

Hallux valgus correction

Anatomy & Pathophysiology

DEFINITION AND ETIOLOGY

- Hallux valgus is defined as lateral deviation of the great toe with medial deviation of the first metatarsal [3].
- Hallux valgus is defined as lateral deviation of the proximal phalanx on the first metatarsal head [9].
- Hallux valgus deformity is defined as the lateral deviation of the proximal phalanx of the first metatarsophalangeal joint [10].
- The etiology of hallux valgus is likely multifactorial, involving intrinsic factors such as genetic predisposition, ligamentous laxity, and predisposing anatomy [3].
- Extrinsic factors such as certain types of footwear, including narrow toe boxes and high heels, play a role in the pathophysiology of hallux valgus [3].
- Hallux valgus is more common in women than in men [9].
- The incidence of hallux valgus deformity is 10 times greater in women than in men [14].
- Of patients with hallux valgus, 70% have a family history of the condition, suggesting a hereditary component [9].
- Hallux valgus is frequently associated with medial deviation of the first metatarsal [9].
- Metatarsus primus varus and pes planus have been implicated in the etiology of hallux valgus [9].
- Other causes of hallux valgus include rheumatoid arthritis, connective tissue disorders, and cerebral palsy [9].
- Hallux valgus is not associated with chronic tightness of the Achilles tendon or gastrocnemius, increased first ray mobility, bilaterality, or pes planus [14].
- The deformity is usually progressive, although the rate and degree of progression is often nonlinear [10].
- Hallux valgus is most commonly seen in female patients in their fourth or fifth decades of life [10].

PATHOANATOMY

- The pathoanatomy of hallux valgus involves gradual failure of the medial supportive structures, specifically the medial collateral ligament and tibial sesamoid, resulting in a varus position of the first metatarsal [10].

- Medial capsular attenuation is a component of the pathoanatomy of hallux valgus [3].
- The proximal phalanx drifts laterally in hallux valgus [3].
- Plantar-lateral migration of the abductor hallucis causes the proximal phalangeal unit to plantar flex and pronate the hallux [3].
- The pronation of the hallux is amplified by the proximal phalangeal attachment of the adductor hallucis [3].
- Stretching of the extensor hood of the extensor hallucis longus occurs in hallux valgus [3].
- Lateral deviation of the extensor hallucis longus and flexor hallucis longus causes a muscular imbalance and deforming force for valgus progression and pronation of the great toe [3].
- The first metatarsal head moves medially off the sesamoids, increasing the intermetatarsal angle [3].
- Pronation leads to rounding of the lateral metatarsal head, which should have a flat contour with no rotational deformity [3].
- Secondary contracture of the lateral capsule, adductor hallucis, and lateral metatarsal-sesamoid and intermetatarsal ligaments occurs in hallux valgus [3].
- With chronic deformity, the medial joint capsule becomes attenuated, and the lateral joint capsule becomes contracted [14].
- The sesamoids slowly erode the crista as the metatarsal head is pushed medially, allowing for lateral subluxation of the sesamoids from directly plantar to the first metatarsal [14].
- With severe deformity, both extrinsic and intrinsic muscles lie lateral to the longitudinal axis of the first metatarsophalangeal joint, enhancing the deformity [14].
- Pronation of the hallux occurs because attenuation of the dorsomedial capsule allows the abductor hallucis tendon to slide beneath the metatarsal head and rotate the proximal phalanx into a position of pronation [14].
- The sesamoid ridge on the plantar surface of the first metatarsal head (the crista) flattens because of pressure from the tibial sesamoid [16].
- The fibular sesamoid displaces partially or completely into the first intermetatarsal space when the crista flattens [16].
- The deep transverse intermetatarsal ligament runs between the plantar plates at the metatarsophalangeal joints and does not insert into bone on the adjacent sides of the metatarsal heads [16].
- The valgus posture of the great toe frequently causes a hammer toe-like deformity of the second toe [16].
- Secondary pathology and deformity can develop in the lesser toes, such as hammertoes and claw toes, which may be symptomatic [10].

