

THE SUB-TWO SYNDROME

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Lesser metatarsalgia is a common catchall diagnosis for a number of pathologic conditions localized to the forefoot. Often, practitioners apply vague diagnoses, such as metatarsalgia, to label a confusing clinical presentation. The "Sub-Two Syndrome" is a common complaint of pain and/or a lesion beneath the second metatarsal head. The author will describe the clinical presentation of the "Sub-Two Syndrome," the etiologies, differential diagnoses, and finally a common sense approach to surgical planning. An algorithm will be designed to provide a step-wise approach to deal with this often frustrating entity.

CLINICAL PRESENTATION

Common forefoot complaints include bunions, hammertoes, neuromas, and lesser metatarsalgia. Frequently, there are multiple "pathologies" present upon examination, however, the main complaint is pain under the ball of the foot. Patients describe a "stone bruise" or lump underneath the metatarsal head. Frequently there may be neuroma-like symptoms with electrical sensations shooting to the toes. Hammertoe formation or subtle metatarsophalangeal joint subluxation may be present. Callus formation beneath the second metatarsal head is common, but not always present. Tenderness is present with palpation on the plantar aspect of the metatarsophalangeal joint. An important clinical point is that pain may be disproportional to the clinical findings. When the plantar plate is inflamed or ruptured, the greatest amount of pain is palpated plantarly just distal the joint. When the plantar plate is inflamed, plantarflexion of the metatarsophalangeal joint may produce excruciating pain.

ETIOLOGY

Pain beneath the metatarsal heads is a common complaint in the general population. Lesser metatarsal overload is prevalent due to two important factors. First, and most important, is the

influence of a pathologic first ray segment. Hallux valgus, hallux limitus, or metatarsus primus elevatus may contribute to lesser metatarsal overload. In addition, the second digit is predisposed to contracture, secondary to the pathologic first ray. Hammertoe formation causes a plantarflexory retrograde force to the metatarsal head (Fig. 1). In each instance, increased load is transferred to the second metatarsophalangeal joint. The iatrogenic pathologic metatarsal parabola is another common etiology of pain beneath the 2nd metatarsal (Figs. 2A, 2B). This may be due to an osteotomy that has resulted in excessive iatrogenic shortening and/or elevation of the first metatarsal. Prior lesser metatarsal osteotomies or condylectomies are commonly incriminated in sub-two pain. In short, sub-two pain is usually caused by a functional (biomechanical) pathology of the first ray and/or second digit. Structural causes of sub-two pain include a long second metatarsal and/or plantarflexed metatarsal. It is the author's opinion that purely structural deformities are relatively uncommon, with the exception of those which are iatrogenic or post-traumatic in nature.

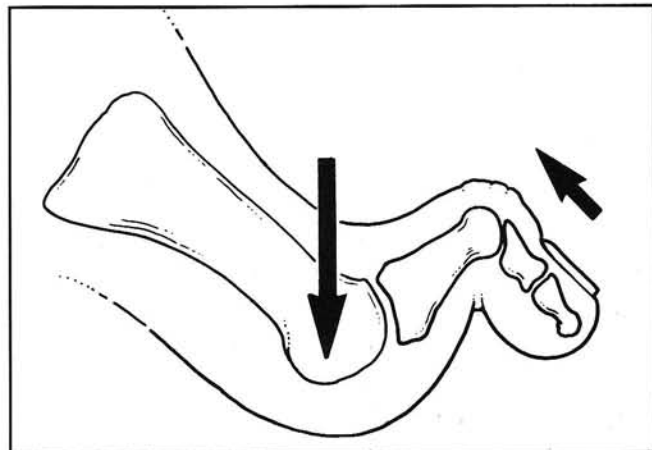


Figure 1. Illustration of plantarflexory force on the metatarsal due to hammertoe deformity.



Figure 2A. Iatrogenic etiology of sub-two pain.



Figure 2B. Osteochondral graft is utilized to re-establish a functional metatarsal parabola.

DIFFERENTIAL DIAGNOSIS

Pain beneath the second metatarsal is the most common site of lesser metatarsalgia. A complete list of differential diagnoses can be found in Table 1. In general, pathology can be attributed to structural or functional (biomechanical) causes or a combination of the two. As with all areas of medicine, the most common diagnosis should be considered first. When appropriate treatment fails, then the need for re-evaluation and investigation of less common entities is warranted.

The classic orthopedic literature has focused on the structural etiology of sub-metatarsal pain. The two commonly accepted structural deformities include a second metatarsal that is either excessively long and/or plantarflexed in relation to its adjacent metatarsals. This has been the dogma throughout the years. As a result, a common surgical technique to attempt to alleviate sub-metatarsal pain has been lesser metatarsal osteotomies to shorten and/or elevate metatarsal heads. Results, however, have been less than predictable and often there is a worsening of the condition with new pathology superimposed.

