A Retrospective Analysis of 772 Patients with Hallux Limitus

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In this retrospective analysis of 772 patients with symptomatic hallux limitus, 428 patients (55%) were successfully treated with conservative care alone; of these 428 patients, 362 (84%) were treated with orthoses. Corticosteroid injections and a change in shoes allowed 24 patients (6% of conservatively treated patients) and 42 patients (10%), respectively, to have less discomfort and return to previous activity levels. Overall, 47% of the patients in this analysis were successfully treated with orthoses. Surgical procedures were performed on 296 patients (38% of all patients) who did not respond to conservative care. In this analysis, 48 of the patients (6% of all patients) who did not respond to conservative care either refused surgery or were not surgical candidates. These data are intended to provide podiatric physicians with expected outcomes for conservative care of hallux limitus. The etiology, symptoms, conservative management, and surgical treatments of hallux limitus and hallux rigidus are also reviewed. (J Am Podiatr Med Assoc 92(2): 102-108, 2002)

Hiss[1] first described the motion of the first metatarsophalangeal joint in 1937. Since then, many authors have reported actual values on the range of motion of this joint. During normal gait, 65° to 75° of dorsiflexion of the hallux on the first metatarsal is necessary during propulsion. The first ray is plantarflexed by the action of the peroneus longus tendon pulling about a rigid lateral column and allowing the ground reaction forces to dorsiflex the hallux. Without normal plantarflexion of the first metatarsal, only 25° to 30° of metatarsophalangeal joint dorsiflexion can occur during ambulation. A limitation of dorsiflexion in this joint of less than 20° is termed hallux limitus. Hallux rigidus is the end stage of hallux limitus when the joint may become ankylosed.[2-7]

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Hallux limitus was first described in the English literature in 1887 by Davies-Colley,[8] who termed the condition hallux flexus. One year later, Cotterill[9] coined the term hallux rigidus to describe a stiff great toe. Some authors believe that this condition should be termed hallux equinus because hallux limitus and rigidus are definitions of static deformities.[10] Hallux limitus has been referred to as the second most common condition affecting the first metatarsophalangeal joint (with hallux valgus being the most prevalent), and it is one of the most disabling.[11, 12] Because of the differences of historical definition of the term hallux limitus, the present authors have chosen to turn to the original 1887 definition in which Davies-Colley used 10° of dorsiflexion to define the term.

Etiology

Hallux limitus has many causes, and there are usually multiple factors influencing the amount of limitation in the joint.[6, 7, 12-21] The etiologic factors associated with hallux limitus and hallux rigidus are listed in Table 1.

Table 1. Etiologic Factors Associated with Hallux Limitus/ Hallux Rigidus

- Acute trauma
- Arthritis of the sesamoids
- Congenitally short medial plantar fascial band
- Elevated first metatarsal
  - Intrinsic: apex of deformity within the metatarsal shaft
  - Extrinsic: apex of deformity proximal to the metatarsal/ cuneiform joint
- Forefoot rectus foot type with abnormal subtalar joint pronation
- High-heeled shoes
- Hypermobile first ray
- Iatrogenic causes following surgery
- Increased pronation in midstance and toe-off
- Long first metatarsal
- Long proximal phalanx
- Metabolic conditions
  - Rheumatoid arthritis, gout, psoriatic arthritis, Reiter's syndrome, ankylosing spondylitis
- Peroneal spastic flatfoot
- Repetitive trauma
  - Dancers, runners, athletes.
  - Occupations requiring repeated squatting or climbing
- Square metatarsal head
- Tarsal coalition
- Tightness of the flexor hallucis brevis with the sesamoids present

In the current analysis, the authors determined that more than one etiology was present in 330 patients (43%). The primary causes of hallux limitus were trauma, metatarsus primus elevatus, elongated first metatarsal, excessive pronation, gout, Reiter's syndrome, ankylosing spondylitis, and rheumatoid arthritis.

