Tarsal Coalitions

A Surgical Classification

MICHAEL S. DOWNEY, DPM*

The surgical alternatives for the treatment of tarsal coalitions include procedures as diverse as arthroplasty and arthrodesis. Traditional classifications of tarsal coalitions are primarily descriptive and afford little information regarding preferred treatment. For this reason, the author introduces the Articular Classification System, which is based on the patient's osseous age, the articular involvement of the coalition, and the associated secondary arthritic changes. This classification system can be used as a framework to discuss recommended surgical procedures and their long-term results.

Tarsal coalitions occur when there is absent or restricted motion between two or more tarsal bones. Tarsal coalitions may be asymptomatic or may produce a dramatic, and many times characteristic, symptom complex. This symptom complex may ultimately be associated with a rigid pes planovalgus foot deformity. Secondary tonic muscle spasm, most commonly of the peroneus brevis, may also occur, creating peroneal spastic flatfoot. The diagnosis of a tarsal coalition is made through the identification of this symptom complex or associated clinical deformity, in combination with appropriate radiographic and other imaging studies.

Once identified, both conservative and surgical treatment regimens are available for the management of the symptomatic tarsal coalition. However, surgical management of tarsal coalitions has essentially been confined to either resection of the coalition or fusion of the involved joint complex. Since most reports involve only a small series of patients, significant controversy exists as to the indications and results to be expected from these two diverse surgical approaches. For this reason, the author proposes a new classification system, which may be used as a framework for the construction of an appropriate treatment plan. The classification system is not meant to be all-inclusive, but it includes several important parameters used in the development of any treatment regimen: patient age, articular involvement, and extent of secondary arthritic changes.[1]

Tarsal coalitions have traditionally been classified in several ways, including etiologic type, anatomical type, and tissue type.

Classification According to Etiologic Type

Initially, almost all tarsal coalitions were considered to be congenital. It is now certain that there are many different etiologies, and that not all tarsal coalitions are congenital. For this reason, tarsal coalitions can be classified according to their etiology: either congenital or acquired.[2]

Congenital tarsal coalitions remain the most frequently identified and reported, although the exact mechanism of congenital coalition is not known. Pfitzner[3] suggested that congenital tarsal coalitions are formed by the incorporation or fusion of accessory ossicles into two adjacent tarsal bones. For example, an os trigonum is an ossicle that may fuse to the talus or the calcaneus, creating a tarsal coalition.[4] Although this is one possible cause of

* Fellow, American College of Foot Surgeons; Chairman and Associate Professor, Department of Surgery, Pennsylvania College of Podiatric Medicine; Faculty Member, The Podiatry Institute. *Mailing address*: Eighth at Race St, Philadelphia, PA 19107.

congenital coalition, Harris[5] has proven that it is not the sole cause by demonstrating a tarsal coalition in a fetus.

Harris' findings support those of Leboucq,[6] who suggested that congenital tarsal coalition results from the failure of differentiation and segmentation of primitive mesenchyme. This theory would attribute congenital coalitions to a heritable defect or to an insult in the first trimester of pregnancy. Subsequently, numerous authors have reported hereditary patterns of tarsal coalitions.[7–14] A large field study by Leonard[15] has provided the most supportive evidence of Leboucq's theory. Leonard concluded that tarsal coalition was a unifactorial disorder with autosomal dominant inheritance. Thus, Leboucq's theory is the most commonly accepted hypothesis for the etiology of congenital tarsal coalitions.

It is now well known that tarsal coalitions can be acquired. Acquired tarsal coalition can result from arthritis, infection, trauma, neoplasms, or other causes. Acquired coalition is less common in pediatric and adolescent patients than in older patients. The causes of acquired tarsal coalition can lead to varying degrees of joint limitation without complete restriction of motion. When all age groups are considered, acquired tarsal coalition is a frequent cause of symptomatic peroneal spastic flatfoot.[16]

Classification According to Anatomical Type

Tarsal coalitions may be classified according to their anatomical constituents. Tachdjian[17] provided a classification that subdivides coalitions into the bones that are abnormally united, or less frequently, as part of a complex malformation (Fig. 1). Although only descriptive in nature, Tachdjian's classification suggests the importance of assessing other areas of the foot and the remainder of the body when an apparently local or isolated coalition is identified.

