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The Medial Heel Skive Technique

Improving Pronation Control in Foot Orthoses

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A new method of foot orthosis modification that enhances the pronation controlling ability of foot orthoses is presented. The medial heel skive technique involves selectively removing small amounts of the medial portion of the plantar heel of the positive cast of the foot to create a unique varus wedging effect within the heel cup of the foot orthosis. The resulting increase in supination moment across the subtalar joint axis of the foot clinically produces significantly improved pronation control on pediatric flexible flat feet, posterior tibial dysfunction, and other types of excessively pronated feet.

Foot orthoses are the preferred method of treatment of a majority of biomechanically induced pathologies in the feet and lower extremities. During the course of the last century, foot orthoses have been used in the treatment of common foot ailments. There have been a multitude of modifications made in their design, materials, and construction techniques.

For example, in 1913, Whitman,[1] an orthopedic surgeon, described the use of a metal foot brace, which had medial and lateral flanges, that was designed to rock into an inverted position once the patient stepped down on it. The inversion motion of the plate increased the pronation control ability of the Whitman brace not only by inverting the heel of the device but also by increasing the pressure of the medial flange on the navicular area of the foot. (The term "pronation control" is meant to indicate that the orthotic device does not have absolute control over the foot's motion, but simply indicates that abnormal motion is being reduced.)

At about the same time as Whitman, Roberts developed a metal brace that was smaller than the Whitman brace but had medial and lateral heel clips and a deep inverted heel cup to help invert the heel of the foot.[2] In the 1920s, Schuster, a podiatrist, combined the ideas of the Whitman brace and the Roberts brace to make the Roberts-Whitman brace, which had the deep inverted heel cup of the Roberts brace and the broader dimensions of the Whitman brace.[2]

Current foot orthosis types used within the podiatric and orthopedic communities to enhance the subtalar joint pronation control features of the device include the Blake inverted orthosis, the University of California Biomechanics Laboratory orthosis, and the Root functional orthosis.[3-6] Modifications to the Root functional orthoses commonly used by podiatrists to enhance the subtalar joint pronation control features of the device include the following: using stiffer orthosis plate materials; increasing the medial longitudinal arch height of the orthosis; using medial and lateral flanges; using deeper heel cups; using longer rearfoot posts; using medial flares on rearfoot posts, inverting the orthosis to the ground, and using forefoot extensions.[3]

Foot Orthoses Influence on Subtalar Joint Pronation

In order to reduce the pronated position of the subtalar joint during weightbearing, the foot orthosis must be designed to increase the supination moment, ie, supination torque, across the subtalar joint

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axis of the foot. In order for a foot orthosis to accomplish the goal of increasing supination moment across the subtalar joint axis of the foot, it must cause either a decrease in the pronation moment or an increase in the supination moment across the subtalar joint axis during weightbearing activities.[7,8]

By convention, force exerted by the ground on the plantar structures of the foot is called ground reactive force. Because ground reactive force is always directed, during standing, vertically upward on the plantar aspect of the foot, any ground reactive force that acts medial to the subtalar joint axis causes supination moment and any ground reactive force that acts lateral to the subtalar joint axis causes pronation moment across the subtalar joint axis (Fig. 1). In addition, since the moment of force across a joint axis is the mathematical product of the magnitude of the force and the perpendicular distance from the point of application of the force to the joint axis, forces with larger magnitudes and also forces that act further away from the joint axis will produce the greatest amount of moment across the joint axis.[7-10]

Since the orthosis plate itself must exert forces directly on the plantar surface of the foot, the author suggests that any forces acting at the orthosis-foot interface be called an orthosis reactive force.[8] Force exerted by the ground on the foot is ground reactive force and force exerted by the orthosis on the foot is orthosis reactive force (Fig. 2). Just like ground reactive force, any orthosis reactive force that is located medial to the subtalar joint axis will result in supination moment and any orthosis reactive force located lateral to the subtalar joint axis will result in pronation moment.

During barefoot standing, the majority of moment that is produced across the subtalar joint axis is caused by the effects of ground reactive force acting on the plantar structures of the foot. During normal barefoot standing, ground reactive force produces both pronation moments and supination moments across the subtalar joint axis.[7-10] In a foot that is maximally pronated at the subtalar joint during standing, for example, the summation of the pronation and supination moments acting across the subtalar joint axis caused by ground reactive force effects would, in nearly all cases, be a pronation moment.[7] In other words, since there is a net pronation moment, the center of ground reactive force in most maximally pronated feet is lateral to the subtalar joint axis.

When this same foot, which is maximally pronated, is standing on an orthosis that is properly designed to control pronation, orthosis reactive force will be exerted on the plantar surface of the foot in areas medial to the subtalar joint axis, such as in the medial aspect of the plantar heel or in the medial longitudinal arch of the foot (Fig. 2). The more medially located orthosis reactive force in the medial plantar heel and medial longitudinal arch of the foot shifts the weight borne by the foot from lateral to medial to the subtalar joint axis.[8] This shifting in reactive forces from lateral to medial on the plantar surface of the foot causes a net increase in supination moment acting across the subtalar joint axis and, in effect, decreases the total pronation moment acting across the subtalar joint axis.

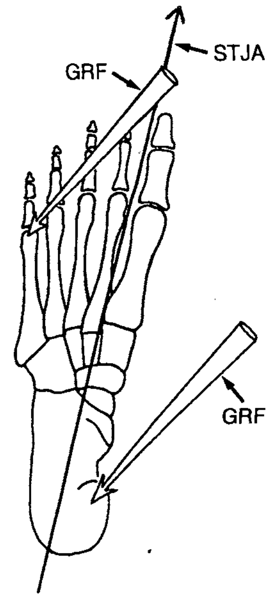

Figure 1. Ground reactive force (GRF) on the medial calcaneal tubercle causes a supination moment across the subtalar joint axis (STJA) since the force acts medial to the subtalar joint axis. Ground reactive force on the metatarsal heads lateral to the subtalar joint axis causes a pronation moment across the subtalar joint axis (redrawn from Kirby KA: Methods for determination of positional variations in the subtalar joint axis. JAPMA **77:** 117, 1987).