Classification

Many different systems are used to classify hallux limitus and hallux rigidus; five classifications are discussed in this section. Nilsonne[13] classified hallux limitus as primary or secondary. The primary form is usually seen in adolescents with a long first metatarsal. The secondary form is identified in older patients with arthritis, hallux abducto valgus deformity, or local trauma to the area. Giannestras[22] also classified primary hallux limitus as caused by post-traumatic arthritis, and the arthridities are the etiologies in the secondary form. Mann et al[23] classified hallux limitus and hallux rigidus into three types. The congenital type is a result of a flattened or misshaped metatarsal head. The second type is acquired secondary to post-traumatic arthritis, and the third type is acquired secondary to the general arthridities. Probably the most accepted classification system is the one described by Regnauld.[24] The Regnauld classification system is presented in Table 2. This system is based on both clinical and radiographic findings. Hanft et al,[25] however, believed that this system, like others, failed to address all of the radiographic findings of hallux limitus and they devised a classification system based on radiographic findings. Furthermore, subchondral pathology and cyst formation were incorporated into this system. From this classification, Hanft et al[25] developed a surgical algorithm, which is presented in Table 3.

Signs and Symptoms

Clinical presentations vary depending upon the degree of hallux limitus. In most cases, a patient presents with pain in the first metatarsophalangeal joint. The pain can be deep within the joint or, if hypertrophy of the bone is present, on the dorsal aspect of the joint. The proper dorsal digital branch of the medial dorsal cutaneous nerve may get irritated and cause a burning type of pain. Patients may have hyperkeratotic buildup at the plantar aspect of the hallux interphalangeal joint or the medial aspect of the

Table 2. The Regnauld Classification System for Hallux Limitus/Hallux Rigidus

- First Degree
  - Acute/subacute pain
  - Less than 40° of dorsiflexion and 20° of plantarflexion of the hallux
  - Joint enlargement/mild dorsal spurring
  - Slight narrowing of the joint space
  - Regular, but slightly enlarged, sesamoids
- Second Degree
  - Intermittent pain and tingling at rest
  - Limitation of metatarsophalangeal joint motion
  - Metatarsalgia
  - Narrowing of joint space
  - Flattening of the first metatarsal and phalanx
  - Elongation and elevation of the first metatarsal
  - Hypertrophy and irregularity of sesamoids
- Third Degree
  - Extensive spurring of dorsal, medial, and lateral aspects of the joint
  - Flexor hallucis longus contracture
  - Severe loss of joint space
  - Hypertrophy of metatarsal, phalanx, and sesamoids
  - Particular osteophytes bridge the metatarsosesamoid joint
  - Joint mice
  - Approaches ankylosis

Table 3. Radiographic Classification System for Hallux Limitus/Hallux Rigidus by Hanft et al[28]

Grade I
Metatarsus primus elevatus
Mild spurring with dorsal hypertrophy of the first metatarsal head and phalangeal base
Junctional sclerosis surrounding the first metatarsophalangeal joint
Grade II — Elements of Grade I plus:
Broadening or flattening of the first metatarsal head and base of proximal phalanx
Decrease in joint space
Sesamoid hypertrophy
Lateral spur formation on first metatarsal head
Grade IIB — Elements of Grade II plus:
Evidence of osteochondral defects
Subchondral cyst formation
Fracture of subchondral bone plate
Loose bodies
Grade III — Elements of Grade II plus:
More severe flattening of the first metatarsal head and phalanx
Minimal first metatarsophalangeal joint space
Severe dorsal and lateral spurring and osteophyte formation
Extensive sesamoid hypertrophy
Grade IIIB — Elements of Grade III plus:
Large osteochondral defects
Loose bodies
Subchondral cyst formation

hallux. Some patients experience pain along the lateral column of the foot because of lateral weight transfer to avoid the first metatarsophalangeal joint.[7] Sometimes patients experience chronic subungual hematoma or dystrophic nail changes with hyperextension of the hallux to compensate for lack of dorsiflexion of the first metatarsophalangeal joint.[20] Patients may aggravate their symptoms by going barefoot or wearing a flexible-soled shoe as opposed to a rigid-soled shoe. When the soles of a patient's shoes are examined, there is usually a distinct pattern of wear beneath the hallux interphalangeal joint and the second metatarsophalangeal joint. There is also usually an oblique angulation of the crease in the shoe at the metatarsophalangeal joint level instead of the transverse crease that is normally seen.[7]