Table 1

ETIOLOGY OF SUB-METATARSAL PAIN

Pathomechanical first ray (HV, HL, Metatarsal Elevatus)
Digital deformity at the MPJ
Predislocation Syndrome
Synovitis/capsulitis
Iatrogenic pathologic metatarsal parabola
Systemic Arthropathies
Degenerative Joint disease
Trauma
Freiberg's Infarction
Soft Tissue (verruca, porokeratosis, IPKs, keloids, plantar fibromas, Anterior displacement of the fat pad)
Stress Fracture Neuroma
Soft Tissue Mass

The podiatric literature has adopted much of the orthopedic dogma, however experience with biomechanics has added a better understanding of the etiology of lesser metatarsalgia. The real question then lies, where is the actual pathology in sub-second metatarsal pain? Experience over the years has proven that it makes no sense to alter normal anatomy through surgical procedures. Unfortunately, it is often difficult for clinicians to accept that pain beneath the second metatarsal head may not be due to a plantarflexed second ray.

CLINICAL EVALUATION

Evaluation of the first ray segment is crucial in the work-up of pain beneath the second metatarsal. An elevated first ray, whether it is purely structural or functional may result in lesser metatarsal overload. There are multiple reasons that the second metatarsal is most often involved in metatarsalgia. The second ray is usually the longest and may bear more pressure. The second ray is inherently stable and non-accommodating due to its anatomic relationship in its cuneiform mortise. The second metatarsophalangeal joint is predisposed to subluxation and eventual dislocation due to the pathomechanics of the first ray. Pathology of the second metatarsophalangeal joint has a significant influence on sub-metatarsal pain. Throughout the years, the faculty of The Podiatry Institute have

described the pathologic effects of the retrograde buckling forces on metatarsals (Fig. 3). Malay has described the influence of digital stabilization on lesser metatarsalgia.

A critical physical examination of the second metatarsophalangeal joint is paramount. Inspection for gross visual deformities is made. Subtle edema and or erythema may be apparent in inflammatory conditions. It is important to localize the exact point of maximum tenderness. Pain can be located in the joint or in a peri-articular location. Pain localized to the dorsal aspect of the joint is usually consistent with capsulitis. Pain located in the plantar aspect has historically been attributed to bursitis, which is probably inflammation of the plantar plate. Intra-articular pain, especially with range of motion is significant for degenerative joint disease. Pain between the metatarsals has been associated with a Morton's neuroma. It is the author's opinion that a second interspace neuroma is uncommon. Much of the interspace pain attributed to a neuroma is actually inflammation of the metatarsophalangeal joint capsule and plantar plate. In addition there may be inflammation of intermetatarsal bursae that compresses interdigital nerves mimicking a neuroma syndrome (Fig. 4). This raises an interesting question regarding diagnostic injections to rule out neuromas. Many clinicians feel confident with the neuroma diagnosis when pain is abolished with an injection.

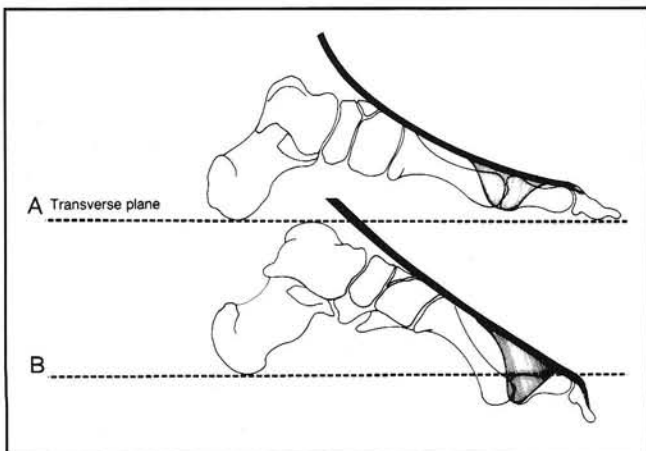


Figure 3. A. Illustration of a normal foot. B. Illustration of anterior cavus foot. Note the forefoot is plantarflexed. The extensor tendons would have to lengthen to straighten the toes. This is not possible, so plantarflexed metatarsals create "passive" pull on the extensor tendons causing dorsiflexion at the metatarsophalangeal joint (hammertoe formation).