In order for any foot orthosis modification to successfully lead to better control of pronation of the subtalar joint in the foot, the following criteria must be met: 1) The foot orthosis modification must result in an overall net increase in supination moment across the subtalar joint axis; 2) the foot orthosis modification must be relatively comfortable and not cause other significant symptoms of pathology to occur; and 3) the foot orthosis modification must be able to fit into available shoes that will not detract from the overall pronation control features of the orthosis.

Over the last 7 years, the author has been analyzing and recording the actual subtalar joint axis location in relation to the plantar surfaces of the foot.[9] It has become apparent during this time that the feet that have the most flattened medial longitudinal arches, most everted calcanei, and most convex shape to the medial midtarsal joint area also have subtalar joint axes. These axes are the most medially positioned or are the most internally rotated in relation to the plantar structures of the foot (Fig. 3). Feet that have this abnormally medial subtalar joint axis location are classified as having medially deviated subtalar joint axes.[7–9]

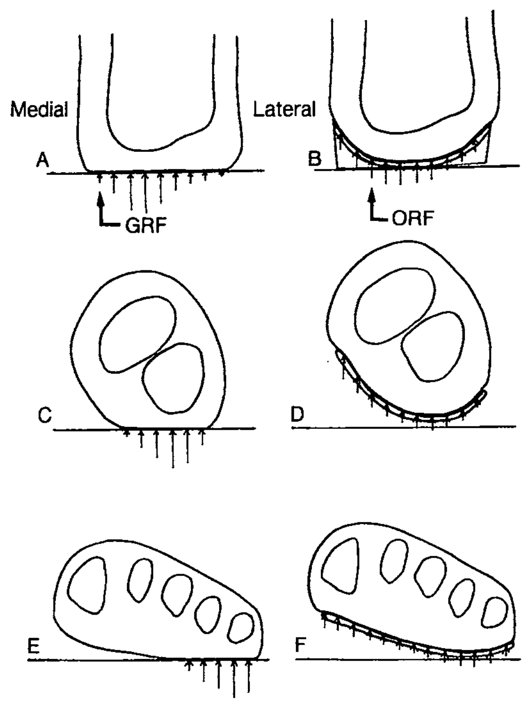

Figure 2. The force the ground exerts against a bare foot is the ground reactive force (GRF) (A, C, and E); the force that a foot orthosis exerts against a foot is the orthosis reactive force (ORF) (B, D, and F). A, At the level of the medial tubercle of the calcaneus, the ground reactive force is distributed primarily under the medial tubercle. B, When an orthosis acts on the heel, the orthosis reactive force is distributed more evenly from the medial to lateral heel. C, At the level of the distal talus and distal calcaneus (ie, the midtarsal joint), the ground reactive force is distributed primarily under the calcaneocuboid joint. D, When an orthosis acts on the midtarsal joint, the orthosis reactive force is lessened under the calcaneocuboid joint and widely increased under the talar head and navicular. E, At the level of the midshafts of the metatarsals, the ground reactive force is distributed primarily under the fourth and fifth metatarsal bases. F, When an orthosis acts at the midshafts of the metatarsals, the orthosis reactive force is decreased under the fourth and fifth metatarsals and increased under the first, second, and third metatarsals. It is this conversion of a laterally positioned ground reactive force to a more medially positioned orthosis reactive force that allows a foot orthosis to exert a supination moment across the subtalar joint axis and resist subtalar joint pronation (from Kirby K, Green D: "Evaluation and Nonoperative Management of Pes Valgus," in *Foot and Ankle Disorders in Children*, ed by S DeValentine, Churchill Livingstone, New York, 1992. Reprinted with permission).

Since the subtalar joint axis passes through the talar head and the talar head is abnormally medially positioned and internally rotated in relation to the calcaneus in these excessively pronated feet, it seems reasonable to assume that the further the talar head is internally rotated off the calcaneus, the more medially deviated the subtalar joint axis will be. The more medially deviated the subtalar joint axis, the greater the magnitude of pronation moment will be acting upon that foot during weightbearing activities.[7–9]

As mentioned previously, a foot orthosis can only exert supination moment across the subtalar joint axis by exerting orthosis reactive force medial to the subtalar joint axis on the plantar surface of the foot. However, in feet that have medially deviated subtalar joint axes, the actual amount of surface area on the plantar aspect of the foot that is medial to the subtalar joint axis is greatly decreased. The surface area on the plantar aspect of the foot that is lateral to the subtalar joint axis is greatly increased (Fig. 4). When the subtalar joint

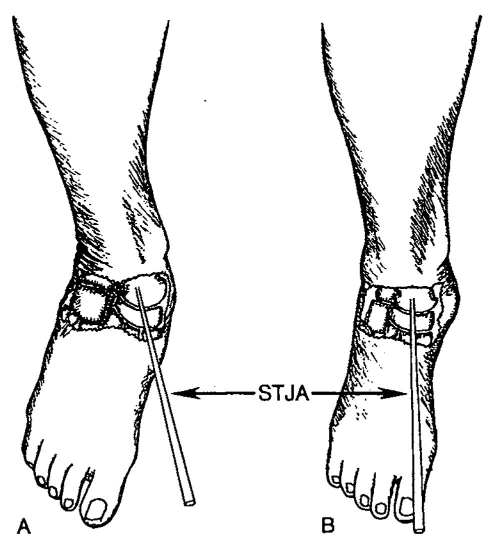

Figure 3. Feet with a medially deviated subtalar joint axis (STJA) have the talar head relatively internally rotated and medially positioned in relation to the foot (A). The abnormal clinical appearance of this foot is readily apparent when compared to feet with normal subtalar joint axis location (B), which have the talar head more directly superior to the calcaneus and the rest of the foot.

axis is medially deviated, any force acting on the medial aspect of the plantar heel or arch area of the foot will have a decreased moment arm and, thus, will produce less supination moment than it would acting on a foot with a normal subtalar joint axis location.[8]

For example, imagine a force, Z, acting directly vertically upward on a standing foot that has a magnitude of 120 N, ie, about 27 pounds, and that acts on a specific area of the medial aspect of the plantar calcaneus, point C (Fig. 5). In a foot that has a normal subtalar joint axis location, point C is located exactly 10 mm medial to the subtalar joint axis. Using the equation moment = force × moment arm, the supination moment produced by Z acting on point C is (120 N) (0.01 m) = 1.2 Nm. Newton-meters is the standard measurement of moment or torque in biomechanics.

Now, let's imagine that same force, Z, acting on a foot that has a medially deviated subtalar joint axis.

