Continuing Medical Education

Differential Diagnosis of Metatarsus Adductus

The author clarifies how to make the correct diagnosis of this condition.

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Goals and Objectives

1) To improve the practitioner's ability to assess metatarsus adductus

2) To improve the practitioner's ability to differentiate metatarsus adductus from other adductory conditions

3) To convey the importance of making a proper diagnosis relative to patient management

4) To review the pathoanatomy, clinical features, and clinical course of metatarsus adductus

5) To review assessment and treatment parameters

6) To review, compare, and contrast other adductory conditions that are important in the assessment and management of metatarsus adductus

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*Following this article, an answer sheet and full set of instructions are provided (pg. 148).—**Editor***

The most common inquiries from practitioners concern whether metatarsus adductus in a particular patient requires therapeutic intervention at all, whether the patient is age-appropriate for treatment, whether there are associated torsional or rotational conditions, or if detected, whether or not this condition even needs to be addressed. Fortunately, current technology enables remote viewing, so that gait video (where age appropriate), clinical photos, and radiographs are available for assessment. Unfortunately, too often the condition has

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been misdiagnosed.

Practitioners who are not readily familiar with pediatric norms at given stages of development sometimes miss subtle but tell-tale findings that are important in assessment and treatment. This article will focus on metatarsus adductus as well as the differential diagnosis of adductory conditions that may have a component of metatarsus (or forefoot) adductus. There are, however, different conditions with different clinical courses which require different interventions. The reader is reminded that much of the information on the specific conditions referenced is readily available through the Internet and s/he is encouraged to review that information.

Metatarsus Adductus

Metatarsus adductus is the most common congenital foot condition encountered. The foot is "C-shaped" with a convex lateral border and concave medial border (Figure 1). It is most likely caused by intrauterine position (intrauterine packing); however, the literature reports some association with oligohydramnios (lack of amniotic fluid). It is present at birth and most often noted through the first year. The vast majority of cases are flexible (90%); however, a spectrum of flexibility exists, and semi-rigid as well as frankly rigid conditions are encountered.

Approximately 50% of presentations are bilateral, though not necessarily perfectly symmetric. Flexible presentations typically resolve spontaneously in approximately 85% of children. Note that in a small percentage of cases, the condition may be associated with hip dysplasia, and the practitioner should include clinical assessment of hip stability (e.g. Barlow's, Ortolani's, Galeazzi tests) as part of the overall work-up.

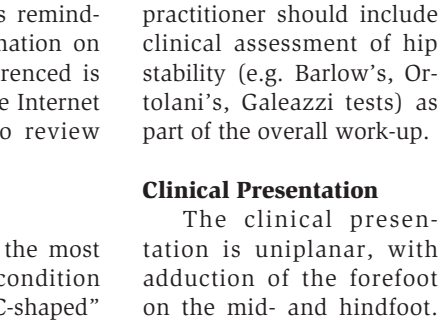

Figure 1: Clinical photo of metatarsus adductus (from plantar view), revealing classic findings of concave medial border and convex lateral border, with the apex of the deformity at the base of the fifth metatarsal.

Figure 3 (left): Clinical photo of foot in relaxed position, with adducted forefoot.

Figure 4 (right): Clinical photo of forefoot manipulated into rectus position on mid- and hindfoot. Note that abduction is performed at the metatarsal head level rather than at the toes, while the hindfoot is maintained in neutral position.

Figure 5: Clinical photo of child in stance, demonstrating bilateral metatarsus adductus with concurrent hallux adductus, a common finding.

Clinical Presentation

The clinical presentation is uniplanar, with adduction of the forefoot on the mid- and hindfoot. While accurately represented as adduction of the metatarsals on the lesser tarsus, it is clinically indistinguishable from forefoot adductus in pre-walkers and beyond. The midfoot is radiographically "silent", meaning that the ossific landmarks of the cuboid and cuneiforms are either not present or not yet well visualized (Figure 2). The ossific nuclei of the tarsals, however, are present.