Conservative Treatment

Conservative care of hallux limitus includes physical therapy, peri- and intra-articular injections with steroids, shoe modifications, orthoses, and oral nonsteroidal anti-inflammatory drugs. Physical therapy modalities include traction, manipulation, hydrotherapy, and ultrasound.[11] Shoe modifications include low-heeled shoes, shoes with a stiffer sole, rocker-bottom shoes, metatarsal bars, and an increase in the height of the toe box. Occasionally, a Morton's extension or a kinetic wedge, which was developed by Dananberg,[26] is used with functional orthoses. For conservative treatment of iatrogenic hallux limitus, without an associated first metatarsal elevatus, continuous passive motion has been beneficial to patients with adhesive capsulitis.[27]

Surgical Treatment

When conservative care fails, multiple surgical procedures can be employed. In young, active patients, the authors prefer the modified Valenti procedure. The original Valenti procedure was described at a Hershey, Pennsylvania, Surgical Seminar in 1987, but Valenti actually began performing the procedure for hallux limitus and hallux rigidus in 1976.[6] The modified Valenti procedure preserves the joint for greater stability because viable cartilage and intrinsic musculature remain intact.[28] Other procedures include the cheilectomy and the Regnauld or enclavement procedure, which are indicated for hallux limitus with minimal degeneration of the cartilaginous surfaces of the joint.[24, 29] Cohen et al[29] described a modification of the Regnauld procedure that uses a square peg configuration fixated with a 2.7-mm cortical screw. In 1958, Bonney and Kessel[30] described removal of a dorsal wedge of bone in the proximal phalanx for treating hallux limitus. In 1977, Purvis et al[31] described a combination of a Bonney-Kessel and a modified Akin procedure for the treatment of hallux limitus with associated hallux abductus.

A more complex procedure is the Green-Watermann, which was introduced at the 1987 Doctors Hospital Seminar.[16, 32] This procedure shortens the first metatarsal, moves the metatarsal head plantarly, and achieves a dorsal cheilectomy. Selner et al[33] described a tricorrectional osteotomy, which is a modification of the bi-plane Austin procedure for treatment of late-stage hallux limitus and hallux rigidus. This procedure was designed by Selner et al[33] and described by Boggs et al.[34] The results achieved by Selner et al[33] with this procedure show an average increase of first metatarsophalangeal joint dorsiflexion of 36.4° and an average joint space increase of 1.08 mm. Another joint-preservation technique is a sagittal plane Z-osteotomy of the proximal phalanx as described by Kissel et al.[35] These authors stated that, as compared with the Regnauld procedure, this procedure is less technically demanding and there is less of a chance of avascular necrosis; hallux function and

purchase are also preserved because the intrinsic muscle insertions are maintained. Gusman et al[15] reported a combination procedure of a Newell phalanx decompression osteotomy, which was a modification of the Bonney-Kessel procedure and a Youngswick[36] metatarsal osteotomy, which is a plantarflexing Austin procedure.[1] A more recently developed operation that can be used in younger patients is tendon interpositional arthroplasty. Cosentino[17] described this technique as using sections of the extensor hallucis longus tendon, extensor digitorum longus or brevis tendons, and the gastrocnemius-soleus tendon. Long-term follow-up does not occur, however, when this procedure is performed in the foot.

Joint-destructive procedures include the Keller arthroplasty, resection of the first metatarsal head as advocated by Heuter; an oblique resection of the metatarsal head as proposed by Stone; Keller arthroplasty with autogenous bone graft; and arthrodesis of the first metatarsophalangeal joint, as described by McKeever.[11, 12, 37, 38] The first resection of part or all of the first metatarsophalangeal joint, the Edmund Rose procedure, was described in 1897 by Heubach.[39] Another joint-destructive procedure is implant arthroplasty, which was first documented in 1951 by Endler.[40] In 1967, Swanson et al[41] used silicone to create a joint spacer for replacing the excised base of the proximal phalanx. Then, in 1974, Swanson et al[42] came out with the double-stemmed hinged Silastic implant. The purpose of the implant was to provide greater stability and function to the first metatarsophalangeal joint. Later, Dow-Corning introduced a titanium grommet to be used with the Silastic implants to help prevent bony erosion, which has been documented with their use.[43] The development of the Bioaction great-toe implant (Orthopaedic Biosystems, Scottsdale, Arizona) was an attempt to improve the results of implant surgery.[3] This implant is made of titanium, cobalt-chrome, and ultrahigh-molecular-weight polyethylene. An adjunctive procedure to many of these osteotomies for hallux limitus and hallux rigidus is the release of the medial fascial band through a small stab incision. This is advocated by Chang[18] to aid in increasing the range of motion of the first metatarsophalangeal joint.