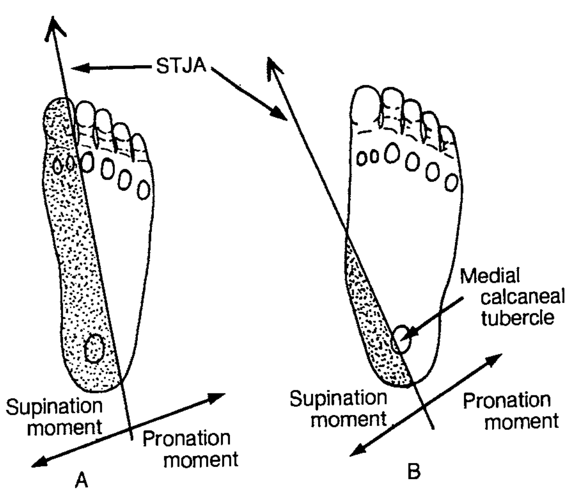

Figure 4. A, The subtalar joint axis (STJA) in a normal foot passes from the posterolateral heel to the first intermetatarsal space. B, In a foot with a medially deviated subtalar joint, the axis passes well medial to the metatarsal heads. Any ground reactive force or orthosis reactive force acting medial to the subtalar joint axis will exert a supination moment across the axis, and any ground reactive force or orthosis reactive force acting lateral to the subtalar joint axis will exert a pronation moment across the axis. A normal foot has much more area available on the plantar surface of the foot for a foot orthosis to exert orthosis reactive force medial to the subtalar joint axis than does a foot with a medially deviated axis. This is one of the main reasons why foot orthoses are more effective at producing subtalar joint supination in a normal foot than they are in a foot with a medially deviated subtalar joint axis (from Kirby K, Green D: "Evaluation and Nonoperative Management of Pes Valgus," in *Foot and Ankle Disorders in Children*, ed by S DeValentine, Churchill Livingstone, NY, 1992. Reprinted with permission).

In this case, the subtalar joint axis is deviated 9.0 mm more medially than in the first example. Even though point C on the plantar aspect of the calcaneus has not anatomically changed, the subtalar joint axis location in relation to point C has now become 9.0 mm more medial than normal. This change in subtalar joint axis position causes point C to now be located just 1.0 mm medial to the subtalar joint axis. The supination moment produced by Z acting on point C in this foot is (120 N) (0.001 m) = 0.12 Nm. Therefore, a 9.0-mm medial shift in the subtalar joint axis position results in force Z, producing only one tenth of the supination moment when it acts on point C in these two examples.

It was because of these and other simple biomechanical concepts that the experimentation with new orthosis design modifications was begun. The author's goal was to create an orthosis modification that would: 1) allow the least alteration of the positive cast of the foot in order for the orthosis to create the greatest increase in supination moment across the subtalar joint axis; 2) be relatively easy for a variety of orthosis laboratory technicians to reliably and consistently duplicate; 3) work exceptionally well in the difficult to control pediatric

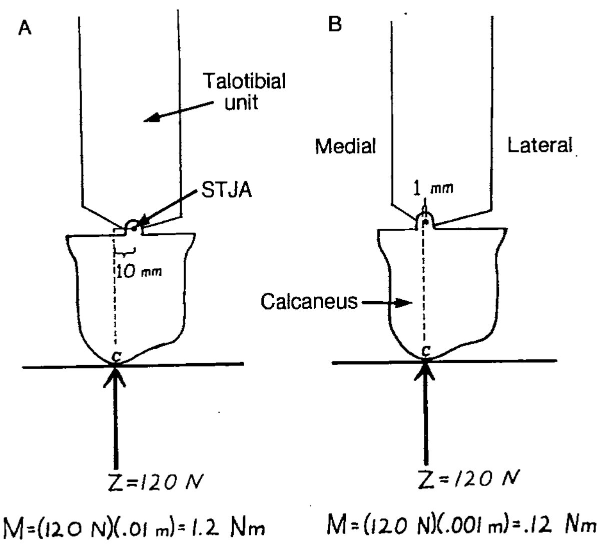

Figure 5. In this model of the posterior aspect of the right foot standing in relaxed calcaneal stance position, the subtalar joint axis (STJA) attaches the talotibial unit to the calcaneus. Point C is the point of application of force Z on the calcaneus. In a foot with a more normal subtalar joint axis location (A), force Z in this example is 10 mm medial to the subtalar joint axis, causing 1.2 Nm of supination moment across the axis. However, when the subtalar joint axis is positioned 9 mm more medial, as may be the case in a foot with a medially deviated subtalar joint axis (B), the supination moment across the axis is only 0.12 Nm, a 90% decrease in supination moment.

flexible flatfoot deformity; and 4) not cause other significant symptoms and pathology to occur.

Experimentation with different orthosis modifications led to the "medial heel skive technique," which, so far, has satisfied the above goals in the author's clinical practice for the past 2 years.

Medial Heel Skive Technique

The medial heel skive technique is a method of positive cast modification that results in a foot orthosis with a greatly enhanced potential to increase the supination moment across the subtalar joint axis and aid in the control of abnormal subtalar joint pronation during weightbearing activities. The medial heel skive technique can be thought of as a method that adds an increased amount of varus wedging to the heel cup area of the orthosis, reintroducing the varus heel cup ideas first described nearly 80 years ago by Whitman and Roberts.

The negative cast used in the medial heel skive technique is a neutral suspension plaster cast as described by Root et al.[11] Once the positive cast is prepared from the negative cast, the positive cast is laid flat on the working surface so that the plantar surface of the cast faces upwards. The plantar heel area is then divided into a medial third and a lateral two thirds and marked. For example, a 60-mm wide heel would be divided into a medial section 20 mm wide and a lateral section 40 mm wide with a mark 20 mm from the medial edge of the cast (Fig. 6). The measurements for the heel width are taken at the level of the plantar heel contact point of the cast, ie, where the heel of the cast would contact the working surface when placed plantar surface down. The mark at the medial third of the cast is used as the reference mark for determining the amount of plaster on the medial portion of the plantar heel, which will be skived, ie, filed, from the cast.

