

## First Metatarsophalangeal Joint Osteoarthritis – A Clinical Review

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### Abstract

The first metatarsophalangeal joint of the human foot may best be classified as an anatomically condyloid synovial juncture. This joint is primarily formed by the rounded head of the first metatarsal bone, in sequence with the shallow concavity of the base of the first proximal phalanx. Whilst there is no dorsal ligament supporting or stabilizing the first metatarsophalangeal joint, the structure is largely secured by both the adjoining collateral ligaments and the plantar metatarsal ligament respectively. The movements permitted at the first metatarsophalangeal joint are inclusive of flexion, extension, abduction and adduction. This articulation is particularly subjected to a significant amount of stress during the weight-bearing activity of human locomotion, and is consequently susceptible to the precipitated development of degenerative osteoarthritis through repetitive loading. Such a pathological sequence can elicit marked intra-articular pain and overall functional limitation capacity of the first metatarsophalangeal joint. In reference to the disorder of first metatarsophalangeal joint osteoarthritis, commonly referred to as either hallux limitus or hallux rigidus, this review will scrutinize the differential diagnoses, predisposing factors, physical examination traits and clinical management of the condition accordingly.

**Keywords:** Osteoarthritis; Bone; Joint; Metatarsophalangeal; Pain; Foot

### Introduction

The first metatarsophalangeal joint of the human foot may best be classified as an anatomically condyloid synovial juncture [1]. This joint is primarily formed by the rounded head of the first metatarsal bone, in sequence with the shallow concavity of the base of the first proximal phalanx [1]. Whilst there is no dorsal ligament supporting or stabilizing the first metatarsophalangeal joint, the structure is largely secured by both the adjoining collateral ligaments and the plantar metatarsal ligament respectively [1]. The movements permitted at the first metatarsophalangeal joint are inclusive of flexion, extension, abduction and adduction [2]. This articulation is particularly subjected to a significant amount of stress during the weight-bearing activity of human locomotion, and is consequently susceptible to the precipitated development of degenerative osteoarthritis through repetitive loading [3]. Such a pathological sequence can elicit marked intra-articular pain and overall functional limitation capacity of the first metatarsophalangeal joint [4]. In reference to the disorder of first metatarsophalangeal joint osteoarthritis, commonly referred to as either hallux limitus or hallux rigidus, this review will scrutinize the differential diagnoses, predisposing factors, physical examination traits and clinical management of the condition accordingly [3].

### Description of the Condition

It is clinically acknowledged that osteoarthritis is the most common form of disease process affecting anatomical joints of the human body [5]. The prevalence of osteoarthritis is strongly correlated with age, and it has been reported that radiographic changes in the first MPJ are evident in approximately 46% of women and 32% of men at 60 years of age [6-8]. The pathological hallmark of osteoarthritis is defined by a

progressive loss of articular cartilage from the load-bearing surface of a synovial joint [5]. This degenerative change is often accompanied by appositional growth of new bone in the subchondral regions, fibrocartilage and bone growth at the margins of articular surfaces, and regional osteonecrosis of subchondral bone [5]. When these pathological features restrict adequate first metatarsophalangeal joint range of motion during terminal-stance and pre-swing phases of gait, biomechanical foot function may be impaired and altered gait patterning can occur [9]. It is noted that the normal range of motion for the first metatarsophalangeal joint equates to one hundred and ten degrees in total [10]. This encompasses seventy-five degrees of dorsiflexion and thirty-five degrees of plantar-flexion respectively [10].

The two types of joint pain presenting with osteoarthritis are of both a mechanical and inflammatory nature [11]. Mechanical osteoarthritic joint pain is aggravated by prolonged functional weight-bearing, excessive range of movement elicited at the joint, and an increased mechanical load [11]. Classic mechanical osteoarthritis is usually described as a deepened dull aching sensation, and with further progression of the disease, these symptoms may become constant [12]. In contrast, the onset and frequency of inflammatory osteoarthritic joint pain is far less predictable [13]. Inflammatory osteoarthritic joint pain is most often described as a burning sensation. This may persist for days if left untreated [13]. Changes in the environmental weather conditions, prolonged walking durations, and minor sprains to the affected joint-line may all be potential triggers of such symptoms [13]. It is recognized that inflammatory osteoarthritic pain intermittently occurs adjunct to mechanical osteoarthritic symptoms, and is depicted as exaggerated residual 'flares' when this occurs [13].

