LONG TERM FOLLOW-UP OF MEDIAL COLUMN FUSION AND TIBIALIS ANTERIOR TRANSPOSITION FOR ADOLESCENT FLATFOOT DEFORMITY

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ABSTRACT

We report the results of three patients (four feet) who had surgical correction of adolescent flatfeet performed over fifty years ago. The surgery involved medial column stabilization with fusion procedures and tibialis anterior transposition into the navicular (Young's tenosuspension procedure). In this small sample, we found a high rate of painful arthrosis that developed over time in the contiguous joints of the foot.

INTRODUCTION

The majority of patients with flexible pes planus are asymptomatic. For the symptomatic, flexible flat foot, numerous authors have described various nonsurgical approaches[1,2,5,12,24]. In the majority of patients, symptoms are alleviated with nonoperative measures. However, there are occasional patients with persistent symptoms whom are considered for surgical treatment. A wide variety of surgical procedures have been described for the correction of these flatfoot deformities[1,6,10,11,12,15,16,21,22].

In 1923 Lowman described his procedure involving talonavicular arthrodesis with transposition and tightening of the tibialis anterior on the navicular with or without tendo Achilles lengthening[18]. Four years later, Miller described a technique involving naviculo-medial cuneiform-first metatarsal arthrodesis with distal advancement of an osteoperiosteal flap based on the tibialis posterior tendon at the navicular[20]. He reported good results in sixteen patients with an average follow-up of 2.5 years with an average age at operation of twelve years. In 1929, Kidner described his procedure for removing the accessory navicular when present, freeing the tibialis posterior, and transplanting the tendon inferiorly on the navicular to pull directly upward, theoretically maintaining the medial longitudinal arch[17]. Hoke, in 1931, reported his success in the treatment of the flexible flatfoot with medial and middle cuneiform-navicular arthrodesis with tendo Achilles lengthening in four patients[13]. Six years later, Butte described his study of 138 patients with flatfoot who underwent naviculocuneiform arthrodesis[3]. He reported excellent results in thirty feet, good in forty, fair in thirty-four feet, and poor in thirty-four. The length of follow-up was as long as nine years, with the majority between one and five years, and an average age at operation of fourteen years.

In 1939, Young published his results with transposition of the tibialis anterior insertion into the navicular with tendo Achilles lengthening in order to prevent depression of the arch and abduction of the forefoot[25]. He reported symptomatic relief, correction of the depressed arch, and eversion and abduction of the forefoot in seven patients with pes planus.

From our review of his surgical record cards, it appears that in that same year (1939) Dr. Arthur Steindler incorporated Young's tenosuspension operation with medial column fusion stabilization for the treatment of flatfeet. In this report we describe the long term results of those surgeries.

METHODS

Fifteen surgical procedures were performed by Dr. Steindler on thirteen patients with flatfoot deformities between 1939 and 1943. These procedures included twelve naviculocuneiform arthrodeses with tibialis anterior transposition into the navicular, and three talonavicular arthrodesis with tibialis anterior transposition into the navicular.

In 1995, we attempted to locate these patients for follow-up. We identified three living patients (four cases). Seven patients were deceased and three others were lost to follow-up. Of the three living patients, one patient with bilateral surgery returned for a complete examination and radiographic assessment, and the other two completed a telephone interview and had radiographs taken of both feet. In this study we report the results of these four cases in three patients with greater than fifty years of follow-up.

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Figure 1A.

CASE REPORTS

Patient 1

B.W. first presented to the University of Iowa Hospitals and Clinics (UIHC) at the age of fourteen with complaints of right foot instability and fatigue. Three years earlier she had jumped over some flowers and severely injured her right foot. Subsequently, she developed a progressive pronation deformity of the midfoot. There was no complaint of pain.

Physical examination revealed bilaterally pronated feet with her right more affected than her left. She was noted to have a tight heelcord on the right. The right peronei were recorded as slightly contracted. Plain radiographs of her right foot revealed an old, healed fracture of the sustentaculum tali. She was diagnosed with a traumatic flatfoot deformity and was treated with a brace. One year later, she underwent naviculocuneiform fusion, tendo Achilles lengthening, and transposition of the tibialis anterior into the navicular of her right foot.

