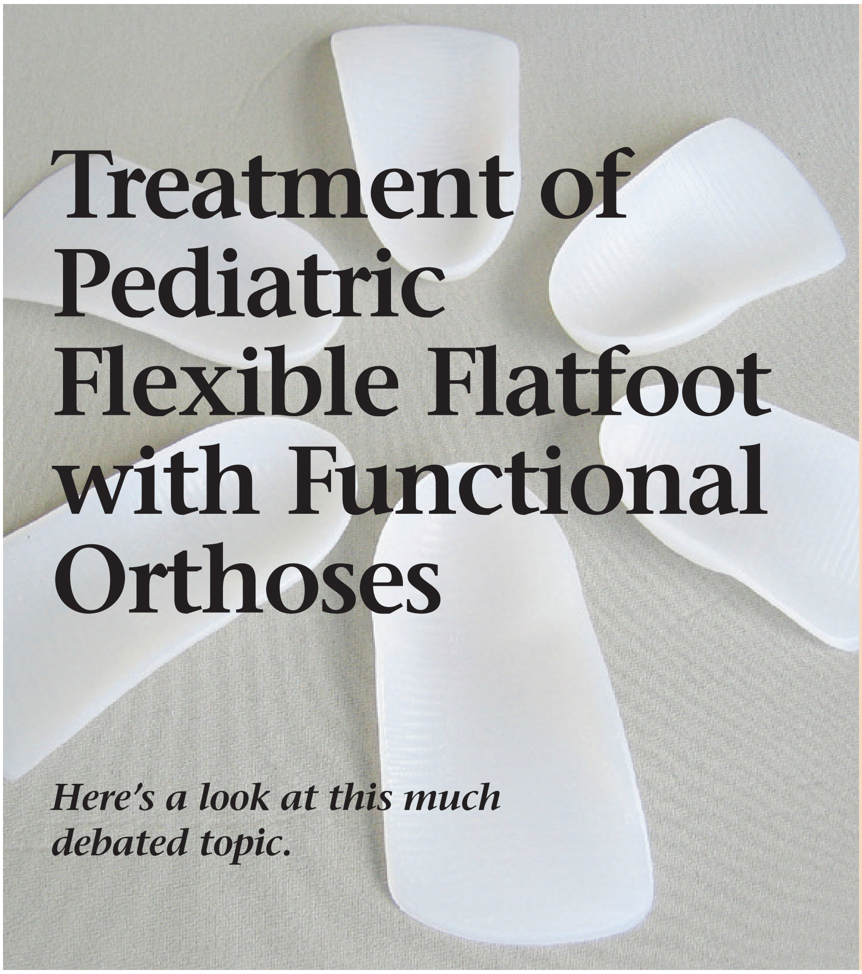

Treatment of Pediatric Flexible Flatfoot with Functional Orthoses

Here's a look at this much debated topic.

Goals and Objectives

1) As a result of reading the article, the clinician will develop a better understanding of the following:

2) The normal and natural development of the human foot from one year of age through seven;

3) The consequences of abnormal development on both the shape of the foot and the function of the foot in children;

4) The specific origins of the pathology, especially in the case of juvenile arthritis, genetic anomalies and neurological influences, can be accounted for in the custom device.

5) The effect on the pediatric foot of the overweight child;

6) Prescription writing for the pediatric patient;

7) The contemporary literature describing the dysfunction of the pediatric flatfoot.

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*Following this article, an answer sheet and full set of instructions are provided (p. 136).—**Editor***

By Paul R. Scherer, D.P.M.

The non-surgical treatment of pediatric flexible flatfoot with functional orthoses has always been mired in controversy and has been debated in the legitimate medical literature for over fifty years. The spectrum of opinions for treatment is so diverse that there is a possibility that no one really has an answer to when or how to treat a child for this "deformity." Furthermore, we still do not have enough clinical trials to tell if early intervention alters midlife outcomes and reduces

Continued on page 130

symptoms.