After the positive cast has been prepared with the prescribed anterior platform, medial expansion, and lateral expansion, the prescribed depth of the medial heel skive is next scored into the cast by sawing at the mark on the medial third of the plantar heel down to the desired depth (Fig. 7). A hacksaw blade, marked in 2-mm increments, is an effective tool with which to saw through the plantar heel of the cast to the prescribed depth.

Once the depth has been marked, a plaster file is used to file down through the plantar heel at a 15° varus angle until the marked depth has been reached at the medial third of the plantar heel (Fig. 8). Care must be taken so that the plaster file is angled within the frontal plane at a 15° varus plane in relationship to the plane of the plantar surface of the anterior platform of the positive cast. In addition, the plaster file should be angled within the sagittal plane so that it is parallel to the plantar aspect of the positive cast from anterior to posterior.

The filing or shaving of a 15° varus heel skive will leave a flat, elliptical plane on the medial portion of the plantar heel (Fig. 8). The deeper the heel skive, the larger the dimensions of the ellipse. The flatness of the skived portion is next rounded by carefully filing the outer margins of the flat ellipse so that it blends into the contours of the plantar heel medially, laterally, anteriorly, and posteriorly (Fig. 9).

A positive cast with a properly filed medial heel skive will have no areas of flatness or concavity on the plantar heel. Areas of flatness or concavity in the plantar heel of the cast can cause sources of ir-

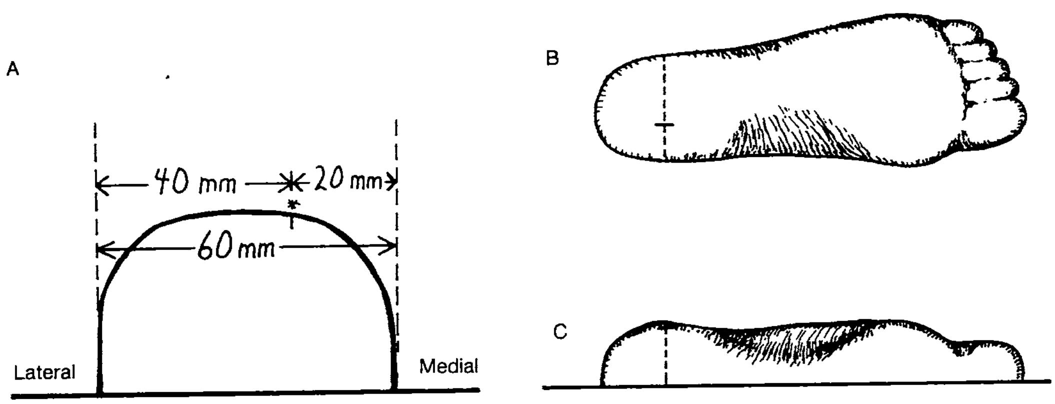

Figure 6. The first step in the preparation of the positive cast for the medial heel skive technique is the marking of the heel contact point of the case into a medial one third and a lateral two thirds. A, In a 60-mm wide heel, the heel should be marked 20 mm medial to the medial edge of the heel; B, a top view of the positive cast; and C, a medial side view of the cast. The dotted line represents the frontal plane section of the cast seen in A.

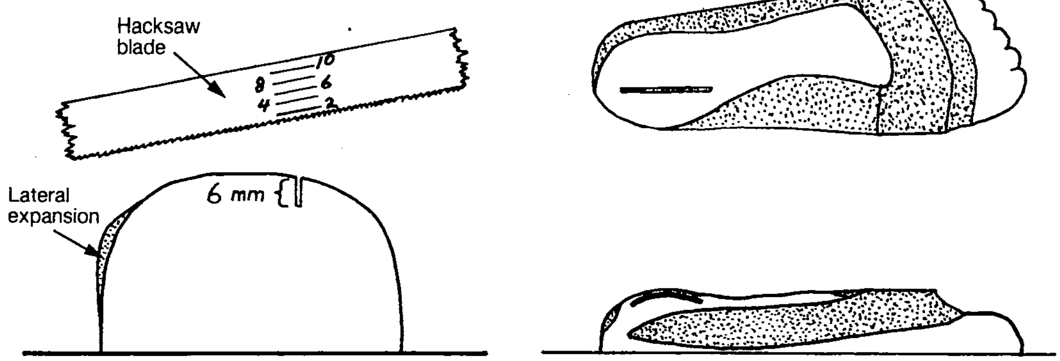

Figure 7. After the medial expansion, lateral expansion, and anterior platforms have been added to the positive cast, a hacksaw blade marked in 2-mm increments is used to saw through the mark on the medial one third of the plantar heel down to the prescribed depth (a depth of 6 mm in this example).

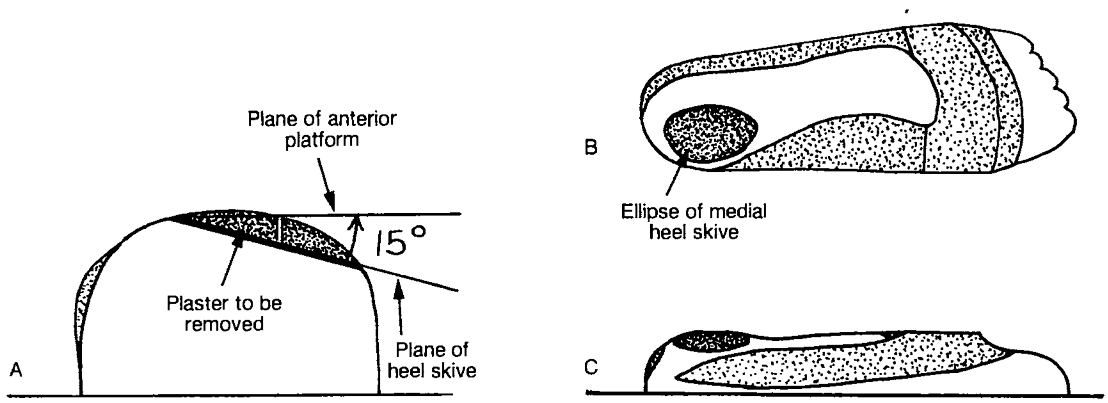

Figure 8. A, Using a plaster file, a 15° angle of skive of medial heel plaster is removed down to the prescribed depth of medial heel skive. The reference plane for the 15° frontal plane varus skive is the plane of the anterior platform of the positive cast. B and C, An elliptical area of skived plaster is left on the plantar heel of the positive cast.