Materials and Methods

This analysis reviewed 772 patients diagnosed with hallux limitus. All patients complained of pain that significantly reduced their activity. The amount of dorsiflexion of the first metatarsophalangeal joint in each patient was less than 10°, but greater than 0°. The amount of dorsiflexion of the hallux was measured against the long axis of the first metatarsal. These patients were reviewed over a 7-year period, from 1987 to 1994, with a minimum follow-up of 1 year. Of the 772 patients, 397 were male (51%) and 375 were female (49%). The patients ranged in age from 17 to 78 years, with an average age of 46. In this study, 83 patients had bilateral hallux limitus of atraumatic origin, but the authors included only the most symptomatic extremity when evaluating their response to treatment.

Patients were evaluated on their response to conservative care. Conservative care options consisted of peri- and intra-articular corticosteroid injections, a change in shoes, and orthoses. When orthotic therapy was used, patients with a bony deformity were placed in functional orthoses, and patients with ligamentous laxity or tibialis posterior tendon dysfunction were placed in Schaffer devices. Those who did not respond to a low-dye taping were placed in orthoses with a Morton's extension.

The authors considered conservative care successful if, after 12 weeks of treatment, the patient had a marked reduction in discomfort and could return to previous activity levels. Patients who received steroid injections were given a second and sometimes a third injection if, after the first injection, they felt at least 50% better, but were less than 80% improved. The injections were given 4 weeks apart. All patients received follow-up for at least 1 year after treatment. During the follow-up period, all patients were able to maintain their previous activity level with less pain and discomfort. No patient who was treated conservatively had an increase in the range of motion of the first metatarsophalangeal joint. Patients who did not respond to conservative care were treated with surgical intervention.

The authors reviewed and classified the etiology of the hallux limitus in this patient population. Many patients had more than one cause relating to hallux limitus. Patients were divided into two major groups: those who had sustained trauma to the first metatarsophalangeal joint and those whose hallux limitus was of atraumatic origin. None of the patients who sustained trauma were bilateral cases. There were 83 bilateral cases in the atraumatic category; these cases were all included in the etiologic breakdown. The etiologies found in the atraumatic group were as follows: metatarsus primus elevatus, in which the Meary's angle was greater than 5°; an elongated first metatarsal, which was at least 1 mm longer than the second metatarsal; excessive pronation at midstance or toe-off with a Kite's angle of greater than 45°; and synovial disease, including gout, rheumatoid arthritis, Reiter's syndrome, and ankylosing spondylitis.

The arthridities were diagnosed and documented by the patient's primary care physician, and a diagnosis of gout was also confirmed by microscopic analysis of the joint aspirate.

Results

Of the 772 patients with symptomatic hallux limitus, 428 responded to conservative care alone, representing 55% of the total (Fig. 1). Twenty-four patients (6% of those treated conservatively) were given the steroid injections. Of these patients, 18 received one injection; 5 patients received two injections; and 1 patient had three injections. Forty-two patients (10%) responded to a simple change in shoes. The remaining 362 patients (84%) responded to orthotic management. Orthoses alone were successfully used to treat 47% of all hallux limitus patients. Of the 362 orthoses, there were 215 functional orthoses, 87 Schaffer devices, 32 with a Morton's extension, and 28 combination-type devices.

The surgical category covered 344 patients, of whom 48 (14%) either refused surgery or were not surgical candidates. Of the remaining 296 patients, the breakdown of surgeries was as follows: 162 (55%) Valenti procedures; 54 (18%) implant arthroplasties (39 Silastic, 15 titanium); 28 (9%) modified Stone procedures; 23 (8%) Keller arthroplastics; 11 (4%) cheilectomies; 11 (4%) arthrodesis procedures; and 7 (2%) enclavement procedures (Fig. 2).