The discussion of pediatric flexible flatfoot symptoms must begin with the assumption that rigid flatfoot caused by vertical talus and tarsal coalition, with or without peroneal spasm, usually requires a surgical approach and not functional orthoses. Significant equinus deformity is also a primary cause of pediatric flatfoot and without its primary correction, orthotic therapy is an unsuccessful and painful experience for the child. Other etiologic origins of pediatric flatfoot must also be identified and considered, especially genetic anomalies and upper and lower motor neuron disorders. Given these exclusions, treatment of pediatric flexible flatfeet with functional devices is generally an accepted treatment.

A classic study in 1983[1] by Bordelon delineated objective x-ray measurements in children with flexible flatfeet, then placed them in an UCBL-type polypropylene device for twenty-five months to determine any change in the osseous structure and position. The study also investigated whether the change achieved by the device would be maintained after the cessation of the orthoses. The children were again evaluated twenty-five months after discontinuing the device. The study demonstrated that the children, from three to nine years of age, maintained the corrected rearfoot-to-forefoot position even after they stopped wearing the device.

The non-surgical treatment of pediatric flexible flatfoot with functional orthoses has always been mired in controversy.

Twenty-five years later, an Australian study[2] compared the treatment of pediatric flexible flatfoot with custom orthoses, prefab devices and no treatment, in a single blinded parallel randomized controlled trial. They found "no evidence to justify the use of in-shoe orthoses" in the management of this deformity. The two studies could not have had more contradictory results. The later study did not use an accepted casting method nor did it identify what standards were used for cast correction of the positive, other than the casts were "sent to an orthotic manufacturing laboratory." We have no idea what type of device was dispensed. The tragedy of this study is the exceptional effort made to structure a valid controlled trial, flawed by using a non-standardized casting method and unknown fabrication process.

Hopefully, we have reached a collective professional opinion accepting that much of the foot pathology seen in adults has a mechanical origin and these dysfunctions must have been present in childhood. The question we have yet to address, by clinical investigation, is whether early and specific interventions with orthoses alter the midlife outcome of pathology and reduce the severity of foot symptoms.

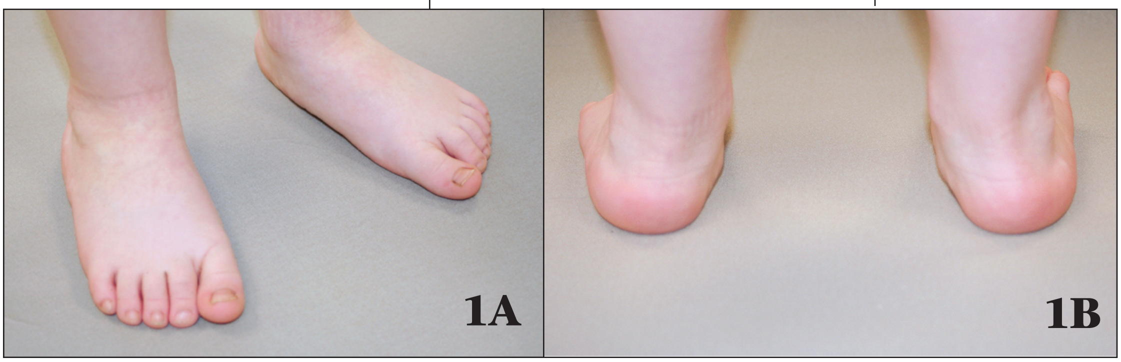

Figure 1A and 1B: Most experts agree that it's quite normal for a child to have a rather flat arch and an everted calcaneus until the age of seven years.

The two diverse articles regarding the effectiveness of orthotic therapy in pediatric flatfoot are only a small sampling of the discussion. Several other articles successfully debate the values and benefits of treatment.[2-4] There is an abundance of literature that recommends treatment for pediatric flatfoot that is symptomatic.[4-8] The objective of this discussion will be to describe the materials and design that would be most effective for the specific individual with flatfoot of specific pathologic origin.