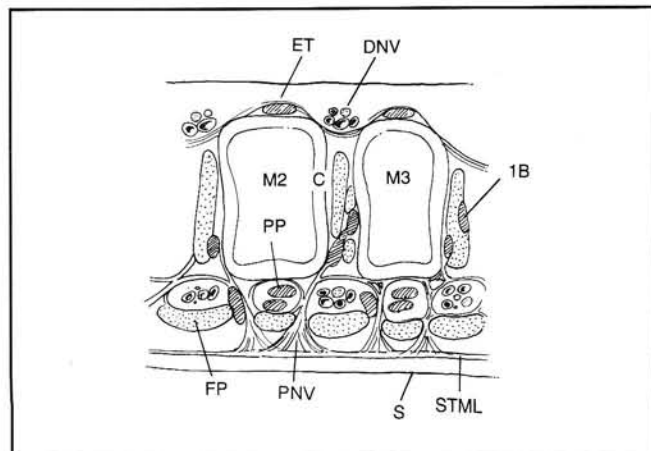


Figure 4. Cross-section of forefoot. Note the sites of irritation: PP, 1B, and C. M=metatarsal, C=capsule, PP=plantar plate, S=skin, ET=extensor tendon, 1B=intermetatarsal bursa, DNV=dorsal neurovascular bundle, PNV=plantar neurovascular bundle, STML=superficial transverse intermetatarsal ligament, FP=fat pad.

The majority of sub-second metatarsal pain is due to capsular and pericapsular inflammation, therefore, local anesthesia will eliminate pain and is not specific for the diagnosis of Morton's neuroma.

Radiographs are necessary in the evaluation of sub-two pain. Obvious bony pathology is ruled out. Rare instances of tumors, degenerative joint diseases (Freiberg's, osteoarthritis, and crystalline arthropathies), systemic rheumatic arthropathies, and stress fractures can readily be appreciated. Most of the time there will be no obvious osseous pathology. When radiographs are used for determination of structural deformities, a word of caution is in order. The relative amount of plantar protrusion of the metatarsal heads should not be based solely on a sesamoid axial radiograph. One should carefully palpate the metatarsal heads. A sagittal plane imbalance can easily be evaluated clinically. The sesamoid axial view, which has been described to assess the relative sagittal plane position of the metatarsal heads, can be misleading. The axial view is taken in such a position that is not consistent with normal gait or stance. It is impossible to get a foot in neutral position to take an axial view. When the metatarsophalangeal joints are hyperextended, there will be plantarflexion of the metatarsals. The first and fifth metatarsals have greater sagittal plane range of motion than the central rays. The second metatarsal is least capable of dorsiflexion due to its inherent stability. Therefore, it is difficult to determine a pure structural deformity of the metatarsals. The dorsoplantar view will reveal the relative lengths of the metatarsals. Remember the "normal" metatarsal

parabola is $2>1=3>4>5$. It is sometimes difficult to ascertain whether the first metatarsal is short or the second metatarsal is long. The lateral view will show the position of the first ray in the sagittal plane. An oblique view will be helpful in identifying sagittal position of the lesser metatarsals.

SURGICAL PLANNING

For intractable cases of sub-two pain, surgery may be indicated. An algorithm has been designed to illustrate a common sense approach to the sub-two syndrome (Fig. 5). When radiographs do not reveal any significant pathology, and soft tissue causes of pain have been ruled out, such as a neuroma or benign skin lesion, then the second digit is evaluated for deformity in the sagittal and transverse plane. All hammertoes are not created equally. If there is a metatarsophalangeal joint contracture, it should be addressed. Only addressing the proximal interphalangeal joint in a complex hammertoe will yield disappointing results. Next, the first ray is evaluated. Findings of hypermobility and structural deformities, such as hallux valgus and hallux limitus/rigidus should be addressed. Figures 6A - 6C will demonstrate a typical presentation of a sub-two lesion with a hypermobile first ray, hallux abducto valgus deformity and second digit hammertoe. Upon clinical examination, when there is a stable first ray without deformity and a rectus second metatarsophalangeal joint, then an osteotomy or condylectomy of the second metatarsal may be indicated for a structural deformity of the second ray.

