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Mr Anthony J Maher
FRCPodS

Mr Timothy E Kilmartin
FRCPodS PhD

Juvenile Hallux Valgus Part 2. Assessment, classification, conservative and surgical treatment

Preface

Back in 2010 Dr Tim Kilmartin and Anthony Maher wrote an extensive review of juvenile hallux valgus with the intention of publishing it as a chapter in a paediatric podiatry textbook. Unfortunately, the book never came to fruition and the manuscript sat unpublished for the next 12 years. The original 'chapter' was based partly on a review of the historic literature relating to juvenile hallux valgus but also drew on Dr Kilmartin's PhD work and both authors clinical experience in podiatric surgery.

Following initial discussions with the editors of the Canonbury Continuing Professional Update series it was agreed to publish the updated manuscript split into two parts. The first article published in November 2022 (available online at https://www.canonbury.com/cpd-articles) provided podiatrists with an understanding of the anatomy, aetiology, and pathophysiology of juvenile hallux valgus. In this second article we will provide a robust approach for the podiatrist wishing to systematically manage this common and important foot deformity.

Assessment of juvenile hallux valgus

Clinical assessment

Kilmartin et al. describe 3 criteria for the clinical diagnosis of juvenile hallux valgus; a metatarso-phalangeal angle above 15°; osteophytic thickening of the metatarsal head; a positive family history[1]. Two key features are characteristic observations noted in juvenile hallux valgus deformities. The first is a prominence of the metatarsal head medially which may demonstrate a degree of osteophytic thickening. The second is abduction of the hallux which may be accompanied by valgus rotation of the digit.

When treating a child with hallux valgus, the clinical assessment should not be restricted to the first ray. Potentially contributory deformities also need to be evaluated. These include Achilles contracture, and postural abnormalities such as a pes cavus or pes

Figure 1. Clinical measurement of juvenile hallux valgus with a goniometer

planus. Systemic disorders should also be assessed with reference to inflammatory arthropathies, neuromuscular diseases such as cerebral palsy, genetic disorders such as Down's syndrome, and connective tissue disorders such as Marfan's syndrome[2 3 4 5 6 8 9].

Examination of the foot is unlikely to reveal a history of pain in all but the most advanced cases. Where pain is present, it is most likely to be a consequence of footwear pressure and irritation over a prominent medial eminence of the metatarsal head[1]. Local inflammation may be noted over the 1st MTP joint, and in more severe cases, an adventitious bursa may be evident. Interdigital pain may occur, secondary to the formation of a keratosis.

The metatarsal head itself may appear enlarged or thickened. This is a consequence of hypertrophic changes and osteophyte formation which occurs as joint congruency is lost[1]. Testing range of motion at the 1st MTP joint may reveal a track bound joint, whereby full motion of the MTP joint is only possible when the hallux is held in its deviated position[9]. An attempt to correct the position towards rectus will result in reduced motion on testing. A track bound range of motion signifies lateral deviation of the sesamoid complex[9]. Range of motion may also be reduced secondary to osteophytic changes about the metatarsal head.

Perhaps the most important measurement made clinically is the position of the hallux. A transverse plane metatarsophalangeal joint angle in excess of 15° is considered diagnostic of hallux valgus. The angle can be measured clinically using a digital goniometer (Figure 1)[1]. Other authors however, suggest that an angle of up to 20° can be considered normal[11].

Radiographic evaluation

Radiographic assessment has always played an important role in the management of juvenile hallux valgus. There is no more accurate means of assessing the true magnitude of hallux valgus than through the examination of plain radiographs. Juvenile hallux valgus is primarily a transverse plane deformity and as such, measurement of radiographic angles tends to focus on this plane as viewed through dorsi-plantar radiographs. Typical measures include the intermetatarsal angle and hallux valgus angle[