Hallux Valgus in Dancers
A Closer Look at Dance Technique and Its Impact on Dancers' Feet

Kathleen L. Davenport, M.D., Liane Simmel, M.D., and Nancy Kadel, M.D.

Abstract

Hallux valgus is a common deformity of the forefoot. There is no doubt that some dancers develop hallux valgus, but the question remains as to whether dancers are at greater risk than the general population for developing this deformity. Review of the literature reveals on-going debate regarding risk factors for hallux valgus, which may include increasing age, female gender, genetic predisposition, constrictive shoe wear, first ray hypermobility, foot architecture, tight Achilles tendon, and first metatarsal length. There is insufficient evidence to demonstrate conclusively that dancing, specifically pointe work, increases the prevalence or severity of hallux valgus; more research is needed. Treatment of hallux valgus in dancers should be conservative, with delay of surgical correction until retirement if possible.

Hallux valgus is a deformity of the foot characterized by medial deviation of the first metatarsal with associated lateral deviation of the great toe.[1] It is relatively common, with the pooled prevalence in the general population being reported as 23% (range 16.3% to 29.6%).[2] Constrictive shoe wear has been shown to be a risk factor for hallux valgus (see Anatomy and Extrinsic Risk Factors below).[3-5] It may, therefore, seem logical that dancers would be at high risk for developing this deformity, and there is no doubt that some dancers are indeed prone to hallux valgus. However, the question remains as to whether dancers are at greater risk than the general population for developing this condition. Additionally, it is uncertain if the demands of some dance techniques, especially ballet dancing en pointe, promote hallux valgus. The intent of the current study was to explore the anatomy, pathophysiology, and risk factors for hallux valgus as they pertain to the dancing population. Given the current literature on this topic, much of this review article is focused on ballet and specifically pointe technique, but many of the observations offered here can be applied to virtually any style of dance.

Anatomy

The anatomy of the foot is quite intricate, involving a complex interaction between multiple articulations, joints, and movements. The foot and ankle contain 26 to 30 bones, with their related ossicles and sesamoids, and are associated with more than 20 muscles and over 10 ligaments.[6,7] The foot is divided for the sake of clinical consideration into the hindfoot, midfoot, and forefoot. The forefoot is comprised of the proximal, middle, and distal phalanges while the midfoot includes the cuboid, navicular, cuneiforms, and metatarsals.[6] Hallux valgus occurs at the interface between the forefoot and the midfoot, at the first metatarsophalangeal (MTP) joint. An increased deviation of the first metatarsal and hypermobility of the first metatarsal-medial cuneiform joint is seen in hallux valgus deformity.

The first MTP joint is classified as a modified ball and socket joint, as it does not permit a similar degree of range of motion compared to the hip or glenohumeral joints, and the articular surface is not a complete sphere (Fig. 1). The sesamoid bones lie embedded in the plantar aspect of the flexor hallucis brevis tendon. Medially, the medial (tibial) sesamoid and the medial collateral ligaments serve to support the metatarsophalangeal joint. Lateral structures include the deep transverse ligament, adductor hallucis muscle, and the lateral (fibular) sesamoid and flexor hallucis brevis muscle. The normal first MTP angle is less than 15°, and the normal first-

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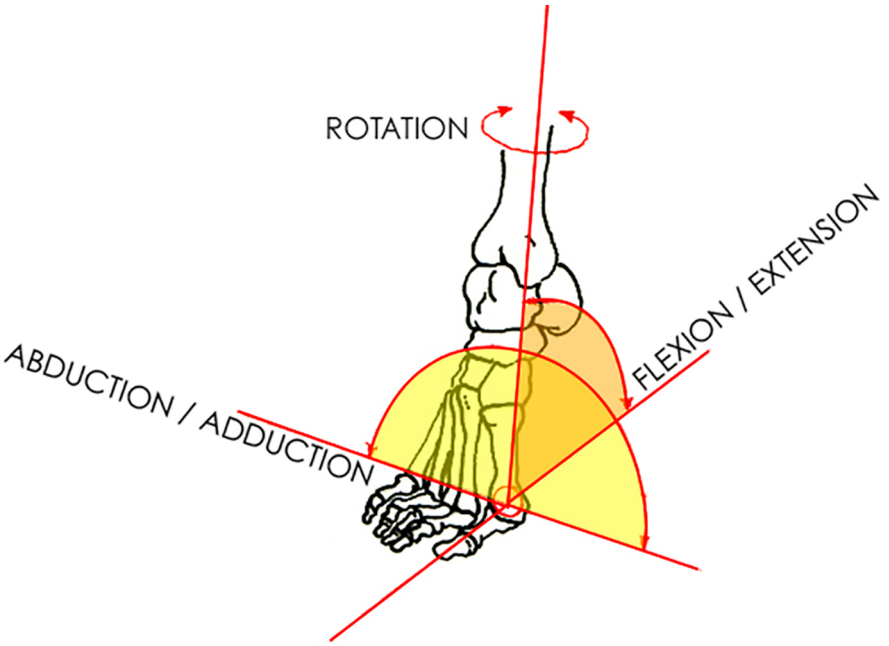