Figure 2: Most of the literature recommends that a custom pediatric flatfoot orthosis must have at least the following characteristics: A. Wide enough at the distal edge to be stable on the frontal plane; B. Deep heel cup of 18 mm. or greater; C. A medial skive that transfers ground reactive forces to the medial side of the rearfoot; D. An elongated rearfoot post for stability.

Although most children are born with a flatter foot than will develop by adulthood, common professional thought is that the human foot should evolve an arch and vertical calcaneus by at least the age of seven years (Figures 1 A,

Continued on page 131

B).[9]

No investigation can be found that documents what ontogenic process occurs to allow the foot to become more stable in some children and to remain flexible in others. The author suspects that the progressive rigidity of the midtarsal joint between the ages of nine and twenty-four months may play a major role. Perhaps the function of orthoses is to assist in the rigidity by bracing the midtarsal joint and changing the apparent morphology while reducing symptoms and future subsequent deformity.

Figure 3: "Kiddythotics" are devices (left) that have many of the recommended characteristics of custom orthoses (right) but are pre-fabricated.

Although two studies estimate the incidence of moderate to severe pediatric flatfoot in the human population at 18% of the general population, neither study attributes this incidence to the particular size or weight of the children.[10,11] Several other studies looked at these parameters. A 1999 study evaluated over one thousand children four to 13 years old by foot print analysis and documented a flatfoot prevalence of 2.7%. Only 28% of these children were given treatment and the study noted that an abnormally high percentage of the children were overweight.[12]

The United States, as well as some other countries, has been addressing the epidemic of overweight children.

A 2006 study evaluated over eight hundred three to six-year-old children with 3D laser surface scanners and compared the heel-to-ground position and the height of the medial arch. Prevalence was 54% at age three and 24% at age six, and again, an increase of flatfoot was found in overweight children.[13]

A 2001 study used photo-podoscope of 243 children eight to 10 years old and found a prevalence rate of flatfoot of 16% for the entire group but 24% prevalence for the overweight children.[14] These studies point a suspicious finger at obesity as a contributing factor to flatfoot.

Two other research groups tried to evaluate if overweight children with high BMI had different function of their feet or just lower and fatter arches. The controlled study determined that the children who were overweight had lower arches but also had much higher forefoot pressures.[15,16]

Ultrasound Measurements

Ultrasound measurements were made in still another study of the actual structures that make up the longitudinal arch and compared this information with pedobarographs of the children to determine if the foot just looked flatter in obese/overweight children or were actually structurally different. The results that compared overweight to normal weight children showed that there was no difference in fat pad thickness but the obese children did actually have a lower arch.[17]

The United States, as well as some other countries, has been addressing the epidemic of overweight children. We now know that this problem has a dramatic effect on the increase in diabetes and heart disease but also on poor foot structure. A 2001 study on this topic unequivocally demonstrated, after testing 377 children between two and six years old, that flatfooted children performed physical tasks poorly and walked more slowly.[18] This implies that the increased pressure, function and structural difference may lead to decreased activity and pathological function carried into adulthood. We are growing a new generation with a propensity for increased foot problems.

It is known that the prevalence of pediatric flexible flatfoot has been shown to significantly correlate with a definite decrease in stride length, cadence and velocity.[18] It is also known that when functional orthotics are given to children with Down's Syndrome, a population with 83% incidence of flexible flatfoot, the ankle movement, walking speed, heel eversion and stride length improved.[19]

Several studies have documented that, in the presence of symptomatic pediatric flexible flatfoot, an almost rigid polypropylene orthosis with a deep heel cup relieved pain and improved gait.[20,21] The specifics of exactly why they work, from a biomechanical prospective, is unknown. During the development of orthoses in the

