According to Hill,\textsuperscript{1} restricted ankle joint dorsiflexion is prevalent and is largely an “acquired deformity.” In a clinical audit of 209 consecutive new patients, Hill determined that 96.5% exhibited ankle equinus. This raises two questions: 1) what method is used to clinically assess ankle joint range,\textsuperscript{2} and 2) what range of ankle joint motion is deemed nonpathologic. The latter question has been studied extensively in dancers.\textsuperscript{3,4}

Children and adult sports participants are affected by the following conditions: Achilles tendinitis, plantar fasciitis, compensatory foot pronation, calcaneal apophysitis, and tarsal tunnel syndrome. All of these conditions are commonly encountered in lower-limb sports injuries, and all may include ankle equinus as either cause or adjunct.

Plantar fasciitis was first described in 1812 and erroneously attributed to tuberculosis.\textsuperscript{6} Plantar fasciitis and Achilles tendinitis are both notoriously resistant to the standard treatment programs of physicians.\textsuperscript{7} Standard management techniques include heel raises, stretching, and orthoses. Corticosteroid infiltration has been found to predispose the plantar fascia to rupture\textsuperscript{8} and to encourage adipose tissue atrophy.\textsuperscript{9} In a study of 105 subjects, Davis and Baxter\textsuperscript{10} found that surgical resection was unnecessary for 89.5% of the subjects if good conservative management was employed. Schepsis et al\textsuperscript{11} also found that surgical resection was not always successful when performed. In contrast, heel spur surgery (either open resection or endoscopic fasciotomy) has been associated with 85% patient satisfaction and pain relief, especially for obese patients.\textsuperscript{12}

Identifying the maintained passive shortening of the plantar fascia and triceps surae during sleep has explained much of the injury mechanism involved. This mechanism may include tensile overload of the plantar fascia at the calcaneal tubercle, enthesopathy, and eventual collagen degeneration.\textsuperscript{6} The ability of connective tissue to creep (plastic deformation in response to strain) is capitalized upon with night stretch splints when consistent strain allows healing of the plantar fascia at its functional length.\textsuperscript{13}

Persistent toe-walking not associated with cerebral palsy has been estimated to occur in 7% to 24% of the population. Recent research on 60 toe-walkers (average age, 3.5 years) found a positive family history of toe-walking in 30% of cases and demonstrable ankle equinus in 46% of cases.\textsuperscript{14} In the acknowledged absence of the necessary longitudinal data, these authors recommended that treatment be considered for idiopathic toe-walking because of the likely development of ankle equinus in these children. Another study of 80 idiopathic toe-walking children compared no treatment, the use of a cast or brace, and surgical

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lengthening. After an average follow-up period of 34 months, the study found that only surgery had made significant improvement.\textsuperscript{15}

Sever’s disease, or calcaneal apophysitis, is a common cause of foot pain in children and adolescents, typically from ages 9 to 14 years, and is characterized by an insidious onset of heel pain. Physical examination shows palpable tenderness along the line of the apophyseal plate and often reduced ankle dorsiflexion due to tightness of the triceps surae. Radiologic examination is generally not helpful for Sever’s disease since there are no specific changes in the apophysis.\textsuperscript{16} However, the presence of erythema or effusion demands radiologic investigation to exclude osteomyelitis or Brodie’s abscess. While Sever’s disease is typically self-limiting, it can produce significant morbidity for the adolescent sports participant. Reduced ankle dorsiflexion, one of the most common findings, must be effectively addressed to alleviate symptoms and promote return to sports participation.

A review of the literature identifies the use of posterior night stretch splints as an effective adjunct in the treatment of persistently symptomatic plantar fasciitis, negating the need for corticosteroid injections and surgery.\textsuperscript{8, 9, 17-19} Night stretch splints were used by Wapner and Sharkey\textsuperscript{19} to treat 14 subjects with recalcitrant plantar fasciitis who had not responded to conventional therapy. In less than 4 months, 11 of the 14 subjects had resolved and 3 subjects failed to improve. Ryan\textsuperscript{18} advocated using a posterior night stretch splint to treat plantar fasciitis in the athletic population before resorting to corticosteroid injection or surgery.