Figure 1 Cardinal motions around the first metatarsal (MTP) joint.

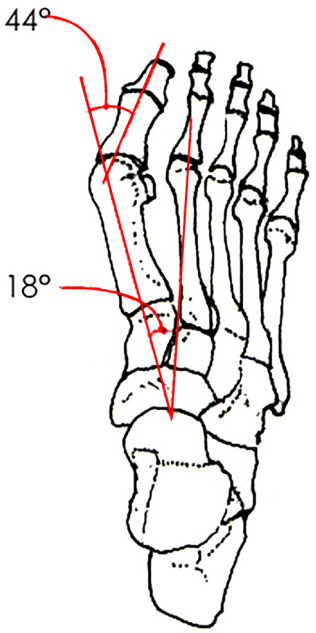

Figure 2 First-second intermetatarsal angle (IMA) of 18°. More than 9° is diagnostic of hallux valgus.

second intermetatarsal angle (IMA) is less than 9° (Fig. 2).[7]

Hallux valgus deformity is the result of a progressive medial shift of the metatarsal head along with pronation of the metatarsal and lateral deviation of the phalanx. The medial capsule and collateral ligaments attenuate, and the lateral structures, including the deep transverse intermetatarsal ligament, the lateral sesamoid complex, and the adductor hallucis muscle, tighten to produce a lateral pull on the phalanx. As the phalanx becomes misaligned, the abductor hallucis can contribute to pronation while the extensor hallucis longus becomes an adducting force on the phalanx, promoting progression of the deformity (Fig. 3). Subluxation of the sesamoids occurs in later stages of the deformity; in actuality, there is no true sesamoid subluxation but rather a medial deviation of the first metatarsal relative to the sesamoid complex.

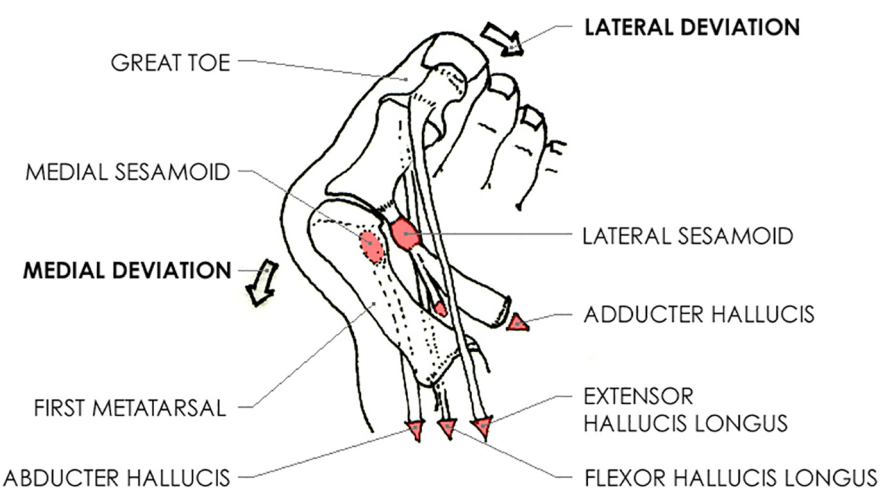

Figure 3 Anatomy of the forefoot demonstrating the altered forces from hallux valgus. The altered anatomy and forces then exacerbates the deformity.