### Differential Diagnosis

Several metabolic, soft-tissue, systemic and other unusual pathologies may surround the symptomatic first metatarsophalangeal joint [14]. Although less common in presentation, these disorders may

include various arthritides, infections, tumors, vascular and neurologic abnormalities, as well as the complex pathologies associated with the diabetic foot [14]. Accordingly, some of the varied differential diagnoses of first metatarsophalangeal joint osteoarthritis can incorporate the following: gout, inflammatory arthropathies, infectious arthritis, osteochondritis dissecans, first metatarsophalangeal joint sprain, first metatarsophalangeal joint synovitis and effusion, articular trauma, joplin's neuritis, stress fracture of the first metatarsal head, sesamoid pathology and osteomyelitis [10,15]. In more specifically clarifying the severity of first metatarsophalangeal joint osteoarthritic degeneration, osteoarthritis of this articulation may be sub-classified as either hallux limitus or hallux rigidus [3]. The clinical differentiation of these two sub-classifications describes restricted first metatarsophalangeal joint sagittal plane motion for hallux limitus, and the complete absence of first metatarsophalangeal joint sagittal plane motion secondary to osseous joint fusion for hallux rigidus [3].

### Aetiology and Predisposing Factors

The aetiology and predisposing factors of first metatarsophalangeal joint osteoarthritis are purportedly numerous and may be multi-factorial [16]. Structural foot morphological measures/features demonstrating an associative causative influence on first metatarsophalangeal joint osteoarthritis include: a greater first metatarsal protrusion distance, an elevated first metatarsal, an increased lateral inter-metatarsal angle, both a longer and shorter first metatarsal, a wider first metatarsal, a wider proximal phalanx, a longer distal phalanx, longer medial and lateral sesamoids, immobility and hypermobility of the first ray, a pes planovalgus foot type [7,10,16-21]. There are several other postulated pathological pre-dispositions of first metatarsophalangeal joint osteoarthritis inclusive of: familial history, acute and repetitive articular trauma, hallux abducto-valgus deformity, osseous tarsal coalition, osteochondritis dissecans, gout formation, excessive pronation moments in gait, neuromuscular disorders, rheumatoid arthritis, seronegative arthritis, infectious arthritis, ill-fitted stiff soled footwear, plantar soft tissue retraction of intrinsic foot muscles, excessive tension of the plantar fascia, progressive fibrosis of the flexor hallucis longus tendon, iatrogenic related causes [10,16,22-27]. It is asserted that these pathological predispositions listed above, affect the anatomical integrity of the first metatarsophalangeal joint and derive articular pain characteristics through joint specific dysfunctional disease processes. Structural articular alteration, muscle weakness and altered functional usage of the osteoarthritic first metatarsophalangeal joint, can further precipitate stretching of the joint capsule, muscular spasm, enthesopathy and bursitis, leading to activity-induced symptomology [13]. Subchondral bone microfracture and osteophytes that distort nerve endings within the periosteum can manifest regular joint pain on functional use [13]. Osseous infarction secondary to the inhibited medullary vascularity and thickened subchondral trabeculae, can lead to intraosseous hypertension and intrasosseous stasis, which is believed to be a contributing attribute of nocturnal joint pain [28]. Articular inflammation incorporating entheses, joint capsules and synovium may elicit osteoarthritic pain at rest [13].

### Examination Traits

As patients can present with either acute or chronic joint pain secondary to first metatarsophalangeal joint osteoarthritis, a comprehensive medical history must be attained to eliminate differential systemic pathologies [14]. Accompanying the relative

generalized foot pain and reported articular discomfort, the clinical signs evident upon physical examination of first metatarsophalangeal joint osteoarthritis may incorporate: articular swelling/effusion and crepitus, restricted first metatarsophalangeal joint range of motion (particularly dorsiflexion movement), bony proliferations dorsal or medial to the anatomical juncture, functional joint pain, joint temperature increases and erythema, neuritic irritation of cutaneous nerves on percussion preceding further sensory changes (including parathesia, hyperesthesia and hypoesthesia), peri-articular muscular wasting, hyperextension of the interphalangeal joint with associative plantar hyperkeratosis, a limped and propulsive gait (as the patient attempts to shift mass laterally or externally rotate at the hip to prolong ground clearance and lever off the lesser metatarsals) [10,13,18,19,27,29-31]. Depicted motion analysis of the first metatarsophalangeal joint in patients with osteoarthritis, reveals instant centers of rotation that are displaced and located eccentrically about the metatarsal head [30]. Higher than average dynamic plantar pressures of the first ray are also observed in symptomatic patients with first metatarsophalangeal joint osteoarthritis [32].

The standard radiographic examination sequence for assessing first metatarsophalangeal joint osteoarthritis should include weight-bearing antero-posterior and lateral views of the symptomatic foot [18]. Accordingly, oblique and axial views of the sesamoid bones may additionally be attained to observe a more plantar interpretation of the first metatarsal [10]. On plain films, first metatarsophalangeal joint osteoarthritis is largely characterized by non-uniform joint space-narrowing, osteophyte proliferation of both the metatarsal head and proximal phalanx, subchondral sclerosis, sub-articular cyst formation and sesamoid hypertrophy [22]. It is acknowledged that radiographic studies are essential for assessing the first metatarsophalangeal joint articular integrity, in establishing the appropriate subsequent surgical procedural requirements as needed [10]. It should be further highlighted that the overall degree of first metatarsophalangeal joint pain reported by symptomatic patients, does not always definitively correlate with the significance of apparent osteoarthritic structural changes obvious on plain radiographs, and vice versa [33].