In infants, metatarsus adductus and forefoot adductus are indistinguishable because the lesser tarsus is radiographically silent.

As a result, the positional relationship between the metatarsals and lesser tarsals cannot be accurately determined. In addition, with the vast majority of cases being flexible, observation and management are undertaken without the need for radiographs. Practically speaking, the preponderance of children presented to the practitioner fall into the pre-walker age bracket, all of which share the feature of radiographic "silence". Therefore, in pre-walkers it falls primarily to the salient assessment of clinical features, including cutaneous landmarks, ranges of motion of the fore-

Figure 2: AP radiograph of metatarsus adductus, demonstrating age-appropriate divergence of Kite's angle, radiographically "silent" lesser tarsus, and adduction of metatarsals. The talar bisection projects lateral to the bisection of the first metatarsal.

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Figure 7 (above): Lateral radiograph demonstrating typical angular relationships in metatarsus adductus, where the lesser tarsus can be visualized.

Figure 6 (left): AP radiograph demonstrating typical angular relationships in metatarsus adductus, where the lesser tarsus can be visualized.

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foot, subtalar and ankle joints, as well as transverse rotation of the leg on the thigh, and hip range of motion, to determine whether additional diagnoses should be considered, as well as the need for radiographs.

A useful clinical parameter in foot assessment is the ease of manual reduction of the forefoot on the hindfoot. Flexible presentations are typified by the forefoot being easily manipulated into a rectus or mildly abducted position (Figures 3 and 4).

Care should be taken to abduct rather than pronate the forefoot, as pronation of the forefoot will lead to a "spurious" reduction and mislead the practitioner into a false sense of its responsiveness to manipulation. This is even more important in semi-rigid or rigid conditions. In the latter two, the practitioner should evaluate cutaneous landmarks, such as creases in the mid-arch and posterior ankle, as these are common with talipes equinovarus. If this is ruled out, intervention via manipulation with serial casting may be required, as over time articular positions and soft tissue adaptation become less amenable to spontaneous reduction with weight-bearing. If serial casting is undertaken, a short-leg cast is as effective as a long-leg cast.

Use of long-leg casts for isolated metatarsus adductus is more pragmatic than therapeutic, especially when dealing with a chubby infant or an older child whose repetitive knee motion may shift the position of the cast on the leg. Where concurrent internal tibial torsion is present (as it frequently is), the practitioner may wish to employ a long-leg cast to correct the conditions simultaneously. Note, however, that as with metatarsus adductus, mild super-structural rotational disorders typically resolve spontaneously.

The typical clinical course for metatarsus adductus resolves spontaneously in most cases.

In older children who are fully weight-bearing and ambulating, pronatory compensation may cause mild FF supinatus with mild hindfoot valgus (important to distinguish from skewfoot). The hallux is often adducted as well and can be exaggerated with weight-bearing (Figure 5).

Where the condition persists to the point that radiographic landmarks are visualized, the following values are typical:

AP/DP view (Figure 6):

- Kite's angle WNL
- talar-1st metatarsal angle $>15°$ ($N = <15°$)
- calcaneo-1st metatarsal angle $>10°$ ($N = 0 \sim 5°$)
- calcaneo-2nd metatarsal angle $>10°$ ($N = 0 \sim 5°$)

Lateral view (Figure 7):

- calcaneal inclination angle: WNL ($N = 18 \sim 25°$)
- talar declination angle: WNL ($N = 15°\text{-}25°$)
- talar-1st metatarsal angle: WNL ($N = 15°\text{-}25°$)

Differential Diagnosis

While it is important to assess the flexibility of metatarsus adductus relative to possible intervention, it is equally important to understand other "adductory" conditions that cosmetically mirror it but that have more significant consequence if missed by the practitioner. They are talipes equinovarus (TEV or clubfoot), skew foot, and to a lesser extent internal tibial torsion, and femoral anteversion.