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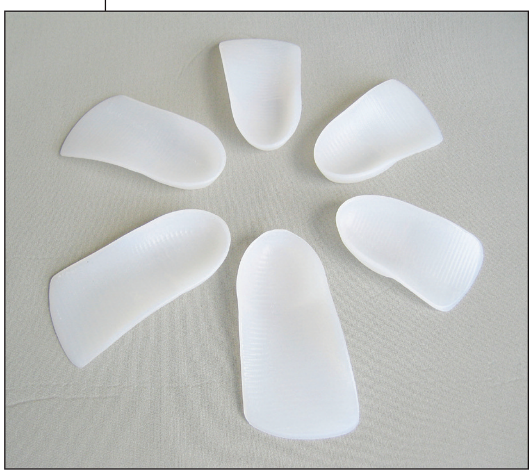

Figure 4: Pre-fabricated "kiddythotics" are produced in sizes that fit children to age seven or eight. Sizer sets are used to find the select length, width and calcaneal correction.

Flatfoot...

mid-twentieth century, the Shaffer Plate and Whitman Roberts Plate[9] were designed to change the morphology of the pediatric foot by raising the arch. Today, the theory of a displaced subtalar joint axis explains why the foot flattens and provides a more sophisticated approach to orthoses designs.[22] This concept requires that the orthoses be constructed to increase ground reactive force on the medial side of the subtalar joint axis, not just raise the arch. The orthosis must create a counterbalance that produces a greater equilibrium across the joint axis.

Orthotic therapy for pediatric flatfoot should address this concept if it is to change both the morphology and function of the foot.

Orthotic Criteria

The orthotic therapy specific to pediatric flexible flatfoot must meet the following criteria (Figure 2):

- It must be of sufficient rigidity to transfer corrective ground reactive forces to the foot and have a realignment effect on the subtalar and midtarsal joint;
- It must be wide enough to exert forces to the medial column of the foot;
- It must not interfere with the ability of the first ray to plantarflex at midstance;
- It should be made from an impression cast of the foot that avoids the pronated position or one that allows the forefoot to invert on the rearfoot;
- It should transfer greater ground reactive forces to the medial side of the rearfoot;
- It should be structured to be stable in the frontal plane when in the shoe;
- It should have a sufficiently deep heel cup that increases calcaneal contact to influence the position of the heel-to-ground position.

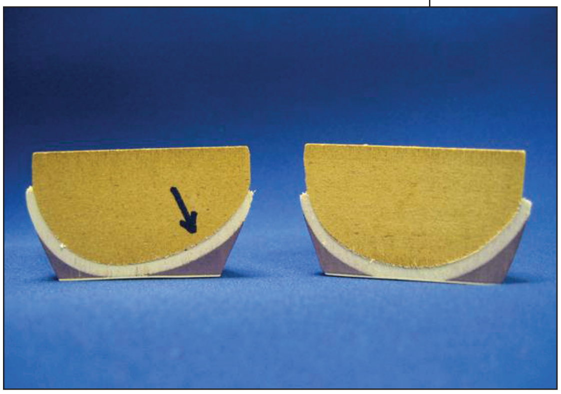

Figure 5: The medial skive technique is a cast modification that raises the medial side of the heel cup (left image) to increase ground reactive force on the medial side of the calcaneus.

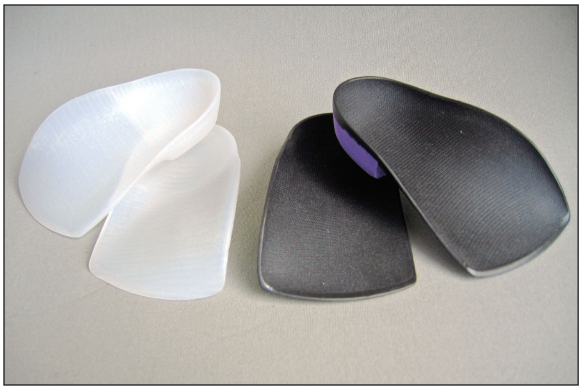

Figure 6: Custom polypropylene functional orthoses are produced either by the milling process (left) or vacuum-forming process (right). Milled is more rigid and thinner than vacuumed-formed.