Classification According to Tissue Type

Tarsal coalitions can be grouped according to the tissue type of their union. In this way, a coalition may be classified as a synostosis (osseous union), synchondrosis (cartilaginous union), syndesmosis (fibrous union), or a combination of tissue types. A synostosis may evolve from a synchondrosis or syndesmosis. This has been thought to occur with age

- **Isolated Anomaly**
  - Dual between two tarsal bones
    - Talocalcaneal
      - Middle
        - Complete
        - Incomplete
        - Rudimentary
      - Posterior
      - Anterior
    - Calcaneonavicular
    - Talonavicular
    - Calcaneocuboid
    - Naviculocuneiform
  - Multiple—combinations of the above
  - Massive—all tarsal bones fused together
- **Part of a Complex Malformation**
  - In association with other synostoses
    - Carpal coalition
    - Symphalangia
  - As one of the manifestations of a syndrome
    - Nievergelt-Pearlman
    - Apert's
  - In association with major limb anomalies
    - Absence of toes or rays
    - Ball-and-socket ankle joint
    - Fibular hemimelia
    - Phocomelia
    - Proximal focal femoral deficiency

Figure 1. Classification of tarsal coalitions according to anatomical type (adapted from Tachdjian MO: *The Child's Foot*, p 262, WB Saunders, Philadelphia, 1985, by permission).

or possibly after trauma to the coalition.[16] A synostosis also may be referred to as a complete coalition, since all motion is necessarily absent. An incomplete coalition has varying amounts of interposed cartilaginous or fibrous tissue and may allow motion between the involved bones. The tissue type of the coalition is important and should be noted when attempting to diagnose a coalition.

It is the author's impression that the aforementioned traditional classification systems are primarily descriptive. By combining these classifications, a useful description of a tarsal coalition can be made. For example, a tarsal coalition may be described as a congenital synchondrosis of the middle facet of the talocalcaneal joint. Given this information, the tarsal coalition can be more accurately understood. However, these traditional classification systems, even when combined, provide only a small amount of information that will be of assistance in developing a successful therapeutic plan. For this reason, a new classification system is proposed, based on the patient's osseous maturity, the articular relationship of the bones involved in the coalition, and the secondary changes in surrounding joints.

Articular Classification System

The author proposes the Articular Classification System as a surgical classification system for tarsal coalitions. When this system is combined with the descriptive parameters already discussed, it may serve as a basis for dialogue and communication about possible surgical treatment. The classification assumes that the most important criteria for determining surgical treatment are the patient's age, the articular involvement or relationship of the bones forming the coalition, and the degree of secondary arthritic changes in joints around the coalition.

Patient Age

The age of a patient is virtually always a factor when the surgical treatment of a tarsal coalition is contemplated. Ideally, in all patients, it would be desirable to resect the tarsal coalition and restore normal or near normal function to the involved joint(s). Practically, though, this is frequently not possible. Thus, the surgeon must balance the likelihood of success of resection of the coalition against the possible need for additional surgery, ie, arthrodesing procedures, should this resection procedure fail.

In the younger patient who has not yet achieved osseous maturity, ie, physeal growth plates are still open, resection would seem to be the treatment of choice for most tarsal coalitions. The remodeling potential of the growing patient is not to be underestimated. For example, it is well documented that the osseously immature patient is much more likely than an adult patient to achieve an asymptomatic recovery with an acceptable return of function after a severe joint depression calcaneal fracture. Similarly, in the juvenile patient, the increased joint motion achieved with resection of a tarsal coalition, combined with continued osseous growth and remodeling, would hopefully result in a more normal, less painful joint complex in the area of the previous coalition. In this osseously immature patient, major arthrodesing procedures could be performed at a later date, even after osseous maturity has been achieved, should the resection attempt fail.

In adult or osseously mature patients, resection of the tarsal coalition may also be considered, but it is more prone to failure. The limited remodeling potential in the adult patient diminishes the probability of recovery to a functional, asymptomatic state. Prior to coalition resection, the patient should be informed of the risk of recurrent or increased joint limitation and symptomatology in the area of the excised tarsal coalition. The patient should further understand that arthrodesis might eventually be necessary to treat the condition and diminish the symptom complex. With this understood, the adult patient with a tarsal coalition can undergo an attempt at resection of the coalition.

There are other factors to weigh when considering resection of a tarsal coalition. Certain patients will be poor candidates for resection regardless of their osseous maturity. When the potential for subjective and objective recovery following resection of a tarsal coalition is dubious, then arthrodesis should generally be considered as the first surgical alternative.

Thus, as stated earlier, the probability of success of resection of the coalition must be weighed against the conceivable need for additional surgery, ie, arthrodesing procedures, should this resection procedure fail. With other factors being equal, generally, the younger the patient, the more amenable the tarsal coalition is to surgical resection.

Articular Involvement

The most important factor when considering the surgical management of a tarsal coalition is the articular involvement, or the joints affected by the tarsal coalition. Tarsal coalitions can be divided into those that are extra-articular, ie, occurring outside normal joint(s), and those that are intra-articular, ie, occurring within normal joint(s) (Fig. 2).