In a six month old, the most common way to differentiate metatarsus adductus from skew foot is the extent of subtalar pronation.

Talipes Equinovarus

Talipes equinovarus (TEV, or clubfoot) shares forefoot adduction, clinically, with metatarsus adductus; however, like skew foot, it is a complex deformity.

The condition is typified by:

- Adduction of the forefoot and midfoot on the hindfoot (not metatarsal adduction on the lesser tarsus). A common distinguishing characteristic in TEV, especially in more severe cases, is a medial fissure (crease) in the mid-arch area (Figure 8), and often a fissure (crease) at the posterior ankle (Figures 9 and 10). Radio-

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graphically, however, both conditions will demonstrate bisection of the first metatarsal falling medial to a bisection of the talus on an AP view (Figures 11 and 12).

• Supination of the subtalar joint. Clinically, the hindfoot will show little range of motion in the frontal plane. Metatarsus adductus demonstrates typical pediatric values (mild increase) for Kite's angle. Tarsal stacking is pathognomonic of TEV and will readily differentiate it radiographically from metatarsus adductus (Figure 11). In addition, a lateral radiograph of TEV (Figure 12) will demonstrate lack of anterior convergence of the talar and calcaneal bisections. The talar bisection will fall in the dorsal half of the ossific nucleus of the cuboid and often project entirely dorsal to it. In more severe TEV, parallelism of the bisections of the talus and calcaneus is present (Figure 12).

The presence of a posterior calcaneal fissure is indicative of hindfoot equinus.

• Hindfoot equinus is another key characteristic that differentiates TEV from metatarsus adductus. In TEV, it is invariably present, because of the posterior calcaneus being drawn upward due to contracture of the posterior ankle joint capsule, the posterior subtalar capsule, the calcaneofibular ligament and the posterior talofibular ligament. Concurrently, there is gastrocsoleus contracture. This combination of contractures maintains the calcaneal pitch low or even negative.

In skewfoot, Kite's angle is expected to be greater than that of metatarsus adductus.

In contrast, with metatarsus adductus, the hindfoot equinus is atypical, and when present, is much more mild and commonly due to gastrocnemius contracture.

The functional significance of these differences is important in management. If a true TEV is misdiagnosed as metatarsus adductus and manipulation with serial casting is undertaken, the practitioner, in an attempt to abduct the metatarsals on the lesser tarsus, will encounter resistance. The undetected hindfoot varus will cause resistance to the abduction. This is because the forefoot adduction in TEV is occurring at Chopart's joint and not Lisfranc's joint.

Unfortunately, if the practitioner is persistent, the tendency is to subluxate the lateral column. A true talipes equinovarus should be manually reduced via the Ponseti method, which entails a different series of maneuvers and hand positions. The reader is referred to the literature and Internet to review the Ponseti method of manipulation, as it is beyond the scope of this article.

If surgical correction is undertaken for what is misdiagnosed as a metatarsus adductus but is truly a TEV, the practitioner will fail to reduce the hindfoot varus, fail to perform a tendo Achilles lengthening and, if required, fail to release the posterior capsules and ligaments. As a result, the forefoot adductus correction will not be maintained, and the hindfoot will remain in equinovarus. Even worse, if a tendo Achilles lengthening is performed but the hindfoot varus has not been addressed, an iatrogenic cavoadductovarus is likely.

Skewfoot

Skewfoot, also referred to as "Z foot", is typified by three areas of deviation:

1) The forefoot is adducted on the midfoot, as with metatarsus adductus. Depending on severity, the first metatarsal lies 2) adducted and 3) plantar-flexed on the medial cuneiform.

• In contrast to metatarsus adductus, the midfoot is abducted relative to the hindfoot, with lateral displacement of the navicular on the head of the talus and abduction of the cuboid on the calcaneus (Figure 11). In more severe cases, the navicular may also lie dorsally subluxed in relation to the talus.

