Tarsal Navicular Bone Collapse in Diabetics

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Introduction: Previous investigations have studied the tarsal navicular but few have focused on collapse of this bone in diabetic individuals1-4. The purpose of our study was to quantify the size of the tarsal navicular in subjects with and without diabetes and to determine whether these size differences are influenced by age, height, weight, body mass index (BMI), gender, smoking, bone mineral density (BMD) and type, duration and level of control of diabetes.

Methods: All consecutive type II diabetic patients who had ankle and foot radiographs within the past year were identified from our institutional database. Our sample population consisted of 200 patients (122 females; 78 males; mean age 58 years [27-89]), 100 with type II diabetes and 100 age-gender matched controls. The anteroposterior (AP) dimension of the mid navicular bone was measured as the line perpendicular to the line connecting the cortical edges of the proximal end of the navicular, excluding osteophytes and enthesophytes (Figure 1). The superoinferior (SI) dimension of the cuboid articular facet of the calcaneus was also measured. From these measurements, the navicular-calcaneus ratio was calculated (Figure 1). This ratio was used to compensate for the effect of individual bone size and radiographic magnification and rotation. Statistical evaluation included independent sample t-tests and linear regression analyses.

Results: Mean AP dimension of the navicular for diabetic subjects was 13.2 mm (SD±1.9, Range 9.1-17.7mm) compared to 13.9 mm (SD±1.9, Range 9.6-20.9mm) for controls. The AP dimensions of the two groups were significantly different (p=0.02). Mean navicular-calcaneus ratio for diabetic subjects was 0.49 (SD±0.08, Range 0.24-0.66) compared to 0.53 (SD±0.08, Range 0.34-0.74) for controls. The navicular-calcaneus ratios of the two groups were significantly different (p=0.001). Mean SI dimension of the calcaneus for diabetic subjects was 27.3 mm (SD±3.3, Range 21.1-39.3) compared to 26.6 mm (SD±3.3, Range 18.9-37.4mm) for controls. There was no significant difference in the calcaneal SI dimension between the two groups.

AP navicular dimension correlated with height (p<0.001). Age, gender, height, BMD, diabetes duration, HbA1C values, and presence of neuropathy or plantar foots ulcer were not correlated with the navicular-calcaneal ratio. Navicular-calcaneal ratio was inversely correlated with weight and BMI (p=0.01 and p<0.001, respectively). The mean navicular-calcaneus ratio in smokers was 0.49 (SD±0.08, Range 0.24-0.65) and was statistically different than the ratio of 0.51 (SD±0.08, Range 0.32-0.74) in non-smokers (p=0.04). The navicular-calcaneal ratio was correlated to the presence of diabetes (p=0.01). SI calcaneal dimension was correlated to height, weight and BMI (p=0.001, respectively).

Discussion: Diabetic subjects had a significantly smaller navicular AP dimension and navicular-calcaneus ratio compared to controls (p=0.02 and p=0.0001, respectively). Age, gender, height and duration of diabetes had no association with the navicular-calcaneus ratio. Navicular-calcaneal ratio was inversely
correlated with weight (p=0.01) and BMI (p<0.001) and directly correlated with smoking (p=0.04).
Diabetic subjects may undergo slow weakening and change in the mechanical properties of the navicular bone. We speculate that the smaller navicular size in diabetic subjects may be related to gradual collapse caused by several factors, notably higher loading of the navicular combined with vascular limitations and neuropathy.

**Significance:** This study associates type II diabetes with dimensional changes in the tarsal navicular. The reduction in navicular size in diabetic subjects may be explained by its vulnerability secondary to higher stresses and to a relative hypovascularity of the middle third.

Figure 1. A 54 year-old female control subject with measurements lines (left). A 56 year-old male diabetic subject with shortened AP dimension (right).

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