Generally, a three-step approach to the management of plantar fasciitis is recommended: 1) address the inflammation, 2) eradicate the inciting factors, and 3) rehabilitate the involved structures.\textsuperscript{6} The use of a night stretch splint is viewed as adjunctive rather than primary. A prospective randomized clinical trial of night stretch splints involving 40 subjects found that all subjects treated with the night stretch splints (16 of 16) responded by 8 to 9 weeks of treatment, in contrast with only 6 of the 17 control subjects. All of the subjects in both the control and treatment groups were treated with standard measures: anti-inflammatory drugs, the patient was experiencing depressive episodes as a result of the protracted pain and financial constraints associated with her inability to work.

Examination revealed gastrocnemius and soleus restriction that impeded ankle range of motion, specifically dorsiflexion. A standard treatment approach of stretching exercises, heel raises, and ice packs resulted in some improvement. A posterior night stretch splint was dispensed, and after 1 month, there was no change. However, the patient had ceased stretching exercises. These exercises were resumed and at a 2-month review, the patient reported a 50% improvement and had returned to work. At a 4-month review, three myofascial trigger points were found in the posteromedial gastrocnemius muscle belly. They responded favorably to stretch and massage technique,\textsuperscript{25} and the patient continued to improve to the point of fully resolving.

Clinical Case Studies

Table 1 presents 20 subjects in which the night stretch splint was used by the author in clinical practice. Arrangement is by age of the patients. The following case examples, the initial five cases managed by the author, demonstrate the effects of posterior night stretch splints for various clinical conditions, some commonly encountered by the podiatric physician.

Case 1: Postsurgery for Heel Spur

A 51-year-old woman (subject 19, Table 1) presented with a 2-year history of right-heel pain. Previous treatment included cortisone infiltrations, orthoses, and finally surgical release of the plantar fascia. Nine weeks postoperatively, there was no relief. Physiotherapy also provided no improvement, and the patient had gastritis following the use of nonsteroidal anti-inflammatory drugs. The patient was experiencing depressive episodes as a result of the protracted pain and financial constraints associated with her inability to work.

Case 2: Recalcitrant Plantar Fasciitis

A 38-year-old woman (subject 14, Table 1) presented with a painful right heel of more than 2 years’ duration, for which foot orthoses had been unsuccessful. She previously had suffered similar pain in her left heel, which had finally resolved with foot orthoses after the unsuccessful use of cortisone infiltration.
Examination revealed plantar fasciitis, gastrocnemius equinus, and a positive slump test indicating neural tension. A standard treatment regimen of stretching exercises, heel raises, and physiotherapy resulted in a partially improved condition. A posterior night stretch splint was dispensed and the patient’s neural tension was alleviated by a change in her spinal flexion posture during sleeping. The patient’s heel pain was eliminated after 3 months of stretch splint use.

Case 3: Calcaneal Apophysitis (Sever’s Disease)

An 11-year-old boy, a soccer player (subject 8, Table 1), had experienced a rapid growth spurt and presented with heel pain consistent with calcaneal apophysitis. He displayed tight hamstrings and gastrocnemius groups. He did not have a pronated foot type. The use of a posterior night stretch splint in addition to stretching exercises, heel raises, and ice packs greatly improved his symptoms and he was able to return to sports after 1 month. After 2 months, he was asymptomatic and discontinued the use of the splint after another month.