Thirty-five years later, the patient underwent a subtalar fusion for degenerative arthritis. Fifty-five years after the initial operation, we contacted the patient and obtained radiographs (Figure 1). At that time she stated that use of the injured foot caused intermittent pain limiting her daily activities, but also noted that for many years she enjoyed relatively painless function of the foot.

Figure 1B.

Figure 1. Standing (A) anteroposterior and (B) lateral radiographs of a patient fifty-five years post-surgery on the right foot. A subtalar arthrodesis was performed for painful arthrosis thirty-five years after the initial procedure. Diffuse degenerative changes in the transverse tarsal and midfoot joints correlate with residual symptoms. Comparative radiographs of the nonoperated foot (C,D) reveal no arthritic changes.

Figure 1C.

Patient 2

J.M. first presented to the UIHC at the age of eleven with complaints of a weakness of his left ankle. His parents reported an incident at age two when he sustained an infra-medial malleolar laceration with resulting hindfoot deformity. Since that time, he had progressive ankle weakness with a noticeable talar head prominence.

Physical examination of the left lower extremity revealed atrophy of the calf musculature with a valgus hindfoot. No palpable activity of the tibialis posterior muscle or tendon was observed. The talus was prominent on the medial aspect of the ankle, and the patient had a tight heelcord.

J.M. subsequently underwent talonavicular fusion and tibialis anterior transposition to the navicular. His postoperative course was complicated by a wound infection and a failure of the talonavicular joint to fuse. Five months following surgery, there was no radiographic evidence of talonavicular fusion, but the patient was ambulating without difficulties and was free of complaints. There was some evidence of hindfoot valgus. At a period of twelve months following surgery the tibialis anterior was noted to actively fire, and there was residual mild hindfoot valgus and forefoot pronation. He was given solid leather insoles to wear and was not contacted for over fifty-six years.

In final follow-up, he had no complaints regarding his foot. He claimed that although he was still flatfooted on both sides, it did not prevent him from walking several miles a day. Plain radiographs obtained of both feet (Figure 2) revealed evidence of the previously attempted talonavicuar fusion and mild degenerative changes in the hindfoot.

Figure 1D.

Figure 2. Standing (A) anteroposterior radiograph of a patient fifty-six years after failed fusion of the talonavicular joint and Young's tenosuspension of the left foot. (B) The lateral radiograph of the left foot shows evidence of mild degenerative changes as compared to the nonoperated right foot (C).

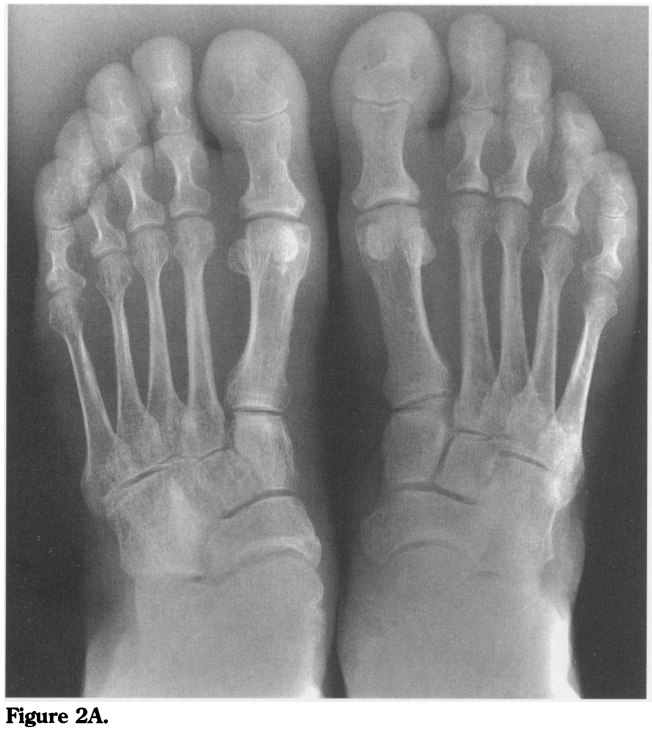

Figure 2A.

Patient 3

S.R. first presented to our clinic at the age of eleven with a five to six year history of bilateral, painful, weak feet that tended to go into valgus. She complained of pain in the arch of her feet and fatigue in her calf muscles after any significant period of ambulation. On physical exam, both of her feet were noted to be in valgus with prominent tali medially. She was tender to palpation under the talonavicular joint. Her heel cords were not noticed to be tight. She was given inserts (bilateral inner wedges and anterior heels) to wear in her shoes. She was also given exercises to perform.