Figure 7: A well cast and fabricated custom orthosis will decrease the calcaneal eversion and off-weight the medial forefoot.

Polypropylene Prefabricated Devices

The polypropylene pre-fabricated pediatric device is another alternative that meets most of the above criteria, but is not required to be constructed from a cast or impression of the child's foot. Although the result of using a pre-fabricated pediatric device, commonly referred to as a "kiddythotic," is not always favorable, the over-the-counter device may function well enough to postpone casting for a custom device (Figure 3).[9]

> ***Polypropylene is most appropriate for the shell of pediatric flatfoot orthoses.***

These pre-fabricated kiddythotics are available in a variety of materials, designs and sizes. In order to meet the optimal orthotic standards outlined, the device should be made from rigid polypropylene and not a material that is flexible or affected by body temperature. The device should have a deep heel cup, sufficient medial flange, and a rearfoot post for stability. The addition of a 6 mm. medial skive correction in the heel is a distinct advantage (Figure 5).

Customarily, suppliers of this type of pre-fabricated device provide a sizer set that can be used to stand the patient upon to determine length, width and calcaneal correction. When the appropriate size is identified, the correct device can be dispensed. The depth of the heel cup must consistently increase with the next larger size (Figure 4).

Custom pediatric orthoses obviously meet all the optimal standards. Additions are added to the prescription specific to the degree of deformity.

The specific origins of the pathology, especially in the case of juvenile arthritis, genetic anomalies and neurological influences can be accounted for in the custom device.

Polypropylene is most appropriate for the shell of pediatric flat-

Continued on page 133

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foot orthoses. This material is the standard of the UCBL device. (UCBL/ Root photo) Polypropylene that is 1/8″ or 3 mm is sufficient in strength and rigidity to control and endure most children up to 50 lbs. (22.7 kg). Beyond this weight, 4mm or 5/32″ poly is necessary through 90 lbs. (40.9 kg). Milled polypropylene, rather than vacuum-formed, is more desirable because a thinner milled poly is more rigid than the same thickness vacuum-formed poly. Also, the milling process produces a spine on the plantar aspect of the device providing a more rigid and durable device (Figure 6).

The Blake technique of inversion of the positive cast has been reported as helpful in controlling the extremes of hypermobility in severe pathology.

Accuracy of the Negative Cast

Careful attention to the accuracy of the negative cast is essential for pediatric patients. Foam impression casting results in a custom orthotic device that usually maintains the foot in its deformed position without altering morphology, let alone function. Negative suspension casting is most desirable, although not the easiest task, considering the cooperation of a three-year to six-year-old child. This alone often makes the pre-fabricated kiddythotic more popular for children and possibly more effective than a custom device from a crush foam impression or a poor quality negative suspension cast.

The objective for negative casting is to place the child's foot in a more aligned position than it adapts to when weight-bearing. Care must be taken to assure that the child has not dorsi-flexed the first ray by contracting the tibialis anterior muscle. Counter pressure by dorsi-flexing the hallux while the plaster sets usually avoids this problem. Care must also be taken to dorsi-flex the forefoot on the rearfoot sufficiently to bring the midtarsal joint to the end of its range of motion, a position that assures a less flexible foot during midstance when the child wears the device.

Prescription Essentials

The prescription essentials for the device should include a deep heel cup of no less than 10 mm. for three-year-olds and no less than 18 mm. for six-year-olds. The anterior edge width should always be wide. This means that the anterior medial edge of the device should extend to the medial edge of the medial sesamoid (Figure 7).