### Management

Prior to commencing any form of clinical management or intervention strategy sequence for the treatment of first metatarsophalangeal joint osteoarthritis, many objective considerations must be evaluated by the investigating clinician [34]. A symptomatic patient's age, physical activity level, treatment expectations of symptom regression and functional improvement, prior treatment regimes and both radiographic and clinical grading, should be collectively appraised in accordance with potential ongoing treatment advancements [34]. This will significantly assist the process of formulating a logical and appropriate therapeutic plan for the patient [34]. The major clinical goals of both conservative and surgical treatment methods for first metatarsophalangeal joint osteoarthritis include: articular pain relief, restoration of adequate joint range of movement, resolution of precipitated lesser metatarsal symptomology, and further prevention of the progressive degenerative osteoarthritic process [35].

The conservative treatment modalities utilized for first metatarsophalangeal joint osteoarthritis are many and varied [3]. Plausible intervention measures may include: joint mobilization and immobilization techniques, joint manipulation, footwear modifications and prescription, physical activity modification/

adjustments, acupuncture, intrinsic musculature strengthening, applicable stretching regimes, electrotherapy, heat or cold therapy, both accommodative and customized foot orthoses [3,10,35]. Pharmacological treatment interventions may primarily constitute: non-steroidal anti-inflammatory or opioid drug prescription, intra-articular cortisone and hyaluronic acid injections, glucosamine and chondroitin supplements, and topical capsaicin cream applications [3,4]. It is advised that a combination of appropriate pharmacological and conservative non-pharmacological treatments be offered initially to all symptomatic patients' suffering first metatarsophalangeal joint osteoarthritis [4].

The surgical treatment options for first metatarsophalangeal joint osteoarthritis may be indicated if conservative therapeutic measures fail to sufficiently alleviate symptoms [3,27]. As with conservative care methods, the decision to adopt an appropriate surgical repertoire should be selectively based on the level or extent of patient symptoms. In the majority of cases, there is no urgency to necessitate recommended surgical procedures for the treatment of first metatarsophalangeal joint osteoarthritis [18]. In saying this however, the disease process of osteoarthritis is uniformly progressive, with continued articular degenerative changes anticipated over the course of time [18]. It is acknowledged that the major surgical procedures routinely implemented by surgeons for this pathology include the following: cheilectomy, arthrodesis, arthroplasty, osteotomy, soft tissue release and sesamoid release or excision [36].

The cheilectomy procedure encompasses a remodeling of the articular osteophytes associated to a dorsal osteotomy of the first metatarsal and proximal phalanx [10]. This surgical movement is essentially utilized to treat lower grades of first metatarsophalangeal joint osteoarthritis, in which both the articular space and cartilage are relatively preserved [34]. The surgery formally aims to improve the amount of first metatarsophalangeal joint dorsiflexion that has been limited by the presence of osteophytes, and to also reduce the apparent residual first metatarsophalangeal joint pain [10]. First metatarsal osteotomies are frequently performed to structurally decompress the first metatarsophalangeal joint, in an effort to achieve an overall lowering positioning of the first metatarsal head [10]. The two procedures listed above may be classified as 'joint salvage' maneuvers, as they each attempt to restore functional capability with minor articular intrusion to the first metatarsophalangeal joint itself [27]. It must be recognized that both of these joint-preserving procedures are only of effective value, where there is apparent absence of severe degenerative articular change [27]. Surgical attempts to restore available joint movement and maintain articular joint surfaces amidst the presence of significant degenerative osteoarthritis or severe cartilage loss, usually results in exaggerated ongoing symptoms for the patient [27].

The surgical treatment of advanced stage first metatarsophalangeal joint osteoarthritis is complex, secondary to the chronicity of the degenerative disease process [34]. The overall degree of osteophyte formation, prominent loss of joint space, and gross restrictions in joint movement all gradually increase over time, collectively leaving peri-articular soft tissues in a contracted state [34]. In the instance whereby there is marked signs of first metatarsophalangeal joint pain during an entire range of motion assessment, and accompanying radiographic depictions of severe degenerative osseous articular changes, requirements for joint destructive surgery means are specifically considered [27]. The options in this circumstance primarily entail an

excisional arthroplasty, interposition arthroplasty, implant arthroplasty or complete arthrodesis [27].

## Conclusion

In conclusion, osteoarthritis of the first metatarsophalangeal joint may result in localized articular and referred foot pain, impeded functional limitation capacity and reduced participation in physical activity [4]. It has been acknowledged that there is a vast range of both conservative and surgical treatment options available to the practicing clinician, depending on appropriate patient-specific variables discussed [4]. It is essential that the continuation of research and well-designed studies evaluating the efficacy of current treatment options for first metatarsophalangeal joint osteoarthritis be performed [3]. This submission has reviewed and scrutinized the differential diagnoses, predisposing factors, physical examination traits and extended clinical management strategies of the condition.

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