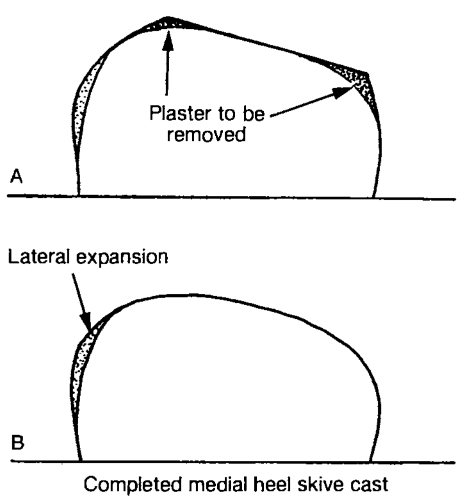

Figure 9. After the 15° skive has been removed from the plantar heel (A), the plaster file is then used to round the edges of the heel skive so that a smoothly rounded contour of the plantar heel is achieved (B).

ritation within the heel cup of the resultant orthosis (Fig. 10). A nicely smoothed and rounded contour to the plantar heel results in a much more comfortable orthosis for the patient and greatly decreases the risk of medial heel cup irritation from the orthosis.

Care must be taken in the filing of the plaster away from the plantar heel in the medial heel skive technique so that only minimal positive cast plaster is removed from the medial border of the plantar heel (Fig. 10). Removal of more than even 2 mm of plaster from the medial border of the heel of the cast can cause excessive narrowing of the heel cup area of the resultant orthosis. Excessive narrowing of the heel cup of the orthosis is a major cause of orthosis failure with the medial heel skive technique because of the intractable heel cup irritation it can cause. For this reason, the vast majority of the plaster filed away from the heel of the positive cast should be re-

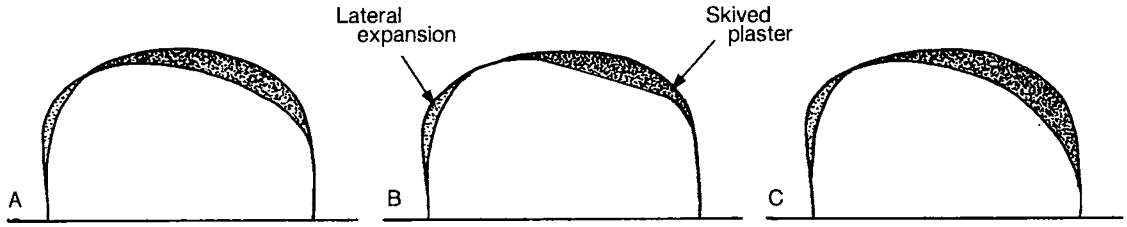

Figure 10. The medial heel skive technique must be performed accurately in order to achieve pronation control without heel irritation. A, A frontal plane section through the heel of the positive cast with a properly *filed medial* heel skive shows no flat areas and little plaster removed from the medial heel. B, Insuffficent rounding of the heel skive leaves a flat area on the positive cast which can cause heel irritation in the resulting orthosis. C, Excessive removal of plaster from the medial aspect of the heel of the cast narrows the heel, which also greatly increases the risk of heel irritation.

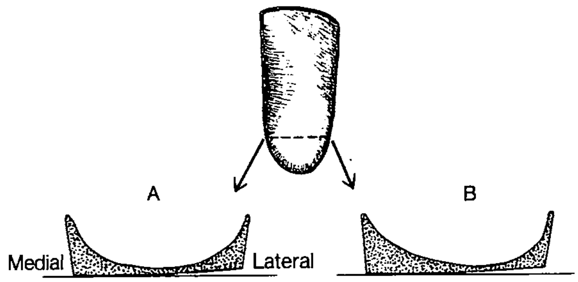

Figure 11. A, The frontal plane section through a typical functional foot orthosis heel cup shows a rounded contour from the lateral to the medial edge of the device. B, A foot orthosis made from a positive cast with a 6-mm medial heel skive technique shows increased varus wedging of the heel cup.

moved only from the plantar aspect of the heel, not from the medial border of the heel.

The foot orthosis made from a cast with a medial heel skive has an increased amount of varus sloping in the heel cup area. It is this increased "varus wedge effect" in the heel cup of the orthosis that helps control pronation (Fig. 11). The medial heel skive technique results in much greater magnitudes of orthosis reactive force on the more medial aspects of the plantar heel and much less magnitude of orthosis reactive force on the lateral aspects of the plantar heel than would occur in an unmodified foot orthosis. This net shifting of the center of orthosis reactive force medially in the heel cup area causes a large net increase in supination moment across the subtalar joint axis during weightbearing activities that effectively enhances the pronation controlling abilities of the orthosis. Figure 12 demonstrates the medial shifting of the center of orthosis reactive force that the medial skive technique offers over a more traditional vertically balanced functional foot orthosis.

Since the medial heel skive technique does cause more of a varus wedging inside the heel cup of the orthosis, there is a slight tendency in some

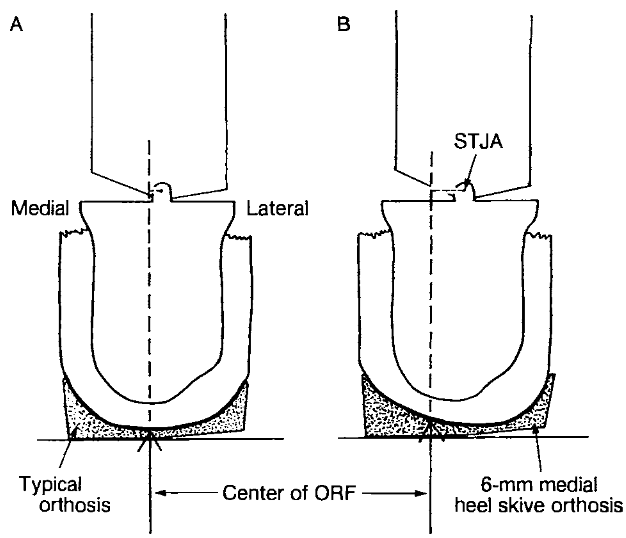

Figure 12. This figure demonstrates the biomechanical effects of a foot with a normal subtalar joint axis (STJA) location standing on two separate orthoses. A, The center of the orthosis reactive force (ORF) is positioned just slightly medial to the subtalar joint axis when the foot stands on a typical functional foot orthosis. B, However, when the foot stands on an orthosis with a medial heel skive, the orthosis reactive force on the lateral heel is decreased and the orthosis reactive force on the medial heel is increased, resulting in a shifting of the center of orthosis reactive force to a more medial location. In this example, the supination moment arm across the subtalar joint axis has increased by over twofold by the use of the medial heel skive orthosis.

patients for the heel of the foot to slide laterally inside the heel cup of the orthosis during weightbearing activities. This may lead to lateral heel cup edge irritation if the lateral heel cup height is not high enough. At least an 18-mm lateral heel cup height is recommended in the orthosis for this reason. It is also wise to choose at least an 18-mm medial heel cup height in the orthosis since this aids in preventing heel cup edge irritation.