Note that in the radiograph shown, the ossific nucleus of the cuboid is

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Figure 8: Clinical photo of talipes equinovarus (from plantar view), demonstrating forefoot adduction. Note the skin crease in the medial arch.

Figure 9: Clinical photo of talipes equinovarus (from anterior view), demonstrating hindfoot varus (hindfoot supination).

Figure 10: Clinical photo of talipes equinovarus (from medial view), demonstrating skin crease at superior heel area, consistent with hindfoot equinus.

Figure 11: AP radiograph of talipes equinovarus, demonstrating superimposition of the talus on the calcaneus (tarsal stacking), and indicative of hindfoot supination.

Figure 12 (right): Lateral radiograph of talipes equinovarus, demonstrating superimposition of the talus on the calcaneus (tarsal stacking), and indicative of hindfoot supination. Note parallelism of talus and calcaneus, with rotation of the calcaneus into equinus. [Clinical Pearl: Note that to accommodate positioning of the lateral border of the foot against the plate, the hindfoot becomes relatively adducted and the ankle becomes more externally rotated. The ankle joint therefore appears as a mortise view while the talus and calcaneus appear foreshortened. Alternatively, the foot can be positioned with the lateral hindfoot against the plate, which will render a true representation of the size and relationship of the tarsal bones, as well as a "true" projection across the ankle. The trade-off is that the forefoot will become distorted.

When serial casting is employed in a patient in whom a skewfoot is undetected (misdiagnosed as metatarsus adductus), the hindfoot will most likely be iatrogenically supinated in the cast.

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present but that of the navicular does not yet show. The diagnostic challenge occurs in more mild cases of skewfoot in infants, pre-walkers and early walkers because the ossific nuclei of the navicular and cuboid are either not visualized or, if visualized, are not well enough delineated radiographically to determine their abductory position relative to the tarsal bones (which are also poorly defined radiographically at this age).

• In contrast to metatarsus adductus, the hindfoot is in valgus, with pronation and concurrent adduction and plantarflexion of the talus. In more severe cases, calcaneal pitch is low, with tight gastrocnemius or gastrosoleus (i.e., tendo Achilles contracture). In pre-walkers, however, the positional valgus may not be readily apparent and the practitioner should carefully evaluate the subtalar range of motion.

The functional significance of these differences is important in management. If a misdiagnosis of metatarsus adductus is made, and manipulation with serial casting is undertaken, the practitioner, in the attempt to abduct the metatarsals on the lesser tarsus, will instead pronate the hindfoot, as the Lisfranc articulations are the most resistant to correction. Therefore, care must be taken to prevent hindfoot pronation with counter pressure at the hindfoot, and to further maintain this in the cast. Otherwise, the subtalar joint, already over-pronated in skewfoot, will continue to pronate, and the practitioner risks a spurious correction in the transverse plane, with the end result of a clinically "rectus" forefoot, but a significantly pronated hindfoot.

If a misdiagnosis of metatarsus adductus is made in the case of a resistant or rigid deformity and surgical correction is undertaken, the practitioner will correct the forefoot and again neglect the abducted midfoot and pronated hindfoot. The result will be a partial correction which will destabilize the foot medially. Weight-bearing children with skewfoot rely on the forefoot adduction for medial stability in stance. Failure to address all components of the deformity concurrently and focus only on the forefoot adduction will exacerbate midfoot abduction and hindfoot pronation when the patient is weight-bearing.

Comparative AP radiographs of metatarsus adductus, TEV and skewfoot are shown (Figure 15). Note that while the metatarsals are adducted in all three conditions, the osseous positions at the lesser tarsus and tarsus are significantly different among the three.

When serial casting is employed in patient in whom a TEV is undetected (misdiagnosed as metatarsus adductus), the metatarsals will resist long-term correction due to hindfoot supination.