The patient's symptoms resolved soon thereafter. She returned six years later complaining of pain and tenderness in both of her feet. Physical examination revealed bilateral, long, narrow feet with tender prominences over the navicular bones. She was also found to be tender over the spring ligaments bilaterally. Her feet were in equinus and valgus. She was again treated with exercise and shoe corrections and started on contrast baths.

Her symptoms persisted and progressed over the following year. At age nineteen, she underwent bilateral accessory navicular excisions, naviculocuneiform fusions and transplantation of the tibialis anterior tendons into the naviculars. Three months after her initial surgery she had bilateral tendo Achilles lengthenings performed. She did well and by age twenty-one stated she was walking as much as she wanted and could play tennis without pain. Her arches were maintained and no tenderness was elicited on examination of both feet. She was able to wear shoes without orthotic support.

S.R. returned fifty-three years after her bilateral naviculocuneiform fusions and tibialis anterior tenosus-

Figure 2B.

Figure 2C.

pensions. She was referred by her primary care physician, who had been treating her bilateral foot pain for eight years with anti-inflammatory medications and shoe inserts. At age seventy-three, she complained of pain around the dorsal and lateral aspects of the hindfoot with ambulation and occasional pain at rest. She had retired from a full career as a nurse and had difficulty remaining active due to difficulties with her feet.

Examination of the right foot revealed tenderness in the subtalar joint region. There was essentially no subtalar motion. She also had some tenderness and pain with motion in the talonavicular and calcaneocuboid joints. On examination of the left foot, she had more subtalar motion (approximately ten degrees) and less pain than the right foot. Her tenderness on the left was mostly in the mid-foot region. Her neurovascular exam was normal.

Plain radiographs revealed her previous fusions with degenerative changes in the subtalar, talonavicular, and calcaneocuboid joints (Figure 3). A bone scan showed increased uptake in the right subtalar, talonavicular and calcaneocuboid joints and the left midfoot (Figure 4). She was prescribed orthotics and shoe modifications.

Despite these measures, she continued to have painful symptoms and underwent a right triple arthrodesis. She gradually increased her ambulation, and by four months after her hindfoot fusion, she complained only of mild anterior ankle pain related to being on her feet for excessive periods of time.

Eight months following her right hindfoot fusion, she reported occasional pain in her right foot only when she descended stairs. Otherwise, her right foot was described as pain free and she was very satisfied with surgery. She desired the same procedure on her left foot, which continued to give her problems.

Figure 3. Standing (A) anteroposterior and (B) lateral radiographs of both feet of a patient fifty-three years after surgery. The patient had diffuse pain throughout both feet around the midfoot and hindfoot regions. The degenerative changes are more striking in the more symptomatic right foot.

Figure 3A.