Presentation

Diagnosis of hallux valgus is usually made on the basis of clinical and radiographic findings. Patients often present with pain over the medial eminence or MTP pain.[8-10] This pain is frequently due to, or exacerbated by, pressure from constrictive shoes. Skin irritation, bursal swelling, and skin breakdown have all been associated with hallux valgus.[1,8] On physical exam, the patient often has tenderness to palpation over the medial eminence. The foot should be examined for pes planus, hypermobility of the first ray, Achilles tendon contracture, and MTP joint mobility, which have all been implicated, but not necessarily established, as risk factors for hallux valgus formation.[1,8,9,11-13] These factors will be discussed in more detail later. An attempt at passively reducing the deformity to neutral is recommended during the physical exam so that the practitioner can tailor treatment options accordingly. The deformity often worsens with weightbearing, and both seated and standing evaluation should be performed for diagnosis.[8]

Radiographic findings are often included in the diagnosis of hallux valgus, which can be described radiographically

Figure 4 Congruent hallux valgus.

Figure 5 Incongruent hallux valgus.

as congruent (Fig. 4) or incongruent (Fig. 5). Congruent hallux valgus has increased MTP and IMA angles, which are less than 20° and 12°, respectively. Incongruent hallux valgus involves MTP and IMA angles greater than 20° and 12°, respectively.[7] A severe hallux valgus is characterized by an MTP angle greater than 40° and an IMA angle greater than 16°.[8] The alteration of normal foot architecture due to hallux valgus changes the foot's biomechanics and the forces placed on the foot, particularly in the structures surrounding the first MTP joint. The change in force distribution can lead to secondary problems in the foot, such as a soft corn, bursitis, neuroma, stress fracture of the second or third metatarsal, transfer lesion (callous formation under the head of the second metatarsal), sesamoid degeneration, achillodynia, posterior tibial tendonitis, and arthritis.

Intrinsic Risk Factors for Hallux Valgus

Hallux valgus has been shown to increase in prevalence with age; the pooled prevalence is 7.8% in patients under 18, 23% in patients 18 to 65, and 35.7% in patients who are over 65 years of age.[2] Gender also plays a role in the development of the deformity, with the average prevalence in females being 2.3 times greater than in males,[2] although one study showed this prevalence to be as high as 15 times greater in female patients.[14] It has been postulated that the female predisposition to hallux valgus formation may be due to shoe wear rather than innate risk factors.[15] Heredity has been shown to play a role in the development of hallux valgus,[9,14,16] and it is felt to have a genetic predisposition with incomplete penetrance. It is more likely due to genetic factors when present in younger patients.[14] Most patients (86%) with this deformity have a positive family history[9]; one study of 31 juvenile hallux valgus patients noted 29/31 of their mothers (94%) also had the deformity.[16] Hallux valgus has also been shown to be less common in African populations.[17,18]

Anatomical factors, such as first ray hypermobility, foot architecture, tight Achilles tendon, and first metatarsal length, have also been postulated as risk factors for hallux valgus. It may seem logical that hypermobility would place the dancer at increased risk for developing hallux valgus, with theoretical decreased stability in the first MTP joint or the first metatarsocuneiform joint, leading to a widened IM angle. This theory is supported by an increased risk for hallux valgus in patients with such hypermobile conditions as rheumatoid arthritis,[19] Marfan syndrome, and Ehlers-Danlos syndrome.[13] Additionally, patients with hallux valgus have been shown to be hypermobile at the first ray,[9] but causation has never been demonstrated prospectively, and increased Beighton score has not been shown to be associated with hallux valgus.[20]

Another anatomic foot variation, pes planus, has been demonstrated to be associated with hallux valgus[11,21]; however, there is still debate as to its role in hallux valgus formation.[16] Pes planus can promote pronation and therefore increase valgus stress on the first MTP. Severity of pes planus does not correlate with severity of hallux valgus,[9,21] but patients with both pes

planus and hallux valgus may be at increased risk for more rapid progression of the deformity. At this time, it is thought that pes planus likely contributes to hallux valgus pathology, but its role is imperfectly understood.

In addition to pes planus, Achilles tendon contracture or tightness has also been demonstrated to be associated with hallux valgus formation.[1,8] Achilles tendon tightness leads to early loading during the gait cycle and to external rotation of the foot, which then places increased stress over the medial forefoot structures.[15] This stress may place the foot at a biomechanical disadvantage that increases the risk for formation of the deformity. However, in patients with hallux valgus, there is no difference in severity of the foot deformity with worsening ankle dorsiflexion range of motion.[9] Thus, Achilles tightness places the patient at increased risk for developing hallux valgus but not necessarily for a more severe deformity.