Internal Tibial Torsion

Internal tibial torsion is a normal condition in infants and is present through 18-24 months of age. It is defined by the relationship of the leg to the thigh and typically resolves spontaneously. It is easily assessed by internally and externally rotating the leg on the thigh with the knee flexed at 90° and the foot held in neutral. Another commonly used static assessment is the thigh-foot angle (Figure 16). This angle relates to a bisection of the posterior thigh to the centerline of the foot.

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Where the thigh-foot angle is internal and exceeds -10 degrees at 24 months, monitoring (though not necessarily treatment) is warranted. Intervention, where indicated, is most often accomplished with a Wheaton-type brace, which appropriately maintains an abductory force on the tibia with the knee in a flexed position. Older therapies, such as abductory bars at the foot level only, are less effective and tend to shift the moment of force to the femur rather than where it is intended.

Internal tibial torsion is a normal condition in infants and is present through 18-24 months of age.

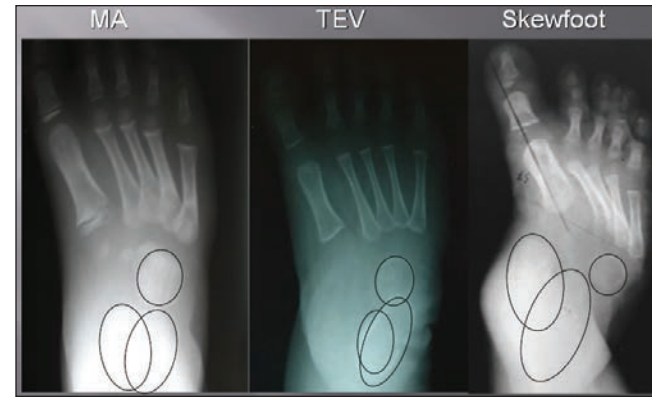

Figure 15: Comparative AP radiographs of metatarsus adductus, talipes equinovarus, and skewfoot, outlining the salient tarsal relationships and position relative to the cuboid and forefoot.

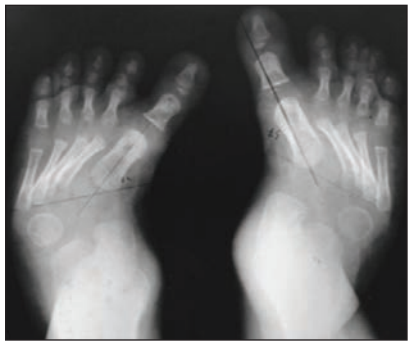

Figure 13: AP radiograph of skewfoot, demonstrating increased Kite's angle, with abduction of the cuboid on the calcaneus, as well as adduction of the metatarsals.

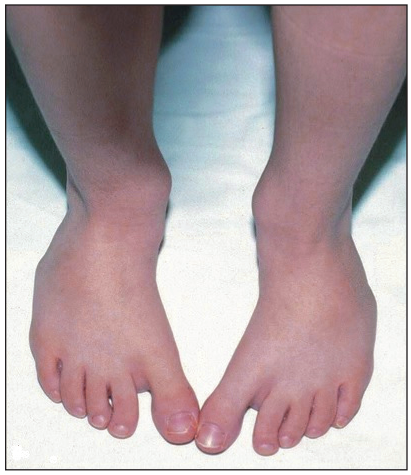

Figure 14: Clinical photo of skewfoot, demonstrating forefoot findings similar in appearance to metatarsus adductus, but significant fibular displacement of the lesser tarsus on relative to the leg, concurrent with hindfoot pronation.

The functional significance in a discussion of metatarsus adductus is that the two conditions often present in tandem. Flexible conditions are of less concern, since both resolve spontaneously in the vast majority of cases. Where either or both persist beyond their natural course, the practitioner needs to be able to anticipate the presence of both, and address management specifically to the areas where it will be effective. As previously indicated, serial long-leg casting will incorporate the appropriate positional abduction at the foot level, while also maintaining an abductory position at the tibia. When followed by bracing (e.g., Whitman brace), the two areas will be incorporated in therapy.