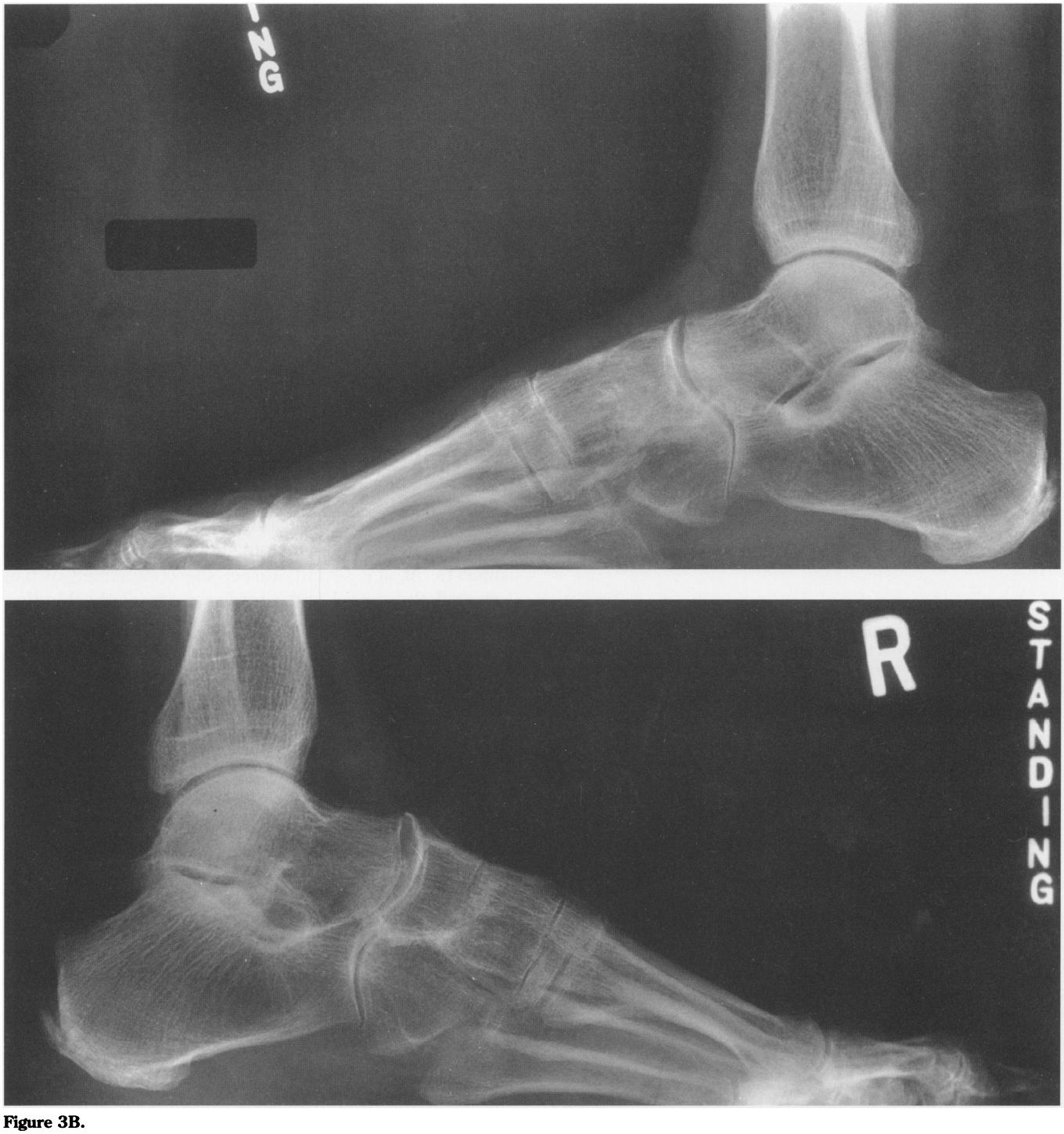

Figure 3B.

The physical and radiographic examinations of the left foot were not conclusive regarding the source of her pain. We proceeded to sequentially inject lidocaine under fluoroscopic guidance into the subtalar, calcaneocuboid, and talonavicular joints. She experienced substantial pain relief with each of these injections. Therefore, a left foot triple arthrodesis was performed.

Her postoperative course was remarkable for the acute development of a tear in the tibialis anterior tendon after removal of the cast. The tendon was subequently debrided and repaired. Six months later the patient returned with the new onset of pain in the second and third metatarsal-cuneiform joints. Radiographs revealed degenerative changes at these joints.

Figure 4. The technetium-labelled nuclear bone scan confirms increased bone turnover in the articulations adjacent to the region of previous surgery. On the left side the patient also has increased uptake at the second and third metatarsocuneiform joints.

She was given a full length carbon fiber customized insert and instructed on the use of a cane. Her pain continued and three months later she underwent a left second and third tarsometatarsal joint arthrodesis. Her midfoot pain subsequently resolved.

DISCUSSION

In this extended case series, we report the long term outcomes of three patients of Dr. Steindler who were treated for adolescent flatfoot deformities with the use of a medial stabilization procedure and a Young's tenosuspension. The remaining patients are either deceased (seven) or lost to follow-up (three). From this study we conclude that the results of successful medial column fusions and tibials anterior transpositons to the navicular are reasonably satisfactory for the major portion of the patient's life, but if the patient lives long enough, he/she will likely develop painful foot arthrosis.