Extra-articular tarsal coalitions are those that occur between two or more tarsal bones that do not normally articulate with one another, or outside the joint spaces of two or more tarsal bones that do

Extra-articular Coalitions
- Calcaneonavicular
- Cubonavicular

Intra-articular Coalitions
- Talocalcaneal
  - Middle
  - Posterior
  - Anterior
  - Combination
- Talonavicular
- Calcaneocuboid
- Naviculocuneiform

Figure 2. Division of tarsal coalitions into extra-articular and intra-articular coalitions. Multiple and massive coalitions are usually intra-articular and are frequently associated with secondary arthritic changes.

articulate with one another. Historically, these coalitions have been referred to as bars, because they bar or limit motion between otherwise supposedly normal tarsal structures. The most common example of an extra-articular tarsal coalition is the calcaneonavicular bar. This coalition occurs between the calcaneus and navicular, two bones between which there is normally no articulating joint. Extra-articular coalitions are generally more responsive to resection, because their excision does not destroy or alter the existing tarsal joint(s).

Intra-articular tarsal coalitions are those that occur within the joint spaces of two or more tarsal bones. Traditionally, these coalitions have been referred to as bridges, because they bridge across a joint. Coalition of the middle facet of the talocalcaneal joint is the most frequently occurring example of an intra-articular tarsal coalition. This coalition, whether osseous, cartilaginous, or fibrous, alters a normal joint relationship. Since the affected joint surfaces in an intra-articular tarsal coalition are not normal, resection of the coalition is more prone to failure. For this reason, the intra-articular tarsal coalition is generally less amenable to resection because its excision destroys or alters an already abnormal tarsal joint.

Secondary Arthritic Changes

The presence or absence of arthritic changes in the joints surrounding a tarsal coalition will have a significant impact on the selection of a surgical remedy. These changes often are considered to be secondary to the restricted motion and altered biomechanics created by the tarsal coalition and are, therefore, called secondary arthritic changes. Many of these changes are classically seen with tarsal coalitions. For example, talonavicular joint beaking is a secondary change commonly seen with a middle facet talocalcaneal joint coalition. Narrowing of joint spaces, joint lipping, or osteophyte formation, and adaptive changes in osseous structures and joints are all frequent secondary arthritic changes that may be associated with a tarsal coalition.

The greater the quantity and severity of the secondary arthritic changes present in conjunction with a tarsal coalition, the more difficult will be the surgical procedure for that coalition. Further, with more secondary arthritic changes, the tarsal area will be less responsive to simple resection of the tarsal coalition. Resection of a tarsal coalition in the presence of significant secondary arthritic changes could necessitate further biochemical adjustment in an already mechanically compensated foot. This generally results in further aggravation of any existing symptom complex. Thus, when significant secondary arthritic changes are associated with a tarsal coalition, an arthrodesis-type procedure usually is considered the procedure of choice.

Juvenile (Osseous Immaturity)
- Type I Extra-articular coalition
  - A No secondary arthritis
  - B Secondary arthritis
- Type II Intra-articular coalition
  - A No secondary arthritis
  - B Secondary arthritis

Adult (Osseous Maturity)
- Type I Extra-articular coalition
  - A No secondary arthritis
  - B Secondary arthritis
- Type II Intra-articular coalition
  - A No secondary arthritis
  - B Secondary arthritis

Figure 3. Articular Classification System.

Proposed Classification System

Based on the aforementioned parameters, the classification system divides patients according to osseous age into juvenile (osseous immaturity) and adult (osseous maturity) categories. These categories are subdivided according to the articular involvement of the coalition, whether extra-articular or intra-articular. Finally, the classification is further subdivided with regard to the presence or absence of significant secondary arthritis or indirect changes within surrounding joints (Fig. 3).

Juvenile IA

The Juvenile IA coalition is an extra-articular coalition with minimal secondary arthritic changes in an osseously immature individual, ie, juvenile patient. Traditionally, an extra-articular coalition, such as a calcaneonavicular coalition, has been considered more amenable to surgical resection. This is particularly true when no secondary degenerative changes have occurred in surrounding joints. Thus, in the younger patient with an extra-articular coalition and minimal secondary arthritic changes, resection of the coalition is generally the procedure of choice (Fig. 4).

If the coalition is a calcaneonavicular bar, the classic interposition arthroplasty procedure, as first described by Badgley,[18] is excision of the coalition with interposition of the extensor digitorum brevis muscle belly into the resultant defect. Many sur-

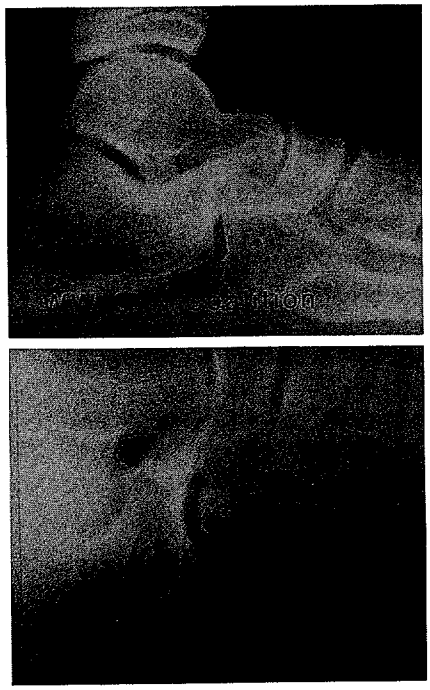

Figure 4. Example of Juvenile IA coalition. A calcaneonavicular bar in an osseously immature, 11-year-old patient. Minimal secondary arthritic changes are noted.