First metatarsal length has been debated as a risk factor for hallux valgus deformity. Short metatarsal length was initially thought to be associated with hallux valgus,[22] but subsequently it has been shown that longer first metatarsal length has a positive correlation with hallux valgus formation.[9,12] It has been postulated that the longer first metatarsal is prone to buckling in constrictive shoe wear, thus weakening the capsule and placing the joint at risk for hypermobility and resulting deformity.[23] Therefore, it is recommended to ensure proper fit of shoe wear, particularly dance shoes with constrictive toe boxes, such as pointe and character shoes.

Extrinsic Risk Factors for Hallux Valgus

As indicated above, footwear has been implicated as another risk factor for hallux valgus deformity. It has also been demonstrated that the use of constrictive footwear is necessary, but not sufficient, for developing hallux valgus.[3] The deformity has been found in unshod populations,[24] and those that have transitioned from unshod or minimal shoe-wear to western style shoes have shown an increase in the prevalence of hallux valgus.[4,5] Therefore, evidence strongly suggests that constrictive shoes play a role in the development of hallux valgus, particularly in the genetically pre-disposed individual. However, these studies do not address whether dance shoes, specifically pointe work, place the dancer at an increased risk compared to the general shoe-wearing population.

Dance in itself has been postulated as a possible risk factor for hallux valgus, due to the unique forces placed on the foot while in the extreme positions required for this discipline. The en pointe and high relevé positions place the foot in abduction, thus increasing the valgus force on the first MTP joint. Improper technique, such as rolling in, winging the foot, or forcing turnout can further increase the valgus forces on the first MTP joint.[25] As already indicated, the constrictive nature of pointe shoes theoretically exacerbates the damaging effect of these alterations in normal foot pressure forces.

Ballet Dance and Hallux Valgus

There is conflicting evidence regarding ballet dancers and hallux valgus deformity. In 1960, it was demonstrated that 89% of professional ballet dancers had hallux valgus, compared to 51% of non-ballet stage performers.[26] Both of these groups' prevalence was well above the 23% reported for the general population in ages 18 to 65.[2] Measurements for this study were done clinically and grading was not applied. In 1995, a study showed no significant difference in mean hallux valgus angle between active dancers and retired dancers.[27] This study used x-ray angulation for the determination of hallux valgus. It did show increased angles with aging in female dancers (19.1° compared to 25.9°) and also higher angles in females than in males. In the same year, it was demonstrated that a higher prevalence of hallux valgus was found in retired ballet dancers than in non-dancer controls aged 50 to 70.[28] Of the 19 dancers recruited, 14 had a hallux valgus greater than 25° (74%) compared to 1 in 19 of age matched controls (< 1%). In a review article, it was proposed that dancing is not an inherent risk factor for developing hallux valgus, but this was based on anecdotal observation and review of the available literature.[29] Currently, there is no evidence-based consensus regarding dance, and specifically pointe work, as a risk factor for developing hallux valgus. Certainly, dancing en pointe is not protective of hallux valgus formation, particularly in the genetically predisposed individual, but there is not sufficient evidence to conclude that pointe work causes the deformity.

Technique may play a role in the development of hallux valgus, though most of the available information has been deduced through biomechanical analysis of a theoretical nature. As previously mentioned, it has been suggested that hyperpronation ("rolling in") or excessive "winging" of the foot while en pointe or demi-pointe can result in microtrauma of the MTP joint capsule and predispose the dancer to hallux valgus deformity.[29] Similarly, rolling in can result in abnormal pressure distribution throughout the foot, which can also place the dancer at risk for developing hallux valgus or other foot deformity.[30] Careful attention should be paid to dancers with certain anatomical body or foot types, such as decreased hip external rotation and a longer second metatarsal. With regard to decreased hip external rotation, turn out may be augmented at the knee, ankle, and foot. While this is common, every effort should be made to avoid hyperpronation of the foot as a compensatory technique, as this may increase the risk of hallux valgus development.[31] Dancers with a longer second metatarsal have been shown to experience increased pain, callus formation, and inflammatory signs at the first MTP joint with pointe work.[32,33] While not a contraindication to dancing en pointe, such dancers may require additional padding to improve force distribution over the toes while en pointe. As reviewed above, pes planus is controversial as a risk factor for development of hallux

valgus, but a dancer with both pes planus and hallux valgus is at higher risk for increased rate of progression.[15] Therefore, dancers may benefit from individualized attention to promote safe pointe work and decrease the risk of hallux valgus and other dance injuries.