Table 1. Data on Subjects Who Used the Night Stretch Splints

<table>
<thead>
<tr>
<th>Subject</th>
<th>Age (years), Gender</th>
<th>Previous Treatment</th>
<th>Diagnosis</th>
<th>Initial Ankle Range (°)</th>
<th>NSS Time (weeks)</th>
<th>Final Ankle Range (°)</th>
<th>Outcome</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 M</td>
<td>Casts</td>
<td>Myositis</td>
<td>−20</td>
<td>52</td>
<td>0</td>
<td>Heel strike</td>
<td>Botox</td>
</tr>
<tr>
<td>2</td>
<td>3 F</td>
<td>None</td>
<td>Toe walk</td>
<td>−10</td>
<td>16</td>
<td>5</td>
<td>Heel strike</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>6 M</td>
<td>None</td>
<td>Toe walk</td>
<td>−5</td>
<td>26</td>
<td>5</td>
<td>Heel strike</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>7 M</td>
<td>S</td>
<td>Toe walk</td>
<td>−10</td>
<td>12</td>
<td>0</td>
<td>Heel strike</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>8 F</td>
<td>S</td>
<td>Hemiplegia</td>
<td>−15</td>
<td>12+</td>
<td>0</td>
<td>Fewer falls</td>
<td>Case 4</td>
</tr>
<tr>
<td>6</td>
<td>9 M</td>
<td>None</td>
<td>Toe walk</td>
<td>−5</td>
<td>8</td>
<td>10</td>
<td>Heel strike</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>10 M</td>
<td>Rest</td>
<td>Sever’s disease</td>
<td>0</td>
<td>8</td>
<td>5</td>
<td>Resolved</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>11 M</td>
<td>None</td>
<td>Sever’s disease</td>
<td>0</td>
<td>6</td>
<td>10</td>
<td>Resolved</td>
<td>Case 3</td>
</tr>
<tr>
<td>9</td>
<td>11 M</td>
<td>PT</td>
<td>Achilles tendinitis</td>
<td>−5</td>
<td>6</td>
<td>5</td>
<td>Resolved</td>
<td>Case 5</td>
</tr>
<tr>
<td>10</td>
<td>12 M</td>
<td>None</td>
<td>Sever’s disease</td>
<td>0</td>
<td>6</td>
<td>5</td>
<td>Resolved</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>13 M</td>
<td>None</td>
<td>Sever’s disease</td>
<td>0</td>
<td>8</td>
<td>10</td>
<td>Resolved</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>13 M</td>
<td>None</td>
<td>Achilles tendinitis</td>
<td>−5</td>
<td>6</td>
<td>5</td>
<td>Resolved</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>28 M</td>
<td>PT, S, O</td>
<td>Achilles tendinitis</td>
<td>−5</td>
<td>20</td>
<td>5</td>
<td>Resolved</td>
<td>Surgery</td>
</tr>
<tr>
<td>14</td>
<td>38 F</td>
<td>C, O</td>
<td>Plantar fasciitis</td>
<td>−5</td>
<td>12</td>
<td>5</td>
<td>Resolved</td>
<td>Case 2</td>
</tr>
<tr>
<td>15</td>
<td>39 F</td>
<td>None</td>
<td>Plantar fasciitis</td>
<td>0</td>
<td>12</td>
<td>5</td>
<td>Resolved</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>45 M</td>
<td>O</td>
<td>Plantar fasciitis</td>
<td>0</td>
<td>16</td>
<td>10</td>
<td>Resolving</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>45 F</td>
<td>O, S</td>
<td>Plantar fasciitis</td>
<td>−5</td>
<td>12</td>
<td>10</td>
<td>Resolved</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>47 F</td>
<td>PT, C, O</td>
<td>Plantar fasciitis</td>
<td>0</td>
<td>8</td>
<td>5</td>
<td>Resolved</td>
<td>Post MVA</td>
</tr>
<tr>
<td>19</td>
<td>51 F</td>
<td>C, O</td>
<td>Postoperative</td>
<td>0</td>
<td>16</td>
<td>5</td>
<td>Resolved</td>
<td>Case 1</td>
</tr>
<tr>
<td>20</td>
<td>71 M</td>
<td>C, S, H</td>
<td>Achilles tendinitis</td>
<td>0</td>
<td>8</td>
<td>10</td>
<td>Resolved</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: C, cortisone infiltrations; H, heel raises; MVA, motor vehicle accident; NSS, night stretch splint; O, orthoses; PT, physical therapy; S, stretching.

* Time of splint use ranged from 6 to 52 weeks.