geons have reported success with this procedure.[19-25] The most commonly described postoperative problem has been varying degrees of recurrence of the limited motion associated with the coalition. This was found to be the result of fibrous or osseous tissue formation at the site of the original coalition, but generally was not a problem if a generous resection of the bar was initially performed. Despite this, several modifications have been proposed to limit the formation of fibrous or osseous tissue at the coalition resection site and from the bleeding resected bone ends. These suggestions include the coagulation of the bone ends,[17] the use of bone wax on the bone ends,[26] the interposition of adipose tissue between the bone ends instead of the muscle belly,[17,27] or the insertion of a silicone implant between the bone ends instead of the muscle belly.[28]

Other, more uncommon extra-articular coalitions without secondary degenerative changes, such as a cubonavicular coalition, should offer similar hope of favorable results following resection.

Several authors[29,30] have discussed the possibility of performing a varus-producing osteotomy of the calcaneus as a means of treating a tarsal coalition. Dwyer[30] reasoned that the valgus position of the rearfoot, commonly seen with a tarsal coalition, produces an "oblique strain of the ligaments" in the rearfoot and ankle, with resultant pain. He advocated an opening wedge calcaneal osteotomy with a bone graft inserted through a lateral approach. Cain and Hyman[29] described success in treating coalitions with an analogous procedure. Instead of an opening osteotomy, they performed a closing osteotomy of the calcaneus through a medial approach. Neither of these reports suggested resection of the coalition along with the calcaneal osteotomy. Logically, the osteotomy alone would seem of limited benefit, as demonstrated by orthotic devices that maintain the heel in a varus position, yet afford only minimal relief of subjective symptoms. However in treating the extra-articular coalition, if significant heel valgus is present, a varus-producing calcaneal osteotomy combined with resection of the coalition may be of some benefit.

Juvenile IB

The Juvenile IB coalition is an extra-articular coalition in an osseously immature individual with significant secondary arthritic changes (Fig. 5). Generally, an extra-articular coalition with secondary arthritic changes is less amenable to simple surgical resection. However, in the younger patient, it should still be strongly considered, with the potential benefits of resection weighed against the possible need for additional surgery, ie, arthrodesis, in the future. If resection of the coalition is to be performed, informed consent should include a discussion of the potential future need for arthrodesis. Alternatively, resection of the coalition with a simple exostectomy of any significant spurring may be considered.

As with any coalition, over time, significant degenerative changes may occur with an extra-articular coalition. In a calcaneonavicular coalition, the talonavicular joint usually will demonstrate the most apparent changes. In the younger patient with mild secondary degenerative changes, extensor digitorum brevis interpositional arthroplasty may be attempted. However, the patient and parents should be told that a triple arthrodesis may be needed in the future. With more significant degenerative changes, triple arthrodesis is the initial procedure of choice. In cases where triple arthrodesis is to be performed, a complete coalition, ie, synostosis, may be left intact. However, if the coalition is incomplete, ie, syndesmosis or synchondrosis, or if significant positional abnormalities exist, the coalition should be resected to obtain optimal postoperative position and fusion. In the osseously immature individual, ideally, triple arthrodesis is delayed until after tarsal osseous maturity.

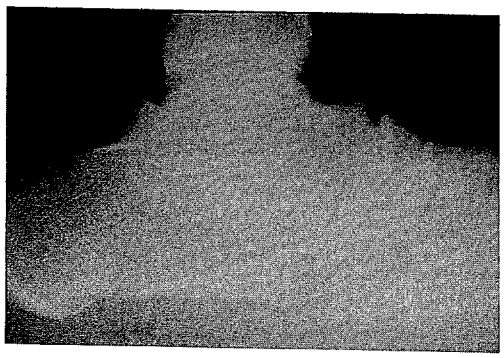

Figure 5. Example of Juvenile IB coalition. A calcaneonavicular bar in an osseously immature, 14-year-old patient with significant secondary arthritic changes. Note talonavicular joint beaking.

Figure 6. Example of Juvenile IIA coalition. A synostosis of the middle facet of the talocalcaneal joint in an osseously immature, 14-year-old patient. Note the following classic lateral radiograph findings of such a coalition: loss of subtalar joint clarity, flattening of the lateral talar process, and halo sign. Minimal secondary arthritic changes, such as talonavicular joint beaking, are noted.

Juvenile IIA

As previously discussed, extra-articular coalitions are generally thought to be more amenable to resection, while intra-articular coalitions are traditionally considered an indication for arthrodesis. The exception to this premise might be the Juvenile IIA coalition. This is an intra-articular coalition that occurs in an osseously immature patient with minimal or no secondary degenerative changes (Fig. 6). In certain situations, resection of this type of coalition may allow objective improvement of the motion of the tarsal joints and a subjective decrease in the patient's symptoms. If the coalition is small or incomplete, it may potentially be even more amenable to resection arthroplasty. Since this intra-articular coalition has permanently altered a joint, it should be remembered that future arthrodesis will many times be necessary.