There were no studies found upon literature review that examine different styles of pointe shoes in relationship to hallux valgus formation. This was not unexpected, as each dancer has a unique foot structure and may have individual pointe shoe needs. While no scientific studies are available for recommendation, many clinicians who treat ballet dancers suggest that inappropriate fit of pointe shoes could exacerbate hallux valgus formation and may be implicated in a painful bursitis or cellulitis. An overly narrow toe box could place the phalanges in an excessively adducted position, thereby causing increased valgus stress at the MTP joint. Conversely, if the toe box is not supportive enough, the toes may collapse and cause the forces to be transmitted through the MTP interphalangeal joints rather than the end of the toes. Additionally, a short toe box that ends below the MTP joint line can promote valgus collapse of the hallux and allow for inappropriate force distribution. If a secondary issue has arisen from dancing en pointe with a bunion, such as cellulitis, bursitis, or a blister under a callous, a constricting toe box is often implicated. Therefore, while further research is needed, proper pointe shoe fit can be recommended to prevent or delay hallux valgus deformity in the predisposed dancer.

Treatment

There is no evidence-based literature available for treatment of hallux valgus in dancers. The following recommendations are, therefore, based solely on clinical opinion, but patients have subjectively reported increased comfort from their application. In its early stages, hallux valgus should be treated conservatively. Certainly, conservative management is recommended if a dancer intends to continue performing at an advanced level. The most important component of treatment is prevention of the deformity through proper technique and alignment. Even after formation of hallux valgus, correction of technique and alignment errors can slow or prevent progression. Distributing weight over the foot appropriately by using the external hip rotators in both turned out and parallel positions is particularly important for prevention (Fig. 6). Stretching a tight or contracted Achilles tendon with its associated ankle plantar muscles may improve distribution of the kinetic forces through the foot. Additionally, dancers should be instructed in exercises to strengthen the intrinsic foot muscles and the abductor hallucis muscle.[30] These exercises can include doming of the foot while keeping the toes extended and pulling a towel posteriorly by flexing the toes only in the proximal interdigital joints. Toe spacers and horseshoe pads can be utilized to improve MTP joint alignment and reduce pressure over it. However, these measures are primarily effective for those dancers whose first MTP joint deformity is flexible and can be moved passively out of the valgus deviation into the neutral position. A toe spacer can be fashioned from a make-up sponge or purchased commercially. Bunion splints can be helpful, particularly when worn at night to improve painful symptoms and an associated bursitis. Yoga toes or similar over the counter bunion aids may also provide relief to the dancer.