Indications, Contraindications, and Prescribing Information

The medial heel skive technique is indicated in any patient who needs additional amounts of pronation control from an orthotic device. In the author's practice, the medial heel skive technique is used most frequently for the treatment of the following conditions: 1) pediatric flexible flatfoot deformity; 2) posterior tibial muscle dysfunction, eg, posterior tibial tear and posterior tibial stenosing tenosynovitis; and 3) any lower extremity pathology that is caused by excessive subtalar joint pronation but that does not completely respond to more conventional foot orthosis designs.

Contraindications to the medial heel skive technique would include any patient with plantar heel pain, ie, heel spur syndrome, plantar heel bursitis, and medial calcaneal neuritis, since the change in the heel cup contour of the orthosis may cause an increase in symptoms. In addition, the medial heel skive technique should not be used for patients who have complaints of lateral ankle instability, since it may cause an increased tendency toward inversion type ankle sprains.

The amount of medial heel skive that should be used for each patient is dependent on a number of factors: the degree of medial deviation of the subtalar joint axis; the type and severity of pronation-related symptoms that the patient is experiencing; and the relative thickness of the plantar heel fat pad in the foot. The greater the degree of medial deviation of the subtalar joint axis of the foot, the greater the magnitude of pronation moment acting across the subtalar joint axis during weightbearing activities. Larger amounts of subtalar joint pronation moment will, in turn, necessitate larger amounts of pronation control from the orthosis to relieve pronation-related symptoms. Greater thicknesses of heel fat pad allow the patient to tolerate increased amounts of medial heel skive in the orthosis. In general, greater amounts of medial heel skive should be used for patients who have more medial subtalar joint axis locations, more severe symptoms, and thicker plantar heel fat pads.

Medial heel skive amounts are ordered in millimeter increments. The greater the heel skive amount, the greater the varus wedging in the heel cup of the orthosis and the more forceful the supination moment exerted by the orthosis. A medial heel skive of 2 mm causes mild supination moment, 4 mm causes moderate supination moment, 6 mm causes moderately intense supination moment, and 8 mm causes intense supination moment to be exerted across the subtalar joint axis during weightbearing activities (Fig. 13).

The following are some guidelines for prescribing the medial heel skive technique. A 2-mm medial heel skive should be ordered when only a mild amount of extra pronation control is needed in an orthosis to totally relieve the patient's symptoms. The 2-mm size is also preferable if a patient has a relatively thin plantar heel fat pad to avoid medial plantar heel irritation from the orthosis.

A 4-mm medial heel skive should be used when a moderate amount of extra pronation control is needed in the orthosis and the patient has a good plantar fat pad thickness. Four mm is also sometimes used when a large amount of extra pronation control is needed in a patient who has a thin fat pad.

A 6-mm medial heel skive should be used when a large amount of extra pronation control is needed in the orthosis because either the pronation forces acting on the foot are severe or the symptoms are significantly disabling, eg, posterior tibial dysfunction. It should only be used for adults when they have normal fat pad thickness. Six mm is the standard amount of medial heel skive used for moderately severe pediatric flexible flatfoot deformities and is routinely tolerable because of the substantial layer of plantar heel fat pad that children possess.

Medial heel skives 8 mm in depth are usually reserved for children with normal heel fat pad thickness or adults with greater than normal fat pad thickness who also have markedly severe pronation-related symptoms or deformities. Increasing the medial heel skive to 8 mm or higher greatly decreases the chances that the orthosis will be tolerable to the patient but does add increased pronation control to the orthosis. The author has had success with orthoses that have medial heel skive amounts up to 10 mm in a few selected cases. However, it is not recommended that physicians use these large amounts of medial heel skive in their patients' orthoses unless they have extreme confidence in their negative casting technique, orthosis prescribing knowledge, and orthosis adjustment technique.

In this light, it must be emphasized that the prescribing physician and the orthosis laboratory that use the medial heel skive technique in their foot orthoses must accept full responsibility for any medial heel pain or inversion ankle sprains that result from the improper use of this technique. Patients who are dispensed orthoses with the medial heel skive technique should have more frequent follow-up visits to ensure proper orthosis function and tolerability.

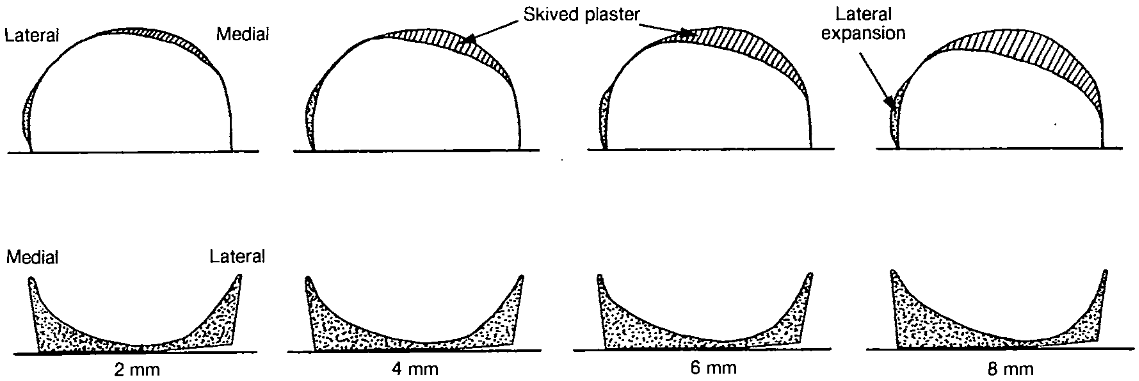

Figure 13. This figure demonstrates the different thicknesses of medial heel skive positive cast corrections with the resultant orthosis heel cup shape just below each. It is evident that the greater the thickness of medial heel skive on the positive cast, the greater the varus wedging within the heel cup of the resulting orthosis.