A medial flange must be included to expand the surface area under the midfoot and arch. The cast fill or arch fill part of the prescription must be "minimum", which is a standard of the Root technique[23] or the UCBL technique.[8] This allows the resulting device to closely resemble the plantar shape of the non-weight-bearing foot in an effort to allow the orthoses to manipulate the foot into a similar position when weight-bearing (Figure 8).

The cast work correction should include the medial skive technique.[21] The severity of this technique, 2 mm. to 8 mm., must correspond to the severity of calcaneal eversion. The greater the eversion, the greater the skive. Children seem to tolerate the 8mm skive with no adverse reaction, provided that the heel cup depth is adequate and artfully sculptured.

Blake Technique

The Blake technique of inversion of the positive cast has been reported as helpful in controlling the extremes of hypermobility in severe pathology.[9] This is an aggressive correction that was devised for athletes who often exhibit a greater degree of pronation, but may have an application in treating hypermobile pediatric flatfoot.[9]

The standard amount of inversion for this technique is twenty-five degrees, which alters the arch and inverts the heel cup of the resulting device. Caution should be used if both the Blake inverted and medial skive technique are used in the same device. This technique shifts the foot dynamics and may decelerate pronation. If both techniques are used in the same orthotic, it will cause the orthotic to shift in the shoe and become ineffective.

Flat and large rearfoot posts are essential in treating pediatric flatfoot. A recent study demonstrated that the rearfoot post not only stabilizes the orthoses in the shoe by increasing the contact surface area, but also increases rearfoot control when compared to the same functional device without a post.[24] An elongated post was more effective than the standard size post (Figure 9).

Topcovering a pediatric device is usually not necessary and sometimes counterproductive since the material usually deteriorates rapidly in active children. EVA seems to be the most durable. Occasionally the provider will use a shoe with a removable insole when pediatric flatfoot is associated with neurologic spasticity, ulcerations secondary to spina bifida, or children

Continued on page 134

Figure 8: The Root-type custom orthosis (left) and the UCBL orthosis (right) are both made from polypropylene. There is no research that yet demonstrates which is more effective. The UCBL has a deeper heel cup and more surface area as well as a medial and lateral flange.

Flatfoot...

with rheumatoid arthritis. These cases require a topcover to off-weight the hot spots, reduce friction, or provide a platform for additions such as metatarsal pads or bars.

Regardless of the controversy and debate of treating pediatric flexible flatfoot, there is ample evidence that treatment with functional orthoses reduces symptoms and improves mobility. Returning the foot to a more consistent morphology with custom orthoses does improve function and gait. Pre-fabricated poly kiddythotics may be an economic alternative or a preliminary treatment for relief of symptoms. Whether this effort of intervention ultimately reduces midlife deformity and symptoms will hopefully be demonstrated in future long-term clinical trials that produce pediatric development registries. ■

Pre-fabricated poly kiddythotics may be an economic alternative or a preliminary treatment for relief ofsymptoms.

Figure 9: A recent study demonstrated that an elongated rearfoot post (left) was more effective than the standard length (right) and the standard was more effective than no post.

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EXAMINATION

See answer sheet on page 137.

1) Which of the following is true about custom functional orthoses for pediatric flatfoot according to the medical literature?:
A) Orthoses can actually create a permanent change in osseous structure of the growing child.
B) There is no evidence to justify the use of custom orthoses in the management of pediatric flatfoot.
C) Both answers A & B are true.
D) Neither answers A & B are true.

2) Most children are born with a flat-looking foot and an everted calcaneus. The arch should begin to develop and the calcaneus should become vertical by the age of:
A) One to two years.
B) Two to four years.
C) Four to five years.
D) Six to seven years+.

3) The pediatric flatfoot occurs in what percentage of the human population, according to two recent studies?:
A) Less than 1%
B) 1% to 3%
C) 6% to 9%
D) 18%

4) In a recent study, when custom orthoses were given to children with Down's Syndrome who had pediatric flatfoot, which of the following occurred?:
A) The walking speed decreased.
B) The walking speed increased.
C) Stride length increased.
D) Both answers B and C.

