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Prognostic Value of the Radiologic Appearance of the Navicular Ossification Center in Congenital Talipes Equinovarus

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ABSTRACT

Congenital talipes equinovarus (CTEV), more commonly known as clubfoot, is a deformity of the foot that is not well understood. The tarsal navicular is at the center of the disease process and exhibits abnormal development and delayed ossification. However, its role in the pathologic process is not clear. The aim of the present study was to better understand the role of the tarsal navicular in CTEV by correlating the presence of the navicular ossification center and relapse of clubfoot deformity after surgical treatment. The medical records and radiographs of 34 patients (41 feet) with surgically treated CTEV were reviewed for the presence of the navicular ossification center and the lateral talocalcaneal angles. Of the 41 feet, 17 (41.46%) did not have the tarsal navicular ossification center present before surgery, and 24 (58.54%) did have the ossification center present. The talocalcaneal angles were similar between those with and without the navicular ossification center present. No significant difference was found in the incidence of relapse between the nonossified navicular group (17.6%) and the ossified navicular group (16.7%; $p = .63$). The presence of the navicular ossification center before surgery does not appear to have prognostic value for the relapse of CTEV after surgical intervention.

Congenital talipes equinovarus (CTEV), more commonly known as clubfoot, is a common pediatric foot deformity, with an estimated incidence of 1 to 2 per 1000 live births (1). This congenital deformity consists of a combination of hindfoot equinus (plantarflexed), hindfoot varus (inverted), midfoot cavus (high arch), and forefoot adductus. The current reference standard for treating clubfoot is the Ponseti method (2). The Ponseti method includes serial casting with bracing, which requires the child to wear a foot abduction brace for 2 or more years (2,3). Although most patients treated with the Ponseti method will experience excellent long-term outcomes, a significant number of patients will still require operative intervention (approximately 10% in 2006) (4).

Tarsal bones, especially the navicular, will develop abnormally in patients with clubfoot deformity, and long-term studies have shown marked deformity and osteoarthritis of the navicular into adulthood (5–7). In CTEV, the tarsal navicular experiences medial subluxation, abnormal ossification, long-term deformity, and osteoarthritis (5–7). These abnormalities confirm the importance of the tarsal navicular in the pathologic features and outcome of CTEV. These studies also prompt the question of whether the tarsal navicular's development, especially in cases of CTEV requiring surgical intervention, has any relationship to the outcomes.

Because CTEV surgeries are not benign procedures without risk (8), prognostic indicators would be of high utility. We are not aware of any published studies that have evaluated the possible prognostic significance of tarsal navicular ossification before surgical intervention. Given its abnormalities in CTEV and the susceptibility of damage with its late ossification, we hypothesized that the presence of the navicular ossification center before surgery would serve as a positive prognostic indicator for the surgical treatment of CTEV. This case-control study, therefore, aimed to evaluate the appearance of the

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Fig. 1. Anteroposterior radiographic appearance of a nonossified tarsal navicular nucleus.

Fig. 2. Anteroposterior radiographic appearance of an ossified tarsal navicular nucleus. *Arrow* indicates navicular ossification center.

navicular ossific nucleus in CTEV and to assess its value in predicting the outcome of operative clubfoot treatment.

Patients and Methods

We reviewed the medical records and plain radiographs of 34 patients (41 feet) with clubfoot deformity, without any associated congenital or neuromuscular disorders, who had undergone soft tissue release for the first time as the primary treatment of CTEV. The study was conducted at Shriners Hospitals for Children (Los Angeles, CA). All patients were treated at the Shriners Hospital for Children from October 1983 to December 1998 (15 years, 2 months). The patients ranged in age from 0.5 to 6.5 (mean 1.4 ± 0.9) years. A single, fellowship-trained pediatric orthopedic surgeon, using the technique described by Turco (9,10), performed all the clubfoot surgeries. The medical records of these patients were reviewed for age, sex, laterality of the deformity (as measured radiographically), degree of deformity, and postoperative infection (defined by a diagnosis of a surgical site infection in the patient's medical records). The medical records were also reviewed for relapse of the clubfoot deformity during the follow-up period, with relapse defined by the development of a clubfoot deformity necessitating any additional intervention. The medical records were reviewed by the senior author (N.Y.O.).

Standard weightbearing anteroposterior and lateral radiographs of the foot were used for the radiologic assessment. All radiographic images were taken before surgical treatment and were evaluated for the presence of the ossific nucleus of the navicular bone. In addition, lateral foot radiographs were evaluated regarding the lateral talocalcaneal angle using the method described by Beatson and Pearson (11). The feet were separated into 2 groups according to the presence or absence of the navicular ossification center before surgery.

The statistical analyses included the use of Student's *t* test to compare age, radiographic follow-up findings, and the mean talocalcaneal angle in relation to navicular ossification. Fisher's exact test (GraphPad Software, Inc., La Jolla, CA) was used to analyze the incidence of relapse and infection in relation to the presence of navicular ossification. The modified Wald method was used to calculate the 95% confidence interval (CI) for the incidence of relapse and infection in relation to the presence of navicular ossification. Statistical significance was defined at the 5% ($p \leq .05$) level. The statistical analyses were performed by 3 of us (A.A.A., J.K.O., D.M.R.).

Results

Of the 41 feet in 33 patients, 17 feet (41.5%) in 14 patients (42.4%) had a nonossified navicular (Fig. 1) and 24 feet (58.5%) in 19 patients (57.6%) had an ossified navicular nucleus (Fig. 2). A statistical description of the case series is presented in the Table. The mean radiographic follow-up duration for the nonossified group was 5.0 ± 2.04 (range 2.2 to 8.9) years compared with 7.0 ± 4.79 (range 2.0 to 17.5) years in the ossified navicular nucleus group. The mean talocalcaneal angle was 29.2° ± 9.51° (range 0° to 45°, n = 17 feet in 14 patients) compared with 39.4° ± 16.8° (range 15° to 65°, n = 8 feet in 7 patients) in the nonossified and ossified groups, respectively; this difference was not statistically significant ($p = .13$). The incidence of relapse of clubfoot in the nonossified navicular group was 17.6% (3 of 17 feet in 14 patients; 95% CI 5.4% to 41.8%) compared with 16.7% (4 of 24 feet in 19 patients, 95% CI 6.1% to 36.5%) in the ossified navicular group (Fig. 3). This difference was also not statistically significant ($p = .63$). A statistically significant difference was not observed in the incidence of postoperative infection between the 2 study groups. Specifically, the incidence of postoperative infection was 17.6% (3 of 17; 95% CI 5.4% to 41.8%) in the nonossified group and was 8.3% (2 of 24; 95% CI 1.2% to 27.0%) in the ossified group; this difference was not statistically significant ($p = .33$).

Discussion

Although CTEV is a very commonly encountered problem in pediatric orthopedic clinics and has been extensively studied, the exact etiology and pathophysiology of CTEV remains unclear. The proposed etiologies