A common example of a Juvenile IIA coalition would be a middle facet coalition of the subtalar joint. Typically, resection of this coalition leaves a defect and an irregular area in one of the articular facets of a major weightbearing joint. Logically, then, it would be expected that resection would result in a limited increase in motion with probable crepitus in the joint space. If the patient has concomitant peroneal muscle spasm, a continuation of the tonic spasm would be expected. Thus, the logical postoperative expectation would seem to be limited objective improvement and potentially little subjective improvement in symptoms. However, several authors have described resection of intra-articular coalitions with or without the interposition of autogenous fat grafts, and have reported satisfactory results.[17,19,25,31] Similarly, interposition arthroplasty may be achieved by performing resection of the coalition accompanied by the use of a subtalar joint motion blocking device or arthroereisis to maintain the joint space (Fig. 7).[1,32]

Another example where resection might be beneficial is the posterior facet talocalcaneal coalition secondary to a fractured Stieda's process or os trigonum. If the coalition occurs within the posterior facet of the subtalar joint, it would be an intra-articular coalition. If it occurred outside the subtalar joint, it would be considered an extra-articular coalition. In either scenario, surgical resection of the coalition and/or os trigonum may lead to a satisfactory functional result.[4]

In the reports of Dwyer[30] and Cain and Hyman,[29] no distinction was made between extra-articular and intra-articular coalitions. They believed that varus-producing osteotomies of the calcaneus could afford relief of symptoms in tarsal coalition without significant secondary arthrosis. No long-term follow-up studies have been reported to substantiate their beliefs. A varus-producing osteotomy of the calcaneus may be a useful surgical adjunct if concomitant resection of the coalition is contemplated.

In cases with significant intra-articular joint involvement or in cases of failed resection, arthrodesis would seem to be the procedure of choice. Since the midtarsal and subtalar joints work in unison, in most instances, triple arthrodesis is preferred over single arthrodesis. With talocalcaneal coalitions involving the middle facet and without secondary arthritic changes, debate continues as to the preferred arthrodesis: isolated subtalar joint arthrodesis or triple arthrodesis. The author contends, as a recent report by Mann and Baumgarten[33] suggests, that isolated arthrodesis generally provides a superior functional result. Arguably, triple arthrodesis should be reserved for

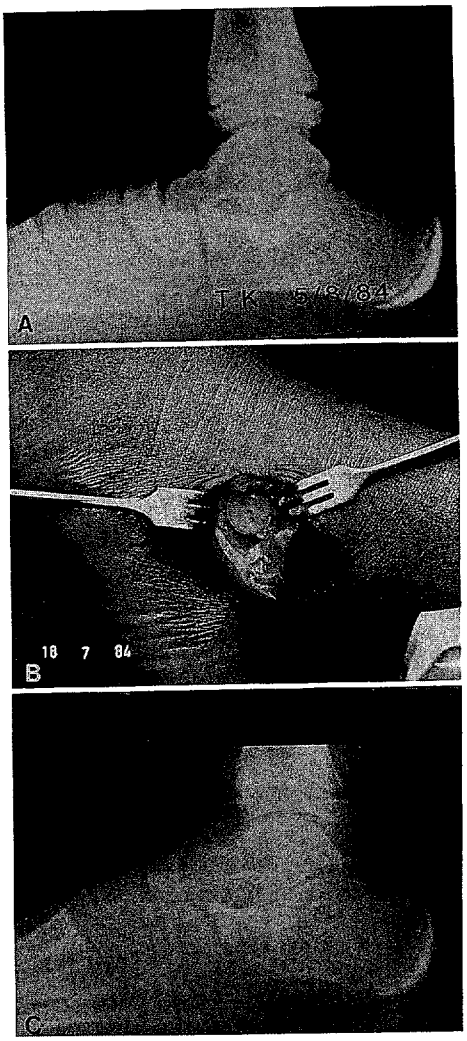

Figure 7. Juvenile patient (12 years old) with middle facet talocalcaneal coalition and minimal secondary arthritic changes, ie, Juvenile IIA coalition. A, Preoperative radiograph; B, insertion of arthroereisis into sinus tarsi; and C, postoperative radiograph. Note the postoperative decrease in the talar declination angle and improved subtalar joint appearance.

cases where the coalition, although not associated with secondary degenerative changes, is demonstrating significant structural influence, eg, profound forefoot varus, rearfoot valgus, or equinus. In such cases, triple arthrodesis would be necessary to obtain a structurally and biomechanically acceptable forefoot-to-rearfoot relationship.