** Outcome refers to the subjective benefit.

Case 4: Gait in a Child with Cerebral Palsy

An 8-year-old girl (subject 5, Table 1) presented with right-side hemiplegia resulting from cerebral palsy. The right foot exhibited marked ankle equinus and associated toe-walking on the foot. She was unable to run and was clumsy, often falling over. The right leg was 2.5 cm shorter than the left, owing to hypertonic limitation of bone length. With the use of a posterior night stretch splint, this girl had fewer falls and was able to participate in school sports classes. The splint was initially set at 10° plantarflexion and then changed at monthly intervals to 0° (for 2 months). It was not possible to adjust the splint a further 10° into dorsiflexion as the heel would then rise up. This child was able to jog slowly and developed enough calf length to achieve intermittent heel strike. This child benefited socially in addition to gaining physical, functional improvement. The child continues to wear the splint 2 to 3 nights per week.

Case 5: Bilateral Achilles Tendinitis

An 11-year-old boy (subject 9, Table 1) presented
with bilateral Achilles tendinitis, which was symp-
tomatically worse upon rising and when playing Aus-
tralian Rules football. He had a history of calcaneal
apophysitis and habitual toe-walking, both associat-
ed with ankle equinus. Initial treatment consisted of
stretching exercise, heel raises, and ice packs and the
condition had resolved. Subsequent growth resulted
in increased muscle inflexibility and a return of symp-
toms that did not completely respond to the repeti-
tion of the initial treatment. After the use of a posteri-
or night stretch splint for 1 week, pain was reduced.
After 6 weeks, the boy was free of pain and had re-
turned to sports. Habitual toe-walking, which had
persisted from infancy, was eliminated.15

Discussion

Neurologic factors, particularly increased neural ten-
sion and myofascial trigger points, are a common
cause of pain. Trigger-point acupuncture has been
demonstrated to be useful in subjects responding
poorly to conservative management of heel pain.27 Po-
diatric sports physicians must include neural tension
and trigger points in their checklist of differential di-
agnoses.28, 29 The treatment of heel pain often involves
the need to address gastrocnemius or soleal equinus,
sometimes in conjunction with myofascial trigger
points and increased neural tension.26, 30

Disclosure of etiologic factors involved in presen-
tation with gastrocnemius or soleal equinus by chil-
dren requires comprehensive history taking and ex-
amination. Children with abnormal muscle tone have
various anomalies of alignment of the foot and ankle;
inhibitory casts have been a successful adjunctive
therapy for hypertonicity in these conditions.22 Botu-
linum A toxin injected into the gastrocnemius muscle
in children with cerebral palsy has been found to im-
prove ankle dorsiflexion in both stance and swing
over the short term.23, 24

A number of posterior stretch splints are commer-
cially available (Fig. 1), and while all are designed for
primarily the same purpose, ankle dorsiflexion, ease
of application, durability, and patient preference may
vary slightly. The splint usually is worn to bed each
night. If gastrocnemius tightness is found in addition
to soleal or plantar fascial tension, the knee is kept
as extended as possible. Once symptoms have re-
olved, the night stretch splint may be worn alternate
nights for an additional 1 to 2 weeks and then discon-
tinued. Alternatively, the splint may be worn for peri-
ods during the day in a straight-leg seated position.
This is particularly useful for patients who exhibit
tight hamstring or gastrocnemius groups, although
cautions must be exercised in those with lumbar

spine symptoms. It is essential that patients stretch
tight structures in addition to wearing the splint and
continue with these exercises after they stop wearing
the splint.

Conclusion

The night stretch splint is a useful adjunct to conser-
vative treatment for painful conditions of the rear-
foot, heel, and ankle. In the case of recalcitrant plan-
tar fasciitis, the efficacy of the night stretch splint is
well supported by a randomized control trial and
abundant clinical outcome data. The podiatric physi-
cian must do a thorough, differential diagnosis for
the patient with rearfoot and, especially, heel pain.
Ankle equinus, myofascial trigger points, neural ten-
sion, muscle tone, and body postures must be includ-
ed in the objective clinical examination.

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