The wider distribution of T-T ratio with OA ankles than non-OA ankles demonstrated that either anterior or posterior talar displacement is involved with articular degeneration with ankle arthritis. To explore the effect of this type of malalignment on articular degeneration with ankle osteoarthritis or to determine the importance of ankle alignment with total ankle replacement, the T-T ratio should be utilized in future clinical investigations.

References

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