Even though in the author's clinical use of the medial heel skive technique no patients have suffered anything more than mild symptoms from its use, the potential remains for chronic medial heel pain, medial calcaneal neuritis, and severe inversion ankle sprains as a result of improper patient selection and from improper fabrication of the medial heel skive technique orthosis. One physical principle of foot orthosis therapy that is readily apparent in the use of the medial heel skive technique is that the harder the foot is pushed by the orthosis, the greater the potential mechanical control of the foot and the greater the chances of orthosis irritation to the foot.

Treatment of Pediatric Flexible Flatfoot

Many orthosis modifications have been used to treat pediatric flexible flatfoot deformity, including the University of California Biomechanics Laboratory and the Blake inverted orthoses. The author has had little experience with the University of California Biomechanics Laboratory orthosis but has had considerable experience in using the Blake inverted orthosis for pediatric flexible flatfoot deformity. Even though the Blake inverted orthosis seems to routinely produce increased pronation control on the adult foot when compared to a standard Root orthosis, the Blake orthosis often results in only mild increases in pronation control in many pediatric flatfoot patients.

In 8 years of experience with the Blake orthosis, the author has found it superior to the standard Root orthosis in the control of pronation in the pediatric flatfoot. However, trying to predict when the Blake orthosis would control pronation very well and when it would only control pronation to a slight degree was often difficult. The author's orthosis prescription for a moderately to severely pronated pediatric flatfoot is a 35° inverted Blake orthosis.

The reason that the Blake inverted orthosis often does not work as well in children as it does in adults is because of the shape of the plantar heel fat pad in children. Young children have rounded plantar heels, ie, their plantar heels are shaped in an arc with a small radius of curvature spanning a large number of degrees. As individuals get older and years of accumulated weightbearing compress the plantar heel fat pad, the plantar heel becomes molded into a flatter shape, ie, their plantar heels are shaped in an arc with a large radius of curvature spanning a small number of degrees (Fig. 14).

The Blake inverted orthosis is made over a positive cast in which the whole foot is highly inverted.[3,5] Because of the unique nature of positive cast construction in the Blake orthosis, a foot that has a flatter shape to its plantar heel is more likely to result in the desired varus wedging in the heel cup of the orthosis than a foot with a very rounded plantar heel. Casts of feet that have rounded plantar heels, such as those of children, show little change in their plantar contours toward a varus heel cup when they are inverted to the ground, such as would be performed in the fabrication of the Blake inverted orthosis (Fig. 14). It is for this reason that the medial heel skive technique has in the last 2 years gradually become this author's preferred orthotic technique for children with flexible flatfoot deformities.

In the orthotic treatment of children with flexible flatfoot deformity, other orthotic modifica-

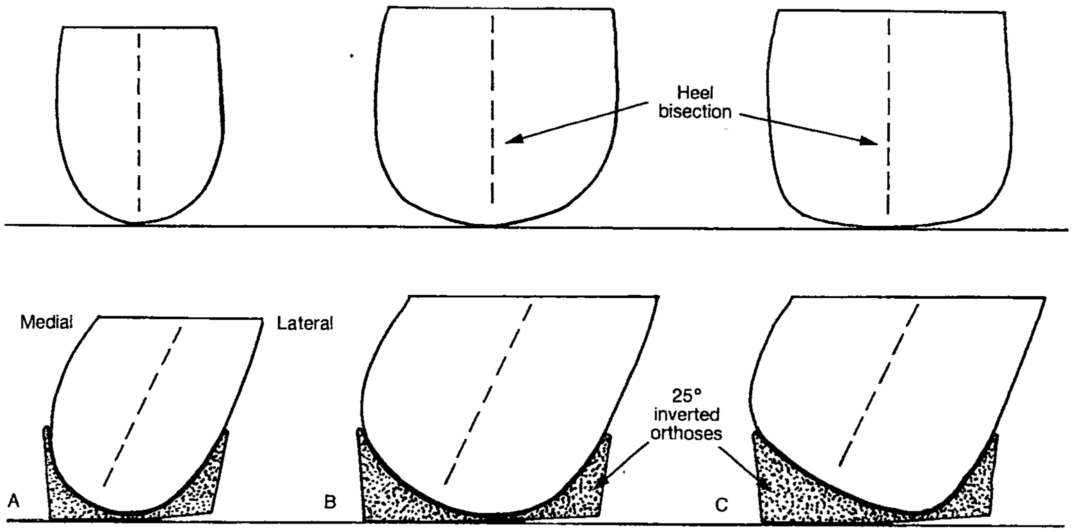

Figure 14. This figure demonstrates three different shapes of plantar heels with the resultant 25° inverted Blake orthosis just below each. In a very rounded heel (A), such as is common in a child, inverting the heel of the cast 25° does little to create varus wedging within the heel cup of the orthosis. In a normally rounded heel (B), inverting the heel of the cast 25° results in some varus wedging. However, in a heel with a relatively flat plantar contour (C), 25° of cast inversion results in extreme varus wedging within the heel cup of the orthosis.

tions, in addition to the medial heel skive technique, are used to decrease the pronated position of the foot. In general, for pediatric flexible flatfoot deformities, negative casting of the child's foot is performed with light dorsal manual pressure over the medial metatarsals to increase the medial longitudinal arch height of the cast of the foot (Fig. 15).[8] The orthosis is prescribed with the heel balanced inverted from 5° to 10°, which also increases the resultant medial longitudinal arch height in the orthosis. In fact, children and adults alike can tolerate increased longitudinal arch height in orthoses when the increase in arch height of the orthoses is made concurrently with the medial heel skive modification.

A stiff orthosis shell with a long rearfoot post is prescribed in pediatric flatfoot deformity to prevent orthosis deformation under weightbearing loads and excessive eversion of the orthosis inside the shoe. The child should wear a relatively firm-soled athletic shoe, preferably a high top athletic shoe, to prevent the orthosis from compressing the medial sole of the shoe, which would allow excessive orthosis eversion and subtalar joint pronation.