5) According to a paper in the medical literature, the biomechanics behind pediatric flatfoot can be explained by which of the following?:
A) The first ray becomes hypermobile.
B) The midtarsal joint becomes rigid.
C) The subtalar joint axis becomes displaced.
D) None of the above.

6) Which of the following is NOT a characteristic of an orthosis for pediatric flexible flatfoot?:
A) It should cushion the foot under the arch.
B) It should have a deep heel cup.
C) It should transfer ground reactive force to the medial side of the foot.
D) It should be rigid.

7) The medial skive technique is designed to do which of the following to an orthosis?:
A) Increase ground reactive force laterally to the rear foot.
B) Increase ground reactive force medially to the rear foot.
C) Increase the strength of the Achilles tendon.
D) Decrease the strength of the Achilles tendon.

8) Which of the following orthotic manufacturing techniques would make an orthosis for pediatric flatfoot more rigid?:
A) Vacuum formed orthoses
B) Vacuum pressed orthoses
C) Milled orthoses
D) Foam box casting

9) When casting a child for a pediatric flatfoot orthosis, the first ray should be positioned in which of the following directions?:
A) Abducted
B) Inverted
C) Dorsi-flexed
D) Plantar-flexed

10) A medial flange on a pediatric flatfoot orthosis is desirable because of which of the following reasons?:
A) It is more comfortable.
B) It increases the surface area of the orthoses.
C) It inverts the orthoses.
D) It fits in the shoe better.

11) Minimum fill cast correction technique is used in pediatric flatfoot orthoses because of which of the following?:
A) It makes the shoe fit easier.
B) It is less painful to the child.
C) It mimics the Shaffer plate.
D) It provides better control of the orthoses.

12) The UCBL device was designed to treat which of the following conditions?:
A) Pediatric plantar fasciitis
B) Pediatric antetorsion
C) Pediatric Flatfoot
D) Knock-knee deformity

13) A rearfoot post on orthoses used for pediatric flatfoot is intended to accomplish which of the following?:
A) Stabilize the orthoses in the shoes.
B) Compensate for equinus deformity.
C) Invert the orthoses.
D) Bring the calcaneus more perpendicular.

14) Research has demonstrated that a rearfoot post works better when which of the following characteristics occur?:
A) The post is varus.
B) The post is shorter.
C) The post is longer.
D) The post is soft.

Continued on page 136

Continuing Medical Education

EXAMINATION

(cont'd)

15) Which of the following topcovers are the most durable when used to modify a pediatric flatfoot orthosis?:
A) EVA
B) Plastazote
C) Poron
D) Aluminum foil

16) Topcovers are essential when treating children who have pediatric flatfoot in combination with and which of the following?:
A) Spina Bifida
B) Cerebral Palsy
C) Muscular Dystrophy
D) All of the above

17) A 6 mm. medial skive technique would be used for a child with which of the following heel positions after age seven years?:
A) Vertical heel
B) 6 degrees inverted
C) 8 degrees inverted
D) 2 degrees inverted

18) Which of the following would be an appropriate heel cup depth for an orthosis used to treat a child with hypermobile flatfoot?:
A) 5 mm.
B) 10 mm.
C) 18 mm.
D) No heel cup

19) Several authors have suggested that a prefabricated "Kiddythotic" may be the most efficient and effective way to treat pediatric flatfoot at which age?:
A) Below three years of age
B) Over seven years of age
C) Only over 10 years of age
D) Should never be used

20) Which of the following pediatric pathologies are not appropriate to treat with orthoses and should not be attempted under any circumstances?:
A) Hypermobile flatfoot
B) Downs Syndrome flatfoot
C) Cerebral Palsy flatfoot
D) Congenital vertical talus

See answer sheet on page 137.