We have no control group for these patients. One patient who had a unilateral procedure stated that the involved foot was never as good as the other, and at follow-up reported that the foot restricted her activites. We do not know whether this was related to the injury, the deformity or the surgery. In the patient who had a successful tendon transfer but talonavicular pseudarthrosis, the long term outcome was good. In the patient who underwent bilateral fusions and tendon transfers, the ultimate outcome was the development of painful joints in the hindfoot and midfoot. Despite this the patient was pleased with the outcome of her initial surgery because she was able to work unrestricted as a nurse for most of her adult life.

This report presents the longest average follow-up of patients undergoing similar procedures. Others have reported earlier follow-up results for patients with similar conditions. Duncan and Lovell reported a procedure which involved a navicular-medial cuneiform fusion with tibialis anterior and plantar fascia tightening to maintain the arch[8]. They reported an average follow-up of 1.7 years in seventeen feet with all patients experiencing symptomatic relief and an improved medial longitudinal arch. Jack reported his three to six year results with forty-six feet which underwent naviculocuneiform arthrodesis[14]. Twenty-five outcomes were deemed ex-

cellent, thirteen were good, and only eight were considered to be unsatisfactory. Caldwell described the Durham flatfoot plasty which involved naviculocuneiform fusion with tightening of a raised osteoperiosteal flap into the sustentacular tunnel, thereby forming a strong, plantar sling to support the medial longitudinal arch of the foot[4]. In seventy-six feet with an average follow-up of six years, the results in 76 percent were considered to be excellent, 18 percent were classified as good, and 5 percent were deemed poor.

Macnicol and Voutsinas reported their results with both: 1) excision of an accessory navicular bone, and 2) the Kidner procedure which involved excision of an accessory navicular bone as well as transplanting the tibialis posterior inferiorly on the navicular[19]. With the Kidner procedure, nineteen out of twenty-two patients (86 percent) reported significant symptomatic relief and fourteen out of twenty-two patients (64 percent) had an improved arch. The average follow-up for the Kidner procedure was ten years. With excision of the accessory navicular alone, five out of six patients reported relief of symptoms, and four out of six patients had an improved arch. The average follow-up for this procedure was twelve years. Crego and Ford reported their results of several related procedures[7]. Young's procedure with mobilization of the tibialis anterior was performed in six feet with a 100 percent satisfactory result at an average follow-up of 5.5 years. In the same series, they reported the results of nine naviculocuneiform fusions at an average of 9.5 years. In this group they had seven poor results and two good results.

Fraser et al. reported on thirty-eight naviculocuneiform fusions with advancement of an osteoperiosteal flap beneath the tibialis anterior tendon with an average twelve year follow-up[9]. Thirty-five of the feet underwent tendo Achilles lengthening and seven also had a first metatarsal-cuneiform fusion. Eighty-four percent reported a satisfactory clinical result. They believed that successful results following the Miller and Durham procedures are due, in large part, to the soft tissue suspensions and tightening which appear to protect the tarsal joints from degenerative changes[9]. Interestingly, they reported a 21 percent rate of nonunion which was unrelated to the development of pain[9]. The longest published follow-up of adolescent flatfoot procedures was reported by Seymour. He described thirty-two feet which underwent naviculocuneiform fusion between the ages of eleven to fourteen, with a follow-up of between sixteen and nineteen years following surgery[23]. Ten (31 percent) of the cases were deemed excellent, six (19 percent) were deemed good, and sixteen (50 percent) were considered unsatisfactory. He concluded that the early encouraging results of naviculocuneiform fusion for the mobile flatfoot had not been maintained and this procedure hastens degenerative changes in the other tarsal joints.

The present study documents the eventual demise of contiguous joints after fusion and tenosuspension of the medial longitudinal arch. However, the procedures appeared to restore function and relieve pain for the major portion of the patients' lives. Orthopaedists considering such procedures for the treatment of adolescent flatfeet should realize that if the patient lives long enough, they may develop painful arthrosis of other joints of the hindfoot and midfoot.