Juvenile IIB

The Juvenile IIB coalition is an intra-articular coalition in an osseously immature individual with significant secondary arthritic changes (Fig. 8). Such an intra-articular coalition with moderate-to-

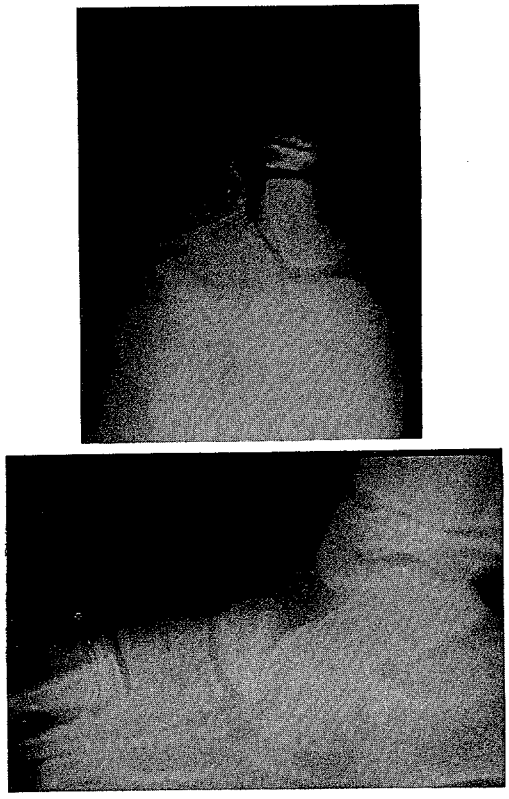

Figure 8. Example of Juvenile IIB coalition. A syndesmosis of the middle facet of the talocalcaneal joint in a 13-year-old patient. Note rearfoot pathology and secondary changes, including a significantly deformed talonavicular joint with severe wedging of the navicular.

severe secondary arthritic changes is optimally treated with a triple arthrodesis after osseous maturity.

Adult IA

The Adult IA coalition is an extra-articular coalition in an osseously mature individual with minimal secondary arthritic changes (Fig. 9). Arthrodesis is generally more strongly considered for the adult patient than for the child patient. However, when the coalition is extra-articular and no secondary arthritic involvement is noted, interpositional arthroplasty may be considered. Since the adult patient has more limited remodeling potential, any resection should be attempted with caution. The patient should be informed preoperatively that recurrent or increased symptoms may result following an interpositional arthroplasty, and that an arthrodesing procedure may be necessary in the future to placate the symptom complex. An individualized decision must be made for each patient, with the benefits of initial resection and the possi-

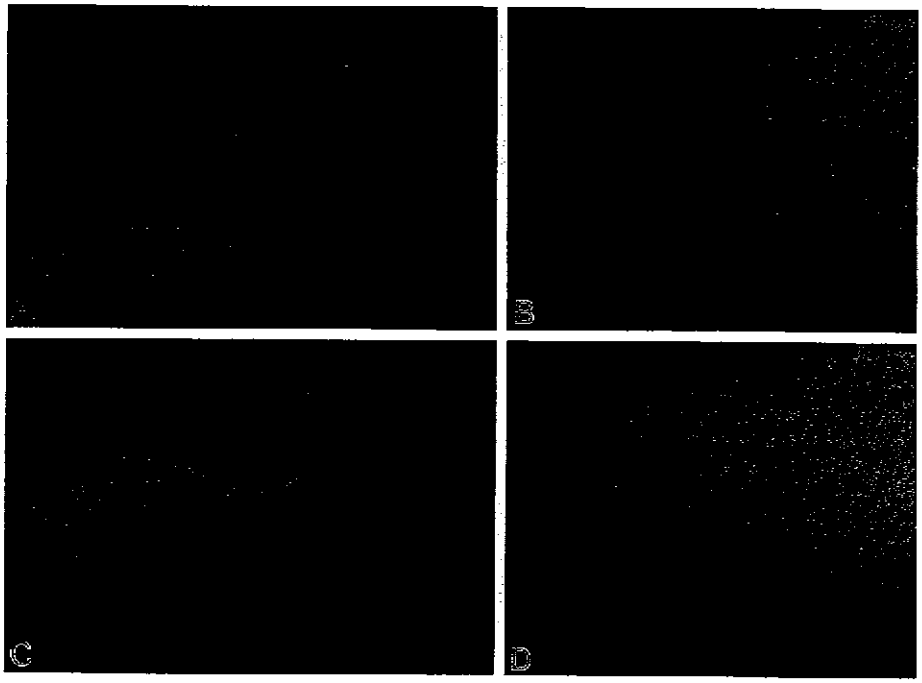

Figure 9. Examples of Adult IA coalitions. A and B, A calcaneonavicular bar with minimal secondary arthritic changes in a 22-year-old patient. Note the cavovarus attitude of the foot. C and D, A cubonavicular synostosis without significant secondary arthritic changes in an 18-year-old patient.

ble need for later arthrodesis weighed against an immediate arthrodesing procedure.