A simple assessment method in ambulatory children to detect femoral anteversion is to observe the patellae as the child approaches during gait.

Femoral Anteversion

Femoral anteversion (medial femoral torsion) is the most common cause of in-toeing in early childhood (Figure 18).

It is defined by the relation between the femoral neck and the transcondylar axis at the knee. It is normal at birth and reduces with age, but if delayed may be a cause of tripping or awkward gait in children, and is commonly the reason for parental presentation of the child. The condition's normal course results in near complete resolution of the in-toeing in more than 80% of affected children by age 10.

Concurrent metatarsus adductus and femoral anteversion is less common than is metatarsus adductus with internal tibial torsion. The functional significance for the practitioner is in making a thorough segmental assessment when faced with the tripping child, or with the child who is presented for "in-toeing." A simple assessment method in ambulatory children is to observe the patellae as the child approaches during gait. The patellae will be internal to the sagittal plane.

Femoral anteversion may be the source, or a contributory element, of the child's adducted angle of gait. The practitioner should be aware that children commonly pronate in compensation for the adduction, and in so doing, may be masking a persistent metatarsus adductus. The practitioner should therefore assess the feet in their compensated position as well as with the child placed in corrected stance position, with both feet placed in neutral stance. If a metatarsus ad-

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ductus (or forefoot adductus) is present, it will become more evident.

Treatment Summary for Metatarsus Adductus

Non-Operative

- Defer treatment if the foot can be passively manipulated past neutral (rectus lateral border).
- Some patients may benefit from passive stretching.
- Adjunctive therapies include bar therapy, straight last or abductory shoes, pre-fabricated AFOs, etc.; while broadly utilized in the past, strong medical evidence is lacking for these interventions.

rection is obtained, several holding casts are advised to maintain correction.

Operative

- Abductor hallucis release, capsulotomy, and metatarsal osteotomy are surgical options for young children; adjunctive cuboid osteotomy has been effectively performed as well.
- Tarsometatarsal capsulotomies are still utilized; however, they should be relegated to young children, as stiffness is common in children five years or older.
- In patients older than five years of age, consider proximal osteotomies of the lesser metatarsals with or without cuboid osteotomy. **PM**

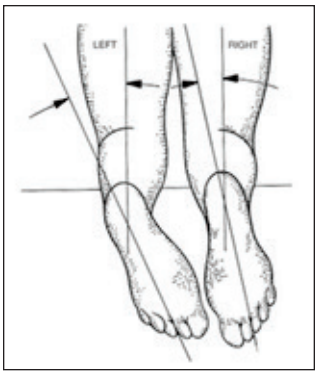

Figure 16: Illustration of the thigh-foot axis.

A Wheaton brace is indicated in a one year-old with resistant metatarsus adductus and internal tibial torsion.

- Serial casting is indicated for rigid or persistent deformity; intervention is best started before the child reaches one year.
- Persistent or rigid forefoot adductus can be readily corrected w/ cast; avoid pronating the forefoot with abduction.
- When concurrent internal tibial torsion is present, casts should extend above the knee (flexed 20-25°); otherwise below-knee casting is adequate.
- Casts are changed biweekly, and correction is usually achieved after two to three changes; once cor-

Figure 17: Clinical photo of a child with internal tibial torsion. Note the position of the foot relative to the patella.

Figure 18: Clinical photo of a child with internal femoral position. Note the adducted position of the patellae and the foot angle in stance.

Suggested Reading

1) The intoeing child: etiology, prognosis, and current treatment options. Harris E. Clin Podiatr Med Surg. 2013 Oct;30(4):531-65.

2) The long-term functional and radiographic outcomes of untreated and non-operatively treated metatarsus adductus. Farsetti,P, Weinstein SL, Ponseti IV; J Bone Joint Surg Am. 1994 Feb;76(2):257-65.