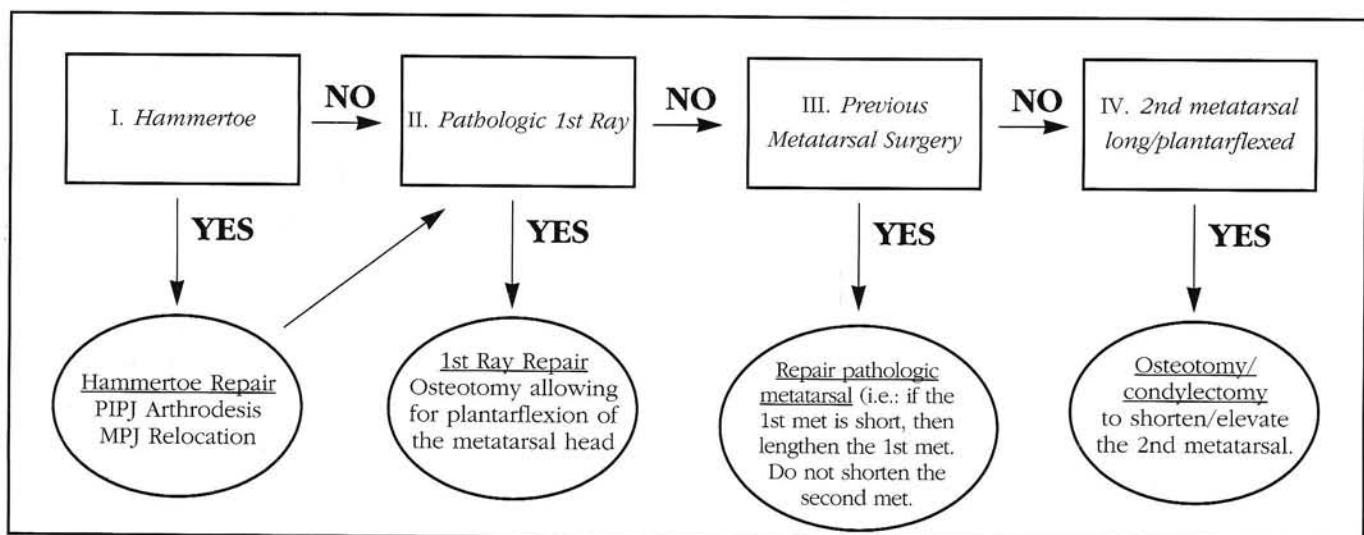


Figure 5. Algorithm for surgical approach to sub-two syndrome.

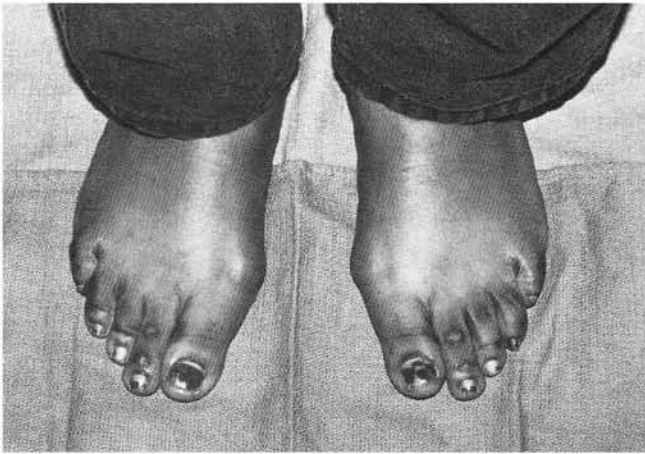


Figure 6A. Moderate HAV deformity.



Figure 6B. Clinically, there is an associated hypermobile first ray.

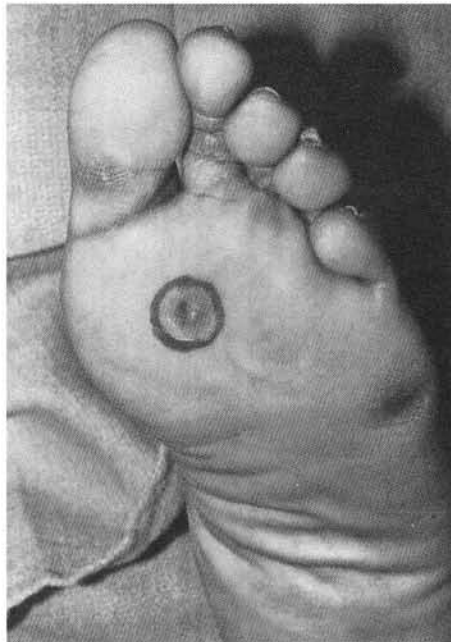


Figure 6C. Typical sub-two lesion.

SUMMARY

The sub-two syndrome is a common complaint in the general population. A common sense approach to the surgical management has been described. The basic premise lies in the fact that an unstable first ray and hammered second digit are usually the etiology of sub-two pain. Therefore, these pathologies should be addressed. Second metatarsal osteotomies and condylectomies should be undertaken with caution. Instances when lesser metatarsal osteotomies may be applicable include structural deformities, which tend to be associated with iatrogenic or traumatic causes.

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