Adult IB

The Adult IB coalition is an extra-articular coalition in an adult or osseously mature individual with significant secondary arthritic changes (Fig. 10). When the extra-articular coalition in the adult is associated with moderate to severe secondary degenerative changes, arthrodesis is preferable. In most cases, triple arthrodesis will be indicated. Notwithstanding, in rare instances where only a single joint demonstrates significant secondary arthritic changes, resection of the coalition with a simple arthroplasty and exostectomy at the involved joint or a single joint arthrodesis may be viable alternatives.

Adult IIA

The Adult IIA coalition is an intra-articular coalition in an osseously mature individual without significant secondary arthritic changes (Fig. 11A). Unlike the juvenile patient, resection of an intra-articular coalition should generally not be considered in the adult patient. Because of the limited potential for recovery to a functional, asymptomatic state following resection, arthrodesis should be viewed as the primary surgical option. Only if the patient is adamant and fully understands the probable future need for arthrodesis should interpositional arthroplasty be considered.

Isolated arthrodesis of the involved joint may be performed if minimal secondary arthritic changes are noted (Fig. 11B). Triple arthrodesis also may be considered, and is certainly preferable if positional correction is needed in the foot. For example, the midtarsal joint resection in a triple arthrodesis could be used to derotate the forefoot in relationship to the rearfoot to correct a significant forefoot varus or supinatus deformity (Fig. 12).

Adult IIB

The Adult IIB coalition is an intra-articular coalition in an osseously mature individual with significant secondary arthritic changes (Fig. 13A). This type of coalition often presents with the most pathologic scenario; a rigid pes planovalgus foot, associated severe degenerative changes, and frequent concomitant peroneal muscle spasm. Therefore, triple arthrodesis is the procedure of choice for the Adult IIB coalition (Fig. 13B).

Thus, the Articular Classification System provides an improved method of grouping tarsal coalitions and debating the surgical options for any individual patient (Fig. 14). It should be remembered that procedural selection will vary from patient to patient, and that recommended surgical procedures are dependent on the combined goals and desires of both the surgeon and the patient in

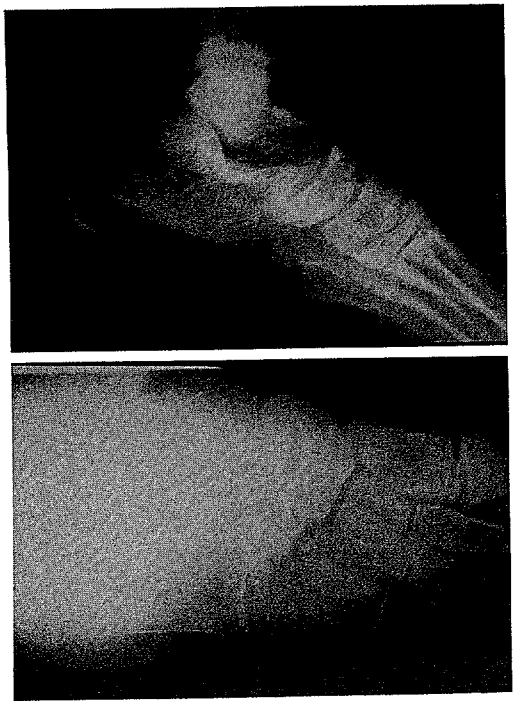

Figure 10. Example of Adult IB coalition. A calcaneonavicular bar with a large talonavicular exostosis in a 20-year-old patient. The patient underwent surgical resection of the coalition with exostectomy of the talonavicular prominence.

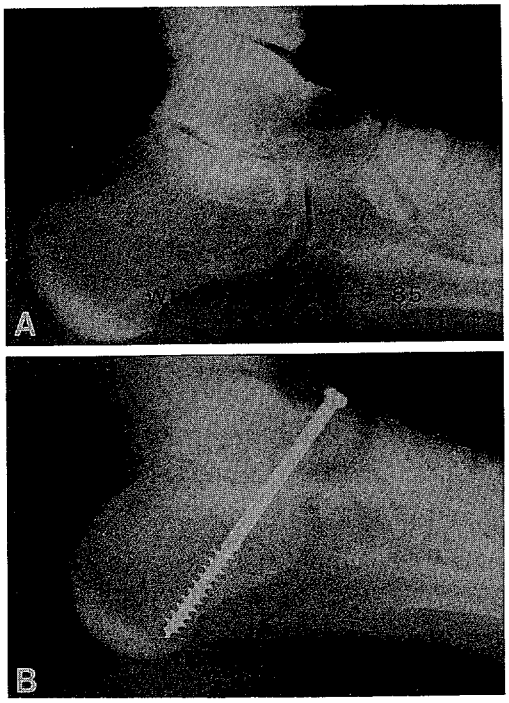

Figure 11. Example of Adult IIA coalition. A, A 19-year-old patient with a syndesmosis of the middle facet of the talocalcaneal joint. Note minimal secondary arthritic changes. B, Postoperative radiograph of the same patient 4 months following isolated subtalar joint arthrodesis with screw fixation.