3) Below-knee plaster cast for the treatment of metatarsus adductus. Katz K, David R, Soudry M.J Pediatr Orthop. 1999 Jan-Feb; 19(1):49-50.

4) Radiological assessment of metatarsus adductus. Dawoodi AI, Perera A.Foot Ankle Surg. 2012 Mar; 18(1):1-8. Epub 2011 Apr 8.

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6) Metatarsus adductus: classification and relationship to outcomes of treatment; Bleck EE. J Pediatr Orthop. 1983 Feb;3(1):2-9.

7) Calcaneal lengthening for valgus deformity of the hindfoot. Results in children who had severe, symptomatic flatfoot and skewfoot.; Mosca VS., J Bone Joint Surg Am. 1995 Apr;77(4):500-12.

8) Resistant metatarsus adductus: prospective randomized trial of casting versus orthosis., Herzenberg JE,Burghardt, RD, J Orthop Sci. 2014 Mar;19(2):250-6. Metatarsus adductus: development of a non-surgical treatment pathway.Williams CM, James AM, Tran T., J Paediatr Child Health. 2013 Sep;49(9):E428-33.

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14) Common rotational variations in children. Lincoln TL, Suen PW.J Am Acad Orthop Surg. 2003 Sep-Oct; 11(5):312-20.

15) The normal development of tibial torsion. Kristiansen LP, Gunderson RB, Steen H, Reikerås O.; Skeletal Radiol. 2001 Sep;30(9):519-22.

16) Measurement of tibial torsion and thigh-foot angle using goniometry and computed tomography. Stuberg W, Temme J, Kaplan P, Clarke A, Fuchs R.Clin Orthop Relat Res. 1991 Nov; (272):208-12.

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SEE ANSWER SHEET ON PAGE 149.

1) Approximately what percent of metatarsus adductus cases are bilateral?
- A) 5%
- B) 50%
- C) 90%
- D) 99%

2) In infants, metatarsus adductus and forefoot adductus are indistinguishable because:
- A) The lesser tarsus is radiographically silent
- B) The tarsal position is the same in either condition
- C) Both are uniplanar
- D) The cuboid is abducted on the calcaneus in both conditions

3) The typical clinical course for metatarsus adductus is:
- A) Persists and causes compensation at the subtalar joint
- B) Resolves spontaneously in most cases
- C) Requires a course of serial casting
- D) Prognosis is poor when concurrent internal tibial torsion is present

4) In a six-month-old, the most common way to differentiate metatarsus adductus from skew foot is:
- A) Rigidity of forefoot adduction
- B) Presence of gastrosoleus contracture
- C) Talus is superimposed on the calcaneus
- D) Extent of subtalar pronation

5) The presence of a posterior calcaneal fissure is indicative of:
- A) Limitation of subtalar range of motion
- B) Intrauterine position
- C) Hindfoot equinus
- D) Rigid metatarsus adductus

6) On reviewing Figures 3 and 4, which of the following constitutes appropriate management?
- A) Serial casting should be initiated
- B) Employ Ponseti technique
- C) Defer treatment and monitor
- D) Supinate hindfoot in cast

7) In skewfoot, Kite's angle is expected to be:
- A) Less than that of metatarsus adductus
- B) Less than that of talipes equinovarus
- C) Greater than that of metatarsus adductus
- D) Equal to that of talipes equinovarus

8) When serial casting is employed in a patient in whom a skewfoot is undetected (misdiagnosed as metatarsus adductus):
- A) The hindfoot will most likely be iatrogenically supinated in the cast
- B) The hindfoot will most likely be iatrogenically pronated
- C) The metatarsals will be the most responsive to correction
- D) The hindfoot will iatrogenically be plantarflexed

9) When serial casting is employed in a patient in whom a TEV is undetected (misdiagnosed as metatarsus adductus):
- A) The hindfoot will most likely be iatrogenically supinated in the cast
- B) Iatrogenic abduction of the cuboid may occur
- C) The hindfoot will be iatrogenically plantarflexed
- D) The metatarsals will resist long-term correction due to hindfoot supination