REFERENCES

1. **Barry, R. J.,** and **Scranton, P. E.:** Flat feet in children. *Clin. Orthop.,* 1983. 181:68-75.
2. **Bordelon, R. L.:** Hypermobile flatfoot in children: comprehension, evaluation, and treatment. *Clin. Orthop.,* 1983. 181:7-14.
3. **Butte, F. L.:** Navicular-cuneiform arthrodesis for flatfoot: An end-result study. *J. Bone and Joint Surg.,* 1937. 19:496-502.
4. **Caldwell, G. D.:** Surgical correction of relaxed flatfoot by the Durham flatfoot plasty. *Clin. Orthop.,* 1953. 2:221-6.
5. **Chang, F. M.:** The flexible flatfoot. In American Academy of Orthopaedic Surgeons *Instructional Course Lectures,* XXXVII. Edited by F. H. Bassett. 1988. American Academy of Orthopaedic Surgeons, Park Ridge, IL. pp. 109-110.
6. **Coleman, S. S.:** Severe flexible planovalgus foot (flatfoot). In *Complex Foot Deformities in Children.* Edited by S. S. Coleman. 1983. Lea & Febiger, Philadelphia. pp. 193-222.
7. **Crego, C. H.,** and **Ford, L. T.:** An end-result study of various operative procedures for correcting flat feet in children. *J. Bone and Joint Surg.,* 1952. 34-A:183-195.
8. **Duncan, J. W.,** and **Lovell, W. W.:** Modified Hoke-Miller flatfoot procedure. *Clin. Orthop.,* 1983. 181:24-27.
9. **Fraser, R. K.; Menelaus, M. B.; Williams, P. F.;** and **Cole, W. G.:** The Miller procedure for mobile flat feet. *J. Bone and Joint Surg.,* 1995. 77-B:396-399.
10. **Giannestras, N. J.:** Static foot problems in the preadolescent and adolescent stages. In *Foot Disorders: Medical and Surgical Management.* Edited by N. J. Giannestras. 1973. Lea & Febiger, Philadelphia. pp. 149-156.
11. **Glancy, G. L.:** Surgical management of the flatfoot. In American Academy of Orthopaedic Surgeons *Instructional Course Lectures,* XXXVII. Edited by F. H. Bassett. 1988. American Academy of Orthopaedic Surgeons, Park Ridge, IL. pp. 111-115.

12. **Harris, R. L.,** and **Beath, T.:** Hypermobile flat-foot with short tendo achilles. *J. Bone and Joint Surg.,* 1948. 30-A:116-138.
13. **Hoke, M.:** An operation for the correction of extremely relaxed flat feet. *J. Bone and Joint Surg.,* 1931. 13:773-783.
14. **Jack, E. A.:** Naviculo-cuneiform fusion in the treatment of flat foot. *J. Bone and Joint Surg.,* 1953. 35-B:75-82.
15. **Jones, B. S.:** Flat foot: a preliminary report of an operation for severe cases. *J. Bone and Joint Surg.,* 1975. 57-B:279-282.
16. **Judet, J.:** New concepts in the corrective surgery of congenital talipes equinovarus and congenital and neurologic flatfeet. *Clin. Orthop.,* 1970. 70:56-61.
17. **Kidner, F. C.:** The prehallux (accessory scaphoid) in its relation to flat-foot. *J. Bone and Joint Surg.,* 1929. 11:831-837.
18. **Lowman, C. L.:** An operative method for correction of certain forms of flatfoot. *JAMA,* 1923. 81:1500-02.
19. **Macnicol, M. F.,** and **Voutsinas, S.:** Surgical treatment of the symptomatic accessory navicular. *J. Bone and Joint Surg.,* 1984. 66B:218-226.
20. **Miller, O. L.:** A plastic foot operation. *J. Bone and Joint Surg.,* 1927. 9:84-89.
21. **Powell, H. D. W.:** Pes planovalgus in children. *Clin. Orthop.,* 1983. 177:133-139.
22. **Purvis, G. D.:** Surgery of the relaxed flatfoot. *Clin. Orthop.,* 1968. 57:221-230.
23. **Seymour, N.:** The late results of naviculocuneiform fusion. *J. Bone and Joint Surg.,* 1967. 49-B:558-559.
24. **Wenger, D. R.; Mauldin, D.; Speck, G.; Morgan, D.;** and **Lieber, R. L.:** Corrective shoes and inserts as treatment for flexible flatfoot in infants and children. *J. Bone and Joint Surg.,* 1989. 71-A:800-810.
25. **Young, C. S.:** Operative treatment of pes planus. *Surg. Gynecol. Obstet.,* 1939. 68:1099-1101.