A heel cup height of at least 18 mm is prescribed to aid in controlling heel motion. In addition, since both the inverted balancing position and the medial heel skive technique tend to make the heel slide laterally on top of the orthosis, higher heel cup heights, ie, at least 18 mm, are necessary to prevent lateral heel cup edge irritation. The heel

Figure 15. In the modified negative casting technique used in pediatric flatfoot deformities, the foot is grasped at the fourth and fifth digits to position the subtalar joint in the neutral position and the midtarsal joint axes in the maximally pronated position. In addition, the other hand is positioned so that light pressure may be applied to the dorsal aspects of the first and second metatarsal bases to plantarflex the medial column during the casting procedure. The resulting negative cast has a higher medial longitudinal arch than usual (from Kirby K, Green D: "Evaluation and Nonoperative Management of Pes Valgus," in *Foot and Ankle Disorders in Children,* ed by S DeValentine, Churchill Livingstone, New York, 1992. Reprinted with permission).

cup height also may need to be increased, depending on the shape of the heel and the depth of the medial heel skive, to prevent medial or lateral heel cup irritation. This decision is most conveniently made by the orthosis laboratory since it is only when the positive cast is built that the necessary heel cup height will become evident.

Using the medial heel skive technique, along with the above modifications, greatly decreases the pronated position of the subtalar joint during the midstance phase of gait. It also significantly increases the resupination of the subtalar joint during the latter half of stance phase in children with even severe flexible flatfoot deformities.

Clinical Simulation of Medial Heel Skive Technique

Even though the medial heel skive technique is a useful method of adding extra pronation control to an orthosis, it is often difficult to determine when to use the technique in patients who already have orthoses but are not completely asymptomatic. Many times, a simple trial and error method is the most efficient and least costly means of determining whether the medial heel skive technique is the most appropriate modification to make to the orthosis to relieve pronation-related symptoms.

The best trial and error method of determining whether the medial heel skive technique will decrease the patient's pronation-related symptoms is to add multiple layers of thin wedging material to the medial heel cup of the orthosis to simulate the varus heel cup inherent in the medial heel skive orthosis (Fig. 16). A preferred method is to use multiple layers of thin moleskin adhered to the medial half of the heel cup of the dorsal orthosis surface, directed from posterolateral to anteromedial, to create a varus wedge in the heel cup of the orthosis.

Many patients report immediate relief of symptoms related to overpronation when first walking in this modified orthosis with the moleskin varus heel cup. If the response from the patient seems favorable, a new orthosis is ordered with a medial heel skive included. This is easily accomplished by using the positive casts from the last pair of orthoses and having the positive casts modified with the desired depth of medial heel skive. In general, at least a 2-mm medial heel skive is necessary for the patient to experience any symptomatic relief from the pronation-related symptoms.

Some of the most dramatic examples of immediate relief of pronation-related symptoms come with the use of the medial heel skive technique for patients with posterior tibial dysfunction or posterior tibial tendinitis. Use of either the layered moleskin in the medial heel cup of the orthosis or the medial heel skive technique for patients with posterior tibial pathology nearly always results in immediate partial relief of pain in the posterior tibial tendon area upon weightbearing.

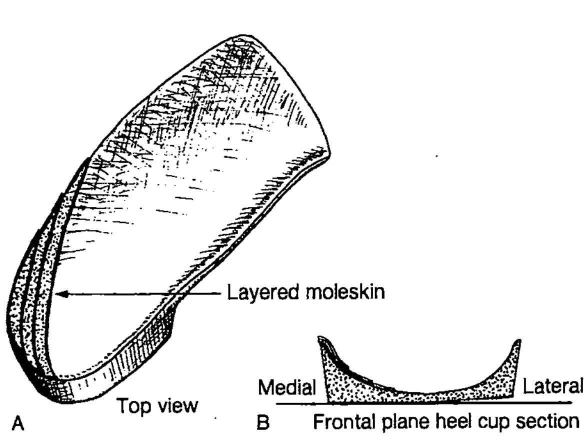

Figure 16. In order to clinically simulate the biomechanical effects of the medial heel skive technique on a preexisting typical functional foot orthosis, multiple layers of moleskin can be added to the medial half of the orthosis heel cup area directed from posterolateral to anteromedial (A). A frontal plane section through the heel cup with layered moleskin shows increased varus wedging through the heel cup of the orthosis (B).

The medial heel skive technique performs remarkably well in controlling pronation and pain in patients with posterior tibial dysfunction since these patients possess little posterior tibial muscle strength to assist in supinating the subtalar joint axis. The increased supination moment across the subtalar joint axis that the medial heel skive technique adds to the pronation-controlling ability of a foot orthosis makes the medial heel skive technique an indispensable method of conservative treatment of these difficult-to-treat patients.

Summary

The medial heel skive technique is a new method of enhancing the pronation-controlling features of prescription foot orthoses. It is based on the idea of inverted heel foot braces used by Whitman and Roberts in the early 1900s and results in an actual increased amount of varus wedging within the heel cup of the orthosis. The increased varus wedging in the orthosis heel cup causes an increased orthosis reactive force on the medial aspect of the plantar heel, which results in increased supination moment across the subtalar joint axis during weightbearing activities.

The increased supination moment that the medial heel skive technique adds to the orthosis is exceptionally useful in the treatment of excessively pronated feet that are normally difficult to control. Pediatric flexible flat feet and patients with posterior tibial dysfunction respond remarkably well to this modification. By careful evaluation of the patient and proper mastery of the biomechanical concepts involved in the medial heel skive technique, many feet that were once uncontrollable and symptomatic with foot orthosis therapy can become controllable and asymptomatic.

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BOOK REVIEW

Textbook of Bunion Surgery, 2nd Ed, edited by Joshua Gerbert, DPM, Futura Publishing Co, Mt Kisco, NY, 1991, $80.00.

The second edition of this text is devoted entirely to the complex subject of bunion surgery. The 560-page book is divided into three sections comprising 19 chapters. The text is generously illustrated with line drawings and radiographs.

Part one of the text covers preoperative evaluation. This section is particularly strong, and detailed information that should be known to every surgeon who undertakes repair of hallux valgus deformities is presented. Part two covers surgical procedures with which the 12 contributing authors indicate considerable experience. Part three includes a detailed review of the complications of bunion surgery and their management.

The book is an excellent text for teaching surgery and should be in the library of every podiatrist. The editor and the contributors are to be congratulated.

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