

Commentary on “Sonanis Tuning Fork Lines” A New Radiologic Method to Determine Talar Shift, Diastasis and Displacement of Lateral Malleolus in Ankle Fractures

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Description

We introduce a new “Sonanis” Tuning Fork Lines (TFL) to be drawn on ankle Anterior-Posterior (AP) radiographs to diagnose and assess the percentage of the talar shift, diastasis, and displacement of the lateral malleolus fractures. Our senior orthopaedic surgeon, was trained and certified by City and Guilds London, to use Auto-CAD and 3D solid modelling software in 1998. Auto-CAD Ankle 3D Reconstruction A 3D ankle joint reconstruction was created by mapping the normal ankle joint, and TFLs were drawn using normal anatomic landmarks on sagittal, coronal, and transverse planes. The ankle joint anatomic relationship with the talus and distal tibia fibula were studied in various rotations simulating radiographic AP views, and percentage of the talar shift, lateral malleolus displacement, and diastasis was measured.

A cohort radiologic study was done by drawing TFL on 100 radiographs with ankle injuries, and the results were observed by a senior clinician.

Sonanis Tuning Fork Lines (TFL)

Two vertical lines were drawn above the ankle joint perpendicular to the distal tibial articular surface at the tibial incisura fibularis. The first line was drawn tangent to anterior crest and the second line was drawn tangent to the posterior crest, parallel to each other around the level of tibial epiphysis-metaphyseal level. The horizontal third line was drawn parallel to the distal tibial articular surface perpendicular joining the first 2 lines at the ankle joint level. The fourth line (handle of the TFL) was drawn vertically below the ankle joint midway between the first 2 lines perpendicular to the third line like a “T.” In a normal AP radiograph or on a mortise view, the medial articular surface of the fibula touched the handle of the TFL, and the superior-lateral dome of the talus lies medial to the handle of TFL. In ankle fractures with diastasis, there is a gap between the fibular articular surface and the handle of TFL and in the presence of talar shift, the TFL handle would cut the talar dome laterally. The lateral displacement of the talus is

graded on the percentage of the superior articular dome of the talus uncovered by distal tibial articular surface; talus lying lateral to the TFL handle.

Sonanis grades of talar shift

Grade 0: No talar shift, and the talus is fully covered by the distal tibial articular surface.

Grade 1: <25% talus uncovered by distal tibial articular surface.

Grade 2: 25% to 50% of talus uncovered by distal tibial articular surface.

Grade 3: 50% to 75% talus uncovered distal tibial articular surface.

Grade 4: 75% to <100% of talus uncovered distal tibial articular surface.

Grade 5: No talus covered by distal tibial articular surface, with complete dislocation of tibio- talar joint.

Fourteen patients had normal radiograph with no fractures or talar shifts. Eighty-six ankle fractures were classified as: Danis-Weber A:17, Danis-Weber B:42, Danis-Weber C:27. The ankle fractures treated conservatively in plaster were 23. Manipulation under anaesthesia and plaster given were in 3 patients. Surgical ORIF with plates and screws were done in 60 patients, out of which ankle diastasis with talar shift was seen in 27 cases, and they were all stabilized with additional diastasis screws, and 33 patients did not have talar shift. The talar shifts in 27 patients were graded by TFL as:

Grade 0 (no shift): 0 patients (0%).

Grade 1 (< 25% shift): 15 patients (4%).

Grade 2 (25% to 50% shift): 7 patients (1.89%).

Grade 3 (50% to 75% shift): 1 patient (0.27%).

Grade 4 (75% to 100% shift): 0 patients (0%).

Grade 5 (100% shift): 4 patients (0.6%).

The talar shifts were anatomically reduced and stabilized and were reconfirmed on TFL and had good clinical results. The radiographs were observed by a single senior orthopedic surgeon and there were no false positives and no false negatives. The TFL confirmed talar shift and inferior tibio-fibular ankle diastasis with a sensitivity of 100% and specificity of 100%.

Key points and limitations

Tuning Fork Lines (TFL) is useful in understanding the static anatomy of the ankle joint, as well as dynamic stability in post-stress views to diagnose instability and displacement.

TFL does not measure actual distance, but it is a relation and a ratio of the vital marker points, so it is not affected by the magnification or rotations of the ankle within the limit.

If ankle Anterior-Posterior (AP) rotation is more than 40 degrees on either side (internal or external), then the validity and accuracy of TFL will be reduced because the frontal view would tend to move away from AP view going more toward lateral view.

If fractures involve incisura fibularis with the displacement of the tibial crest, then ankle anatomic landmarks would change and so the TFL may not be valid, and so further imaging like Computed Tomography (CT) or Magnetic Resonance Imaging (MRI) scan will be more useful.

In severe ankle arthritis, the presence of the abnormal osteophytes with abnormal bone at the tibial crest would cause difficulty in picking

up the marker points or will tend to lateralize the TFLs, and it will again reduce its accuracy and validity.

In growing children, the ankle bony landmarks at distal tibia fibula and incisura fibularis are cartilaginous, and bones are not well developed, so it may not be possible to identify the anatomic osseous landmarks to draw TFLs.

Conclusion

We conclude that on any routine ankle AP radiograph with TFL drawn it will be possible to comment on the percentage of the talar shift, diastasis, and lateral malleolus displacement.

The TFL should at least raise a suspicion of loss of integrity of the normal ankle anatomy in an injured ankle with abnormality even if proper ankle mortise views or further computed tomography scans were not available. The TFL also helped to quantify the talar shift and need for early planning of anatomic reduction and surgical fixation without waiting for further scans.

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