The authors also reviewed the etiologies of hallux limitus. Of the 772 patients with hallux limitus, 426 had a significant history of trauma, representing 55% of the total. Of these patients, trauma was the only cause of hallux limitus in 191 patients. The remaining

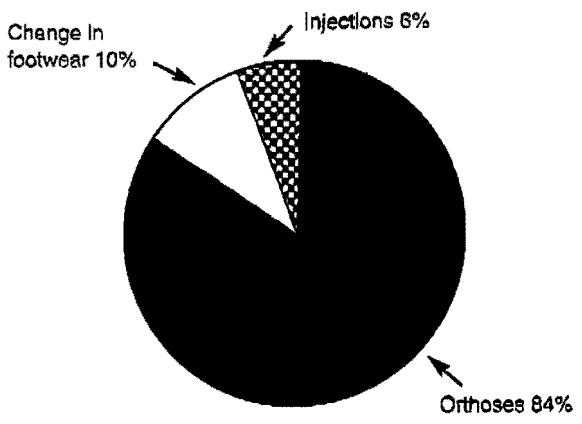

Figure 1. Percentage breakdown of patients who received conservative treatment (n = 428).

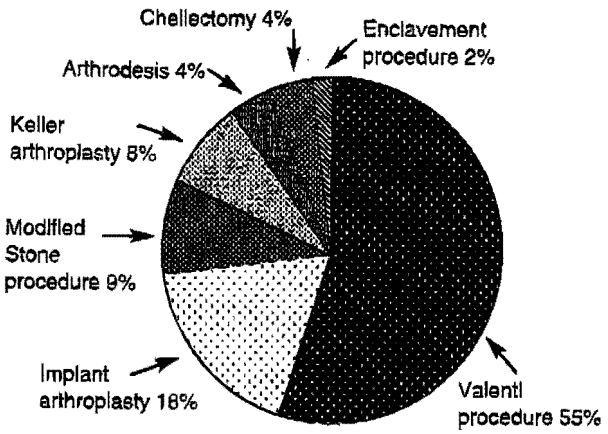

Figure 2. Percentage breakdown of patients who received surgical treatment (n = 296).

235 patients in this category had a second etiology such as a biomechanical deformity or arthridity. Of these 235 patients, 201 patients had metatarsal primus elevatus; 18 had an elongated first metatarsal; 13 had excessive pronation; and 3 patients had synovial disease. The remaining 346 patients in this analysis had an atraumatic origin of their hallux limitus. Of these patients, 83 were bilateral cases. In the atraumatic group, 273 patients had metatarsal primus elevatus; 66 patients had an elongated first metatarsal; 75 patients had excessive pronation; and 15 patients had synovial disease. The specific breakdown of these etiologies is listed in Table 4.

Conclusion

Through a retrospective analysis of 772 patients with symptomatic hallux limitus, the authors concluded that 55% of patients with this condition can be successfully treated conservatively. Treatments consisted of orthoses, peri- and intra-articular corticosteroid injections, and a change in shoes. Orthoses alone successfully treated 47% of all of the patients in the study. Since more than half of the patients responded to conservative care, the authors conclude that orthoses are a very viable treatment option for hallux limitus. In this study, 45% of the patients did not respond to conservative care and required surgical intervention. Interestingly, the authors found that 55% of hallux limitus is caused by some form of trauma, and the remaining cases are caused by biomechanical abnormalities or genetic factors. This analysis did not address which etiology of hallux limitus responded best to the different treatment modalities. In addition, these patients were followed for a minimum of

Table 4. Etiology Breakdown of Patients In Study

	No. of Feet
Patients with trauma (n = 426)	
Trauma only	191
Concurrent metatarsus primus elevatus	201
Elongated first metatarsal (2/201)	
Concurrent elongated first metatarsal	18
Metatarsus primus elevatus (2/18)	
Concurrent excessive pronation	13
Metatarsus primus elevatus (3/13)	
Concurrent synovial disease	3
Metatarsus primus elevatus (2/3)	
Patients with atraumatic origin (n = 346)*	
Concurrent metatarsus primus elevatus	273
Elongated first metatarsal (17/273)	
Concurrent elongated first metatarsal	66
Metatarsus primus elevatus (17/66)	
Concurrent excessive pronation	75
Metatarsus primus elevatus (48/75)	
Elongated first metatarsal (8/75)	
Concurrent synovial disease	15
Metatarsus primus elevatus (6/15)	
Elongated first metatarsal (2/15)	
Excessive pronation (2/15)	

*429 feet; 83 bilateral cases.

1 year to a maximum of 7 years, so the authors cannot conclude how long conservative care can keep a patient free from pain and able to perform normal activities. Future studies will be necessary to address this issue.

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