RADIOGRAPHIC ANGLES AND NORMAL VALUES

- The hallux valgus angle (HVA) is the angle formed by the line along the first metatarsal shaft and the line along the shaft of the proximal phalanx [3].
- The normal hallux valgus angle is less than 15 degrees [3].

- The first-second intermetatarsal angle (IMA) is the angle formed by lines along the first and second metatarsal shafts [3].
- The normal first-second intermetatarsal angle is less than 9 degrees [3].
- The hallux valgus interphalangeus (HVI) angle is the angle formed by lines along the shafts of the proximal phalanx and distal phalanx [3].
- The normal hallux valgus interphalangeus angle is less than 10 degrees [3].
- The distal metatarsal articular angle (DMAA) is the angle formed by the line along the articular surface of the first metatarsal and the line perpendicular to the axis of the first metatarsal [3].
- The normal distal metatarsal articular angle is less than 10 degrees [3].
- An increased distal metatarsal articular angle is associated with a congruent deformity [3].
- The normal hallux valgus angle is $\leq 15^\circ$ [9].
- The normal intermetatarsal angle is $\leq 9^\circ$ [9].
- The normal distal metatarsal articular angle is $\leq 15^\circ$ [9].
- The normal proximal phalangeal articular angle (PPAA) is $\leq 10^\circ$ [9].
- The normal hallux valgus angle is <15 degrees [27].
- The normal intermetatarsal angle is <9 degrees [27].
- The normal distal metatarsal articular angle is <10 degrees [27].
- The normal hallux valgus interphalangeus angle is <10 degrees [27].

JUVENILE AND ADOLESCENT PATHOPHYSIOLOGY

- Hallux valgus in adolescents is frequently hereditary and usually seen in early adolescence [7].
- Adolescent hallux valgus is almost always found in conjunction with a wide forefoot caused by varus of the first metatarsal shaft (metatarsus primus varus) [7].
- The wide forefoot allows severe lateral deviation of the great toe, causing the prominent base of the great toe to rub against the inside of the shoe [7].
- Juvenile hallux valgus is often associated with a smaller medial eminence prominence, increased magnitude of the first-second intermetatarsal angle, increased hypermobility of the first tarsometatarsal joint, and less pronation than in adults [20].
- Juveniles are more likely to have bilateral deformities and a family history of hallux valgus [20].
- A congruent joint with an increased distal metatarsal articular angle is more common in juvenile hallux valgus than in the adult condition [25].
- Generalized ligamentous laxity may be more common in children with hallux valgus than in the general population [25].
- Recurrence of the deformity after surgical correction is a critical factor separating juvenile and adolescent patients from adult patients [11].

- Varus of the first metatarsal with a large intermetatarsal angle is commonly present in juvenile hallux valgus [11].
- The distal metatarsal articular angle is typically increased in juvenile hallux valgus [11].

HALLUX VARUS PATHOPHYSIOLOGY

- Hallux varus is described as a medial deviation of the great toe at the MTP joint [2].
- Acquired hallux varus is rare in children but usually acquired in adults as a complication of hallux valgus surgery [2].
- The most common cause of hallux varus is iatrogenic deformity resulting from hallux valgus repair, with an incidence of 2% to 10% [21].
- Causes of acquired hallux varus include overcorrection from bunion surgeries such as the McBride procedure, trauma, and systemic arthritis [2].
- The main causes for hallux varus after hallux valgus surgery include complete release of lateral structures combined with excessive plication of the medial capsule, excessive resection of the medial eminence, excision of the fibular sesamoid, release of the lateral head of the flexor hallucis brevis, and closure of the intermetatarsal angle to neutral or a negative value [13].
- Hallux varus can be classified into static (supple) and dynamic (fixed) types [13].
- Static hallux varus is asymptomatic and mainly a cosmetic complication, with all deformity occurring at the metatarsophalangeal joint in the transverse or frontal plane [13].
- Dynamic hallux varus is a multiplanar deformity that is often fixed, symptomatic, and difficult to correct surgically [13].
- In dynamic hallux varus, the first metatarsophalangeal joint is hyperextended and the interphalangeal joint is acutely flexed [13].
- Hallux varus is defined as a hallux valgus angle measuring 0° or less [21].
- Hallux varus may be associated with an extension deformity of the MTP joint and flexion of the interphalangeal joint [21].
- Supination of the hallux may be seen in hallux varus [21].
- Hallux varus may be associated with inflammatory conditions such as rheumatoid arthritis or neurologic conditions such as Charcot-Marie-Tooth disease [21].