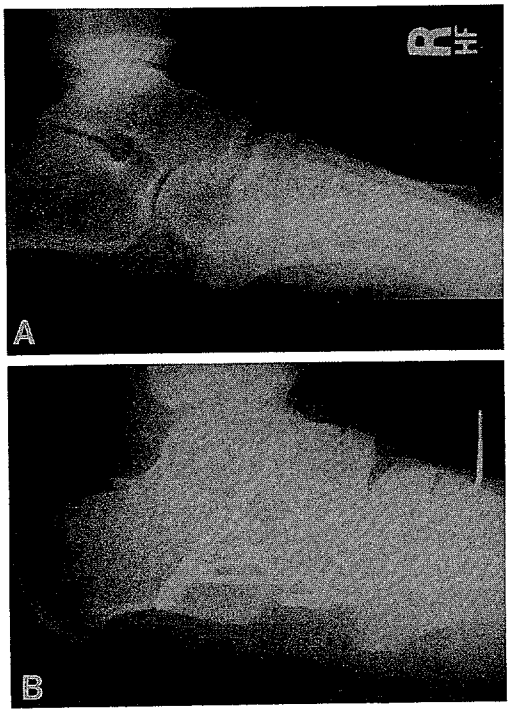

Figure 12. A 17-year-old patient with a synostosis of the talonavicular joint with minimal secondary arthritic changes, ie, Adult IIA coalition. A, Preoperative radiograph. The patient had 20° of forefoot varus deformity. B, Immediate postoperative radiograph following triple arthrodesis with internal fixation.

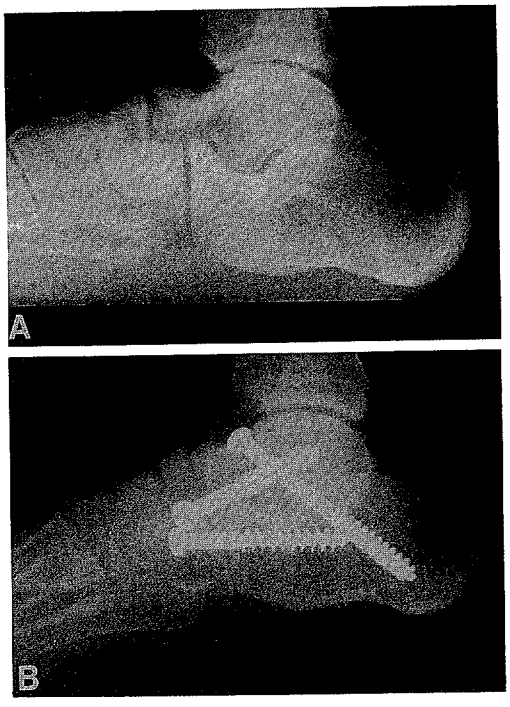

Figure 13. A 17-year-old patient with a synostosis of the middle facet of the talocalcaneal joint. Note significant secondary arthritic changes, including both talonavicular and calcaneocuboid joint beaking, ie, Adult IIB coalition. A, Preoperative radiograph; and B, postoperative radiograph, 3 months following a triple arthrodesis with internal screw fixation.

Juvenile IA

Resection with interposition of extensor digitorum brevis muscle
Resection with interposition of adipose tissue
Resection with varus-producing calcaneal osteotomy
Resection with insertion of implant
Varus-producing calcaneal osteotomy alone

Juvenile IB

Resection with interposition of extensor digitorum brevis muscle
Resection with interposition of adipose tissue
Resection with varus-producing calcaneal osteotomy
Resection with insertion of implant
Varus-producing calcaneal osteotomy alone
Triple arthrodesis

Juvenile IIA

Resection alone
Resection with interposition of adipose tissue
Resection with interposition of arthroereisis
Resection with varus-producing calcaneal osteotomy
Varus-producing calcaneal osteotomy alone
Isolated/single arthrodesis
Triple arthrodesis

Juvenile IIB

Triple arthrodesis

Adult IA

Resection with interposition of extensor digitorum brevis muscle
Resection with interposition of adipose tissue
Resection with varus-producing calcaneal osteotomy
Resection with insertion of implant
Varus-producing calcaneal osteotomy alone
Triple arthrodesis

Adult IB

Resection with isolated/single arthrodesis
Triple arthrodesis

Adult IIA

Isolated/single arthrodesis
Triple arthrodesis

Adult IIB

Triple arthrodesis

Figure 14. Possible surgical procedures based on the Articular Classification System. Note that procedures listed in boldface type are currently the most commonly performed.

attempting to obtain both subjective and objective improvement.

Summary

The author offers the Articular Classification System as a format for discussing management options in the treatment of tarsal coalition. The classification system cannot be encyclopedic, but it does incorporate several important parameters used in the development of a treatment regimen for any coalition: patient age, articular involvement, and the extent of secondary arthritic changes. It is hoped that, based on this system, recommended surgical procedures and the report of long-term results can be more accurately related.

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