Secondary lesions may arise from dancing with a hallux valgus defor-

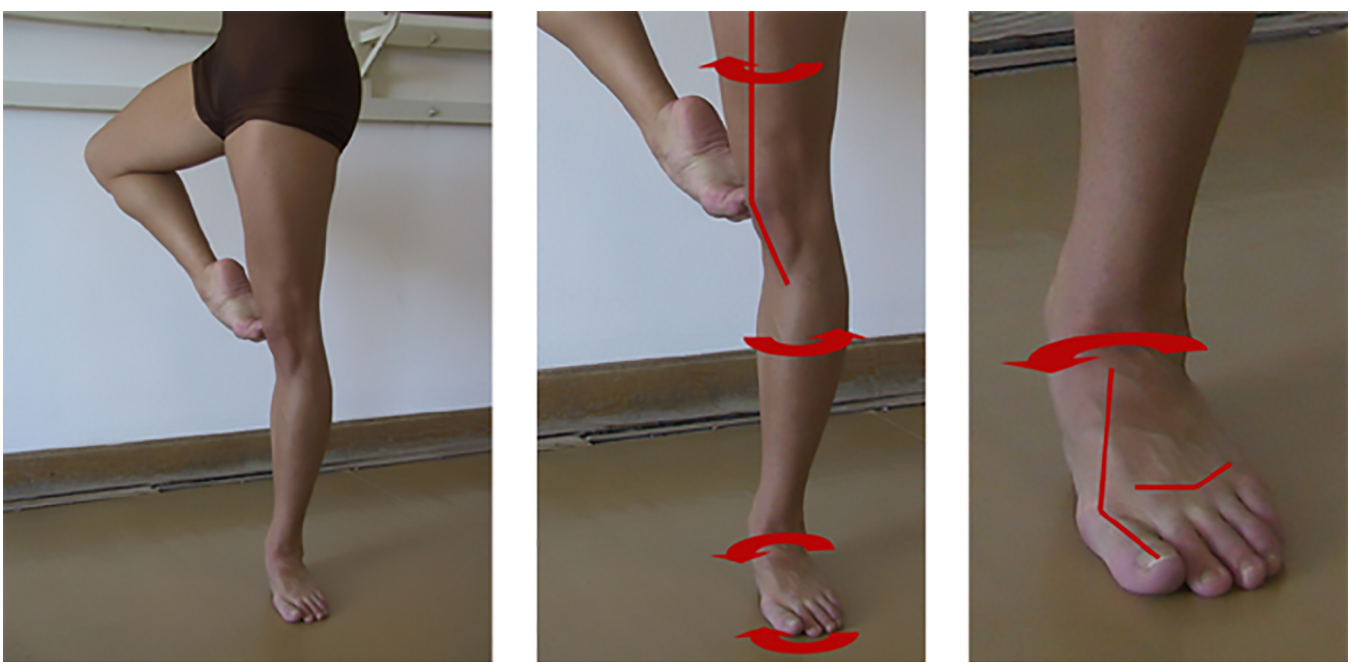

Figure 6 Rotation of the standing leg with even weight distribution over the foot is important for dance technique and for prevention of worsening hallux valgus deformity.

mity. These may include a bursitis, cellulitis, and a blister under the callous. In addition to the primary bunion, it is suggested to also treat a secondary lesion. A bursitis or blister under the callous may be treated with drainage, anti-inflammatory medication, and particular attention to avoiding irritation of the hallux valgus deformity. Irritation may be alleviated with toe spacers and padding in the shoe. A septic bursitis or cellulitis may be a serious complication from irritation of a hallux valgus deformity. These may present with increased erythema and pain. Antibiotics and warm soaks are started if infection is suspected; drainage should be considered if fluctuance is present.

As discussed above, correct fit of pointe shoes is also essential for prevention and management. A higher vamp in the pointe shoe may improve symptoms by promoting additional support of the MTP joint.[34] Many dance medicine practitioners recommend refitting pointe shoes every 2 to 3 years after the epiphyseal plates have closed. It is also important that the dancer not use worn pointe shoes, so as to have adequate support with optimal redistribution of foot pressures while in the en pointe position.[34] These measures may not prevent hallux valgus deformity and are unlikely to correct an ongoing deformity; however, they can slow progression and decrease severity by reducing the valgus force through the MTP joint.

In the professional ballet dancer, it is recommended to avoid surgery until the time of retirement,[29,30,34] as it is rare for a dancer to regain sufficient flexibility of the first metatarsal joint to be able to return to professional ballet after hallux valgus surgery. Nonetheless, if conservative treatment fails, surgical consideration may be necessary[35] (and a dancer specializing in such styles as musical theater or jazz, which do not require the same range of motion, may become a surgical candidate earlier than a professional ballet dancer). Operative reconstruction options depend on the severity of deformity, specifically regarding the level of sesamoid subluxation and increased toe pronation.[8] Specific surgical techniques are beyond the scope of this article. However, it is highly recommended that a foot and ankle surgeon with specialized knowledge of this unique population be consulted if a dancer is considering surgical intervention.

Summary

Hallux valgus is a relatively common deformity in the general, shoe-wearing population. The cause of hallux valgus formation is multifactorial and likely results from a combination of intrinsic factors, such as genetic predisposition and foot shape, and extrinsic factors, such as shoe choice. It is unclear if dance technique, and specifically pointe work, places the dancer at an increased risk for hallux valgus formation. Nevertheless, proper technique and pointe shoe fit are suggested for the prevention of hallux valgus and related dance injuries. Treatment proposals currently remain clinical opinion due to lack of available evidence. Conservative treatment is recommended for the professional dancer, and may include correcting pointe shoe fit and technique issues (specifically avoiding over turn-out and rolling in), use of toe spacers, stretching the ankle plantar flexor muscles, and strengthening the intrinsic foot musculature. The presence of a bursitis or infection may require additional treatment, including antibiotics if indicated. Surgical correction should be tailored to the specific needs of the individual dancer and should be delayed, if possible, until retirement. It is recommended that surgical consultation should be under the guidance of a dance-medicine specialist.

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