10) A simple assessment method in ambulatory children to detect femoral anteversion is to:
- A) Observe the patellae as the child approaches during gait
- B) Observe for cadence differential in unilateral cases
- C) Observe for pelvic tilt
- D) Observe for hyperlordosis

11) Which of the following is an appropriate method of assessing tibial torsion?
- A) Evaluating the thigh-foot axis
- B) Noting the response to serial casting after two applications
- C) Employing Barlow's examination
- D) None of the above

12) Which of the following radiographic values are inconsistent with metatarsus adductus?

AP/DP view:
- A) Kite's angle WNL
- B) Calcaneo-1st metatarsal angle greater than 10°
- C) Calcaneo-2nd metatarsal angle greater than 10°
- D) All of the above

13) Which of the following radiographic values are consistent with metatarsus adductus?

Lateral view:
- A) Talar declination angle: WNL
- B) Talar-1st metatarsal angle WNL
- C) Choices A & B
- D) None of the above

14) A seven-month-old is presented for "intoeing." A course of serial casting was performed by another practitioner at age one month. Four cast changes were performed at two week intervals. The mother reports initial correction, but over time the in-toeing recurred. You have ruled out torsional/rotational factors, and have obtained the radiographs shown in Figures 11 and 12.

Which of the following is the most likely reason for failure of prior treatment?
- A) Casting was initiated too early
- B) More manipulation and

Continued on page 148

cast applications were required
C) An underlying neurologic condition was present
D) Undetected hindfoot varus resisted abduction of the forefoot

15) In the patient referenced in Question #14, current management should include:
A) Reinstitute manipulation via the Ponseti technique
B) Reinstitute manipulation, and both pronate and abduct the forefoot
C) Delay further manipulation until the lesser tarsus is better visualized
D) Delay further manipulation and perform metatarsal osteotomies

16) Internal tibial torsion is a normal condition in infants and is present through _____ months of age.
A) 1-6
B) 6-12
C) 12-18
D) 18-24

17) Serial casting of the foot should, in addition to abduction of the forefoot, include:
A) Abduction of the midfoot on the hindfoot
B) Maintaining the hindfoot in neutral
C) No additional positioning
D) Plantar-flexion of the ankle

18) Which of the radiographs in Figure 15 is consistent with talipes equinovarus?
A) Left
B) Center
C) Right
D) None of the above

19) In metatarsus adductus, the foot is:
A) A-shaped
B) C-Shaped
C) O-shaped
D) S-Shaped

20) Which of the following is most indicated in a one-year-old with resistant metatarsus adductus and internal tibial torsion?
A) Denis-Browne bar
B) Straight last shoe
C) Wheaton brace
D) Short-leg cast

SEE ANSWER SHEET ON PAGE 149.

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EXAM #7/14
Differential Diagnosis of Metatarsus Adductus (Benard)

Circle:

1.	A	B	C	D	11.	A	B	C	D
2.	A	B	C	D	12.	A	B	C	D
3.	A	B	C	D	13.	A	B	C	D
4.	A	B	C	D	14.	A	B	C	D
5.	A	B	C	D	15.	A	B	C	D
6.	A	B	C	D	16.	A	B	C	D
7.	A	B	C	D	17.	A	B	C	D
8.	A	B	C	D	18.	A	B	C	D
9.	A	B	C	D	19.	A	B	C	D
10.	A	B	C	D	20.	A	B	C	D

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Strongly agree [5]	Agree [4]	Neutral [3]	Disagree [2]	Strongly disagree [1]

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2) The educational objectives were accomplished ____

3) I will apply the knowledge I learned from this lesson ____

4) I will makes changes in my practice behavior based on this lesson ____

5) This lesson presented quality information with adequate current references ____

6) What overall grade would you assign this lesson?

A B C D

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