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(1) Each participant achieving a passing grade of 70% or higher on any examination will receive an official computer form stating the number of CE credits earned. This form should be safeguarded and may be used as documentation of credits earned.

(2) Participants receiving a failing grade on any exam will be notified and permitted to take one re-examination at no extra cost.

(3) All answers should be recorded on the answer form below. For each question, decide which choice is the best answer, and circle the letter representing your choice.

(4) Complete all other information on the front and back of this page.

(5) Choose one out of the 3 options for testgrading: mail-in, fax, or phone. To select the type of service that best suits your needs, please read the following section, "Test Grading Options".

TEST GRADING OPTIONS

Mail-In Grading

To receive your CME certificate, complete all information and mail with your credit card information to:

Podiatry Management
P.O. Box 490, East Islip, NY 11730

There is **no charge** for the mail-in service if you have already enrolled in the annual exam CPME program, and we receive this exam during your current enrollment period. If you are not enrolled, please send $20.00 per exam, or $139 to cover all 10 exams (thus saving $61* over the cost of 10 individual exam fees).

Facsimile Grading

To receive your CPME certificate, complete all information and fax 24 hours a day to 1-631-563-1907. Your CPME certificate will be dated and mailed within 48 hours. This service is available for $2.50 per exam if you are currently enrolled in the annual 10-exam CPME program (and this exam falls within your enrollment period), and can be charged to your Visa, MasterCard, or American Express.

If you are *not* enrolled in the annual 10-exam CPME program, the fee is $20 per exam.

Phone-In Grading

You may also complete your exam by using the toll-free service. Call 1-800-232-4422 from 10 a.m. to 5 p.m. EST, Monday through Friday. Your CPME certificate will be dated the same day you call and mailed within 48 hours. There is a $2.50 charge for this service if you are currently enrolled in the annual 10-exam CPME program (and this exam falls within your enrollment period), and this fee can be charged to your Visa, Mastercard, American Express, or Discover. If you are not currently enrolled, the fee is $20 per exam. When you call, please have ready:

1. Program number (Month and Year)
2. The answers to the test
3. Your social security number
4. Credit card information

In the event you require additional CPME information, please contact PMS, Inc., at **1-631-563-1604**.

ENROLLMENT FORM & ANSWER SHEET

Please print clearly...Certificate will be issued from information below.

Name ____ Soc. Sec. #______________________
Please Print: FIRST MI LAST

Address____

City_______________________________ State______________ Zip____________________

Charge to: _____Visa _____ MasterCard _____ American Express

Card #________________________________ Exp. Date_______________

Note: Credit card is the only method of payment. Checks are no longer accepted.

Signature______________________ Soc. Sec.#________________ Daytime Phone__________________

State License(s)___________________ Is this a new address? Yes_______ No_______

Check one: ______ I am currently enrolled. (If faxing or phoning in your answer form please note that $2.50 will be charged to your credit card.)

______ I am not enrolled. Enclosed is my credit card information. Please charge my credit card $20.00 for each exam submitted. (plus $2.50 for each exam if submitting by fax or phone).

______ I am not enrolled and I wish to enroll for 10 courses at $139.00 (thus saving me $61 over the cost of 10 individual exam fees). I understand there will be an additional fee of $2.50 for any exam I wish to submit via fax or phone.

Over, please

Continuing Medical Education

ENROLLMENT FORM & ANSWER SHEET (cont'd)

EXAM #7/08
Treatment of Pediatric Flexible Flatfoot with Functional Orthoses (Scherer)

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

LESSON EVALUATION

Please indicate the date you completed this exam

____

How much time did it take you to complete the lesson?

______ hours ______minutes

How well did this lesson achieve its educational objectives?

_______Very well _________Well

________Somewhat __________Not at all

What overall grade would you assign this lesson?

A B C D

Degree____________________________

Additional comments and suggestions for future exams:

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