CONGENITAL HALLUX VARUS

- Congenital hallux varus can occur in isolation with a normal first metatarsal, where a taut fibrous band runs from the medial side of the great toe to the base of the first metatarsal [2].
- Congenital hallux varus may coexist with other malformations of the foot, such as a longitudinal bracket epiphysis of the first metatarsal or preaxial polydactyly [2].
- Congenital hallux varus is uncommonly part of an underlying skeletal dysplasia, such as diastrophic dwarfism [2].

- Congenital hallux varus is typically unilateral and associated with a short, thick first metatarsal, accessory bones or toes, varus deformity of lateral metatarsals, or a firm fibrous band extending from the medial side of the great toe to the base of the first metatarsal [24].
- The explanation for congenital hallux varus is that two great toes originate in utero, but the medial or accessory one fails to develop, and the rudimentary medial toe and fibrous band act like a taut bowstring pulling the great toe into varus [24].

NEUROMUSCULAR PATHOPHYSIOLOGY

- Hallux valgus deformity in patients with cerebral palsy is usually associated with other deformities such as equinovalgus foot, heel valgus, and external rotation of the tibia [17].
- These conditions cause the foot to pronate, forcing the first metatarsophalangeal joint into abduction and creating a hallux valgus deformity [17].
- The extensor hallucis tendon may sublux into the first web space and become an abductor of the hallux, leading to further deformity in cerebral palsy [17].
- Hallux valgus in patients with cerebral palsy develops in response to an equinovalgus deformity of the hindfoot [22].
- Spasticity of the peroneus longus leads to progressive eversion and abduction of the foot, resulting in lateralization of the origin of the adductor hallucis muscle and increasing pull of the proximal phalanx into adduction [22].
- When combined with external tibial torsion, the toe is pushed laterally as weight is borne by the everted forefoot [22].

Clinical Presentation

DEFINITION AND ETIOLOGY

- Hallux valgus is defined as lateral deviation of the great toe with medial deviation of the first metatarsal [3].
- Hallux valgus is defined as lateral deviation of the proximal phalanx on the first metatarsal head [9].
- Hallux valgus deformity is defined as the lateral deviation of the proximal phalanx of the first metatarsophalangeal joint [10].
- The etiology of hallux valgus is likely multifactorial, involving intrinsic factors such as genetic predisposition, ligamentous laxity, and predisposing anatomy [3].
- Extrinsic factors contributing to hallux valgus include certain types of footwear, specifically narrow toe boxes and high heels [3].
- Hallux valgus is more common in women than in men [9].
- The incidence of hallux valgus deformity is 10 times greater in women than in men [14].
- The incidence of hallux valgus is significantly higher in shod populations than unshod ones [14].

- Of patients with hallux valgus, 70% have a family history of the condition, suggesting a hereditary component [9].
- Other causes of hallux valgus include rheumatoid arthritis, connective tissue disorders, and cerebral palsy [9].
- Hallux valgus is not associated with chronic tightness of the Achilles tendon or gastrocnemius, increased first ray mobility, bilaterality, or pes planus [14].
- Hallux valgus in patients with cerebral palsy develops in response to an equinovalgus deformity of the hindfoot [22].
- In patients with cerebral palsy, spasticity of the peroneus longus leads to progressive eversion and abduction of the foot, resulting in lateralization of the origin of the adductor hallucis muscle [22].

PATHOANATOMY

- The pathoanatomy of hallux valgus involves medial capsular attenuation [3].
- The proximal phalanx drifts laterally, leading to plantar-lateral migration of the abductor hallucis [3].
- Plantar-lateral migration of the abductor hallucis causes the proximal phalangeal unit to plantar flex and pronate the hallux [3].
- The pronation of the hallux is amplified by the proximal phalangeal attachment of the adductor hallucis [3].
- Lateral deviation of the extensor hallucis longus and flexor hallucis longus causes a muscular imbalance and deforming force for valgus progression and pronation of the great toe [3].
- The first metatarsal head moves medially off the sesamoids, increasing the intermetatarsal angle [3].
- Pronation leads to rounding of the lateral metatarsal head, which should have a flat contour with no rotational deformity [3].
- Secondary contracture occurs in the lateral capsule, adductor hallucis, and lateral metatarsal-sesamoid and intermetatarsal ligaments [3].
- The pathoanatomy involves gradual failure of the medial supportive structures, including the medial collateral ligament and tibial sesamoid, resulting in a varus position of the first metatarsal [10].
- As the deformity progresses, the alignment of the flexor and extensor hallucis longus tendons shifts laterally relative to the metatarsophalangeal joint, further exacerbating the deformity [10].
- The first metatarsal varus results in a prominent first metatarsal head medially, which is the bump or “bunion” reported by the patient [10].
- This prominent medial eminence is a common source of pain related to shoe wear [10].
- Secondary pathology and deformity can develop in the lesser toes, such as hammertoes and claw toes, which may be symptomatic [10].
- With chronic deformity, the medial joint capsule becomes attenuated, and the lateral joint capsule becomes contracted [14].
- The sesamoids slowly erode the crista as the metatarsal head is pushed medially, allowing for lateral subluxation of the sesamoids from directly plantar to the first metatarsal [14].

- Pronation of the hallux occurs because attenuation of the weakest portion of the capsule (the dorsomedial aspect) allows the abductor hallucis tendon to slide beneath the metatarsal head and rotate the proximal phalanx into a position of pronation [14].

SYMPTOMS AND SIGNS

- The most common symptom of hallux valgus is pain over the medial eminence [14].
- Patients also complain of pain in the joint and pain under the second metatarsal head, known as a transfer lesion or metatarsalgia [14].
- The deformity may prevent footwear, and activity limitation may be part of the constellation of symptoms [14].
- While seated, the first metatarsophalangeal joint area is evaluated for signs of local irritation and bursal hypertrophy secondary to shoe wear [10].
- Tenderness over the medial eminence is evaluated during the physical examination [10].
- Range of motion of the first metatarsophalangeal joint is evaluated, and any pain with motion may suggest arthritis within the joint [10].
- Numbness can occur in the dorsal medial cutaneous nerve distribution because of external pressure from a shoe [10].
- The first tarsometatarsal joint is evaluated for hypermobility, which remains a diagnostic challenge with poor reproducibility [10].
- The severity of the hallux valgus deformity and any associated pes planus can be best assessed while the patient is standing [10].
- Pronation of the great toe is easily noted by comparing the angulation of the nail of the great toe in relation to the floor [3].

RADIOGRAPHIC EVALUATION

- Diagnostic confirmation of hallux valgus is made with the use of standard AP and lateral weight-bearing radiographs, as non-weight-bearing radiographs tend to underestimate the deformity [10].
- Radiographs should be assessed for presence of arthritis at the first metatarsophalangeal joint, severity of the deformity, sesamoid subluxation, and the hallux valgus angle [10].
- Radiographs are assessed for first tarsometatarsal hypermobility and congruency of the metatarsophalangeal joint [10].
- The hallux valgus angle is the angle formed by the line along the first metatarsal shaft and the line along the shaft of the proximal phalanx [3].
- The normal hallux valgus angle is less than 15 degrees [3].
- The first-second intermetatarsal angle is the angle formed by lines along the first and second metatarsal shafts [3].
- The normal first-second intermetatarsal angle is less than 9 degrees [3].

- The hallux valgus interphalangeus angle is the angle formed by lines along the shafts of the proximal phalanx and distal phalanx [3].
- The normal hallux valgus interphalangeus angle is less than 10 degrees [3].
- The distal metatarsal articular angle is the angle formed by the line along the articular surface of the first metatarsal and the line perpendicular to the axis of the first metatarsal [3].
- The normal distal metatarsal articular angle is less than 10 degrees [3].
- An increased distal metatarsal articular angle is associated with a congruent deformity [3].
- A congruent joint has no lateral subluxation of the proximal phalanx in relation to the first metatarsal head [14].
- An incongruent joint has lateral subluxation of the proximal phalanx on the metatarsal head [14].
- Arthrosis of the metatarsophalangeal joint is characterized by joint space narrowing, subchondral sclerosis, and osteophyte formation [14].
- The first tarsometatarsal joint angle is based on the distal articular surface of the medial cuneiform and the longitudinal axis of the first metatarsal [14].
- Excessive medial deviation of the first tarsometatarsal joint may indicate that hypermobility is present [14].

JUVENILE AND ADOLESCENT PRESENTATION

- Hallux valgus is rare in children but often requires treatment in adolescents [7].
- Adolescent hallux valgus is frequently hereditary and usually seen in early adolescence [7].
- Adolescent hallux valgus is almost always found in conjunction with a wide forefoot caused by varus of the first metatarsal shaft, known as metatarsus primus varus [7].
- The wide forefoot allows severe lateral deviation of the great toe, causing the prominent base of the great toe to rub against the inside of the shoe and create a painful bunion [7].
- Recurrence of the deformity after surgical correction is a critical factor separating juvenile and adolescent patients from adult patients [11].
- Varus of the first metatarsal with a large intermetatarsal angle is commonly present in juvenile and adolescent patients [11].
- The distal metatarsal articular angle is typically increased in juvenile and adolescent patients [11].
- Hallux valgus interphalangeus may be present in juvenile and adolescent patients [11].
- Ligamentous laxity may be present, and a history of Ehlers-Danlos or Marfan syndrome should be elicited [11].
- Family history is frequently positive for hallux valgus in juvenile and adolescent patients [11].

HALLUX VARUS PRESENTATION

- Hallux varus is described as a medial deviation of the great toe at the metatarsophalangeal joint [2].
- In adults, hallux varus is usually acquired as a complication of hallux valgus surgery [2].
- Symptoms from hallux varus are both cosmetic and related to the ability to wear shoes [2].

- Shoe wear is nearly impossible with the deviation of the great toe seen in hallux varus [2].
- The deformity of hallux varus is believed to worsen with age [2].
- Hallux varus can be classified into two types: static (supple) and dynamic (fixed) [13].
- Static hallux varus is asymptomatic and mainly a cosmetic complication [13].
- In static hallux varus, the hallux rests in varus in a weight-bearing position, while the metatarsophalangeal joint rests in a normal position in the sagittal plane [13].
- Dynamic hallux varus deformity is a multiplanar deformity that is often fixed, symptomatic, and difficult to correct surgically [13].
- In dynamic hallux varus, the first metatarsophalangeal joint is hyperextended, usually with some degree of fixed soft-tissue contracture [13].
- In dynamic hallux varus, the interphalangeal joint is acutely flexed [13].
- The most common complaint in dynamic hallux varus is that the toe box of the shoe rubs on the dorsomedial surface of the interphalangeal joint [13].
- A keratotic lesion may be present beneath the first metatarsal head in dynamic hallux varus, caused by the extended hallux pushing the first metatarsal head plantarward [13].
- Lesser toes may develop a hammer deformity and metatarsalgia in dynamic hallux varus as the hallux assists less in the stance phase of the gait cycle [13].

HALLUX RIGIDUS PRESENTATION

- Hallux rigidus is defined as a condition in which there is restriction of motion at the first metatarsophalangeal joint [26].
- Initial symptoms of hallux rigidus mainly consist of pain during gait [26].
- Discomfort in the metatarsophalangeal joint is greatest during heel rise because the great toe normally dorsiflexes at this time [26].
- Physical examination reveals painful limitation in dorsiflexion of the first metatarsophalangeal joint [26].
- Dorsiflexion is lost before plantar flexion is in hallux rigidus [26].
- There is often a palpable osteophyte on the dorsum of the joint, and swelling may be present [26].
- The base of the metatarsal appears more plantar than normal, and the metatarsal head is elevated [26].
- Observation of gait shows that patients walk on the lateral border of the feet to avoid rolling over the great toe [26].
- Radiographs show narrowing of the joint in hallux rigidus [26].
- Lateral plain films can demonstrate dorsal osteophytes at the base of the proximal phalanx and metatarsal head [26].
- The exostoses may become quite large and obscure visualization of the joint itself [26].

Investigations

RADIOGRAPHIC ANGLES AND MEASUREMENTS

- The hallux valgus angle (HVA) is defined as the angle formed by the intersection of lines along the shaft of the first metatarsal and the shaft of the proximal phalanx [3].
- The first-second intermetatarsal angle (IMA) is defined as the angle formed by lines along the shafts of the first and second metatarsals [3].
- The hallux valgus interphalangeus (HVI) angle is defined as the angle formed by lines along the shafts of the proximal phalanx and the distal phalanx [3].
- The distal metatarsal articular angle (DMAA) is defined as the angle formed by the line along the articular surface of the first metatarsal and a line perpendicular to the axis of the first metatarsal [3].
- The proximal phalangeal articular angle (PPAA) is defined as the articular angle of the base of the proximal phalanx in relation to its longitudinal axis [9].
- The normal proximal phalangeal articular angle is less than or equal to 10 degrees [9].
- The distal metatarsal articular angle is measured as the angle of the line bisecting the metatarsal shaft with a line through the base of the distal articular cartilage cap [9].
- The normal distal metatarsal articular angle is less than or equal to 15 degrees [9].
- The normal hallux valgus angle is less than or equal to 15 degrees [9].
- The normal first-second intermetatarsal angle is less than or equal to 9 degrees [9].
- The normal distal metatarsal articular angle is less than 10 degrees of lateral deviation [14].
- The distal metatarsal articular angle is the angle created by the line connecting the ends of the articular surface and a line perpendicular to the long axis of the first metatarsal [10].

IMAGING MODALITIES AND ASSESSMENT

- Diagnostic confirmation of hallux valgus is made with standard anteroposterior and lateral weight-bearing radiographs [10].
- Non-weight-bearing radiographs tend to underestimate the severity of the hallux valgus deformity [10].
- Weight-bearing radiographs are important to evaluate the type and severity of the hallux valgus deformity [14].
- Radiographic evaluation includes assessing the congruency of the first metatarsophalangeal joint, where a congruent joint has no lateral subluxation of the proximal phalanx and an incongruent joint has lateral subluxation [14].
- Radiographs are assessed for the presence of arthritis at the first metatarsophalangeal joint, characterized by joint space narrowing, subchondral sclerosis, and osteophyte formation [14].
- Radiographs are assessed for first tarsometatarsal hypermobility, which may be indicated by medial subluxation and incongruency on anteroposterior views or dorsal subluxation with plantar gapping on lateral views [10].

- The position of the medial sesamoid in relation to a line drawn down the midaxis of the first metatarsal is evaluated, with postoperative sesamoid positions 5 to 7 associated with higher recurrence of deformity [9].
- Weight-bearing computed tomography scans have been used to assess foot alignment in patients with hallux rigidus [1].

CLINICAL EXAMINATION

- The severity of the hallux valgus deformity and any associated pes planus is best assessed while the patient is standing [10].
- The first metatarsocuneiform joint is examined for hypermobility by stabilizing the medial cuneiform and ranging the first metatarsal dorsomedially and plantolaterally [14].
- Range of motion of the first metatarsophalangeal joint is checked in both the deformed and corrected positions to determine the degree of surgical correction possible without impairing motion [14].
- The skin is evaluated for erythema, swelling, ulceration, or callosities during the clinical examination [14].
- Neurovascular status of the foot is assessed, noting absent pulses and venous stasis changes [14].
- Doppler studies are obtained if there is any question regarding the circulatory status of the foot [14].
- The first tarsometatarsal joint is evaluated for hypermobility, which remains a diagnostic challenge with poor reproducibility [10].
- Numbness can occur in the dorsal medial cutaneous nerve distribution due to external pressure from a shoe [10].
- Pain with motion of the first metatarsophalangeal joint may suggest arthritis within the joint [10].

SPECIFIC DEFORMITY ASSESSMENTS

- Hallux varus is defined as a hallux valgus angle measuring 0 degrees or less [21].
- Hallux varus can be associated with an extension deformity of the metatarsophalangeal joint and flexion of the interphalangeal joint [21].
- Supination of the hallux may be seen in association with hallux varus [21].
- It must be determined whether metatarsophalangeal and interphalangeal joint deformities in hallux varus are fixed or passively correctable [21].
- Weight-bearing radiographs can help determine the degree of arthrosis in hallux varus [21].
- Congenital hallux varus may occur in isolation with a normal first metatarsal, coexist with other foot malformations such as longitudinal bracket epiphysis or preaxial polydactyly, or be part of an underlying skeletal dysplasia [2].
- Adolescent hallux valgus is frequently found in conjunction with a wide forefoot caused by varus deviation of the first metatarsal shaft (metatarsus primus varus) [7].
- The distal metatarsal articular angle is an offset of the articular surface that is a predisposing factor in the development of hallux valgus [9].

- The proximal phalangeal articular angle is an offset of the articular angle that is a predisposing factor in the development of hallux valgus [9].
- The first-second intermetatarsal angle is not influenced by overresection of the medial eminence and is not accurate for postoperative evaluation of distal osteotomies [9].

Treatment

NON-OPERATIVE MANAGEMENT

- Nonsurgical management should be considered first in all juvenile and adolescent patients with hallux valgus, especially those with ligamentous laxity or neuromuscular disorders [20].
- Shoes with a wide toe box, toe spacers, and night splints may be used for symptomatic management of juvenile hallux valgus until physeal closure [20].
- Nonoperative treatment of acquired hallux varus is limited to accommodation of the deformity with shoe modifications and shoe stretching [11].

OPERATIVE CORRECTION: JUVENILE AND ADOLESCENT HALLUX VALGUS

- In juvenile and adolescent patients, proximal osteotomy is performed through the medial cuneiform if the first metatarsal physis is open [11].
- If arthrodesis of the first tarsometatarsal (TMT) joint is required for ligamentous laxity in juvenile patients, surgical intervention is delayed until physeal closure [11].
- For juvenile hallux valgus with hallux valgus interphalangeus (HVI), an Akin osteotomy is indicated [11].
- For juvenile hallux valgus with increased distal metatarsal articular angle (DMAA) and an intermetatarsal angle (IMA) of 13 degrees or less, a biplanar distal chevron osteotomy is indicated [11].
- For juvenile hallux valgus with HVI, increased DMAA, and an IMA of 13 degrees or less, an Akin osteotomy combined with a biplanar distal chevron osteotomy is indicated [11].
- For juvenile hallux valgus with an IMA greater than 13 degrees and increased DMAA, a biplanar distal chevron osteotomy combined with an open-wedge medial cuneiform osteotomy is indicated [11].
- For juvenile hallux valgus with HVI, increased DMAA, and an IMA greater than 13 degrees, an Akin osteotomy combined with a biplanar distal chevron osteotomy and an open-wedge medial cuneiform osteotomy is indicated [11].
- In cases of ligamentous laxity in juvenile patients, a first TMT arthrodesis substitutes for a proximal osteotomy to correct the IMA [11].
- Arthrodesis of the metatarsophalangeal joint is appropriate for juvenile hallux valgus in patients with ligamentous laxity (Ehlers-Danlos syndrome), cerebral palsy, Down syndrome, and rheumatoid arthritis [20].
- Surgery for adolescent hallux valgus must address the deformity by trimming the bunion, correcting the varus angulation of the first metatarsal by osteotomy, and centralizing and balancing the hallux valgus by lengthening the adductor hallucis muscle [7].

OPERATIVE CORRECTION: ADULT HALLUX VALGUS

- Indications for soft-tissue repair for recurrent hallux valgus include a first-second intermetatarsal angle of ≤ 13 degrees [5].
- Indications for soft-tissue repair for recurrent hallux valgus include a hallux valgus angle of ≤ 30 degrees [5].
- Indications for soft-tissue repair for recurrent hallux valgus include a normal distal metatarsal articular angle ($<10-15$ degrees) [5].
- Indications for soft-tissue repair for recurrent hallux valgus include minimal degenerative changes at the first metatarsophalangeal joint [5].
- Indications for soft-tissue repair for recurrent hallux valgus include 50 to 60 degrees of passive motion of the first metatarsophalangeal joint [5].
- Indications for soft-tissue repair for recurrent hallux valgus include subluxation but not complete dislocation of sesamoid bones [5].
- Indications for soft-tissue repair for recurrent hallux valgus include the ability to displace the first metatarsal laterally at the metatarsocuneiform joint from its abnormal varus inclination [5].
- Indications for soft-tissue repair for recurrent hallux valgus include some degree of longitudinal arch present when weight bearing [5].
- If the longitudinal arch is improved with passive dorsiflexion of the hallux while standing, the deformity is not fixed and a soft-tissue repair is likely to endure [5].
- Soft-tissue repair for recurrent hallux valgus involves releasing the adductor hallucis tendon from the capsule, capsulosesamoid ligament, and lateral border of the fibular sesamoid [5].
- Soft-tissue repair for recurrent hallux valgus involves removing the adductor hallucis tendon from its insertion into the base of the proximal phalanx [5].
- Soft-tissue repair for recurrent hallux valgus involves sectioning the deep transverse intermetatarsal ligament to allow medial mobility of the fibular sesamoid [5].
- If the fibular sesamoid cannot be placed into its facet on the inferior surface of the first metatarsal head, the lateral capsule is sectioned from dorsal to the fibular sesamoid [5].

OPERATIVE CORRECTION: HALLUX VARUS

- Surgery for congenital hallux varus consists of release of the tight tissues on the medial side of the toe, including the abductor hallucis and the medial capsule of the MTP joint [2].
- In surgery for congenital hallux varus, the great toe is usually syndactylized to the second toe to maintain correction [2].
- Temporary fixation of the MTP joint with a Kirschner wire is performed during surgery for congenital hallux varus to maintain position while tissues heal [2].
- Arthrodesis of the first MTP joint is reserved for cases of congenital hallux varus in whom primary reconstruction fails and painful arthritis develops [2].

- Flexible acquired hallux varus deformity can be corrected with a soft tissue procedure involving release of the abductor hallucis (ABH) muscle and fascia [11].
- Flexible acquired hallux varus deformity can be corrected by transferring a portion of the extensor hallucis longus (EHL) or extensor hallucis brevis (EHB) tendon under the transverse intermetatarsal ligament to the distal metatarsal neck [11].
- In EHL or EHB tendon transfer for hallux varus, the distal portion of the tendon is left intact to create a dynamic stabilizer [11].
- Suture button augmentation is commonly used with tendon reconstruction for hallux varus but should not be utilized in isolation [11].
- Fixed acquired hallux varus deformity, or deformity with limited first MTP motion, joint pain, or presence of first MTP degenerative joint disease, is treated with a first MTP arthrodesis [11].

OPERATIVE CORRECTION: SPECIAL POPULATIONS

- In patients with cerebral palsy, underlying deformities such as heel valgus or external rotation of the tibia should be corrected before surgical correction of the hallux valgus [17].
- Isolated soft-tissue procedures for hallux valgus in patients with cerebral palsy rarely are successful and have a high recurrence rate [17].
- Great toe metatarsophalangeal joint fusion is recommended for hallux valgus in patients with cerebral palsy [17].
- First metatarsophalangeal joint fusion has been shown to provide the best overall outcome with functional gains and anatomic correction of the deformity being maintained in patients with cerebral palsy [17].

Complications

- Acquired hallux varus is usually acquired as a complication of hallux valgus surgery in adults [2].
- Overcorrection from bunion surgeries, such as the McBride procedure, is a cause of acquired hallux varus [2].
- Trauma is a cause of acquired hallux varus [2].
- Systemic arthritis is a cause of acquired hallux varus [2].
- Arthrodesis of the first metatarsophalangeal joint is reserved for cases where primary reconstruction fails and painful arthritis develops [2].

Recovery

- Return to sport and physical activities is a documented outcome following first metatarsophalangeal joint arthrodesis in young patients [1].
- Improved ankle push-off power is observed following cheilectomy for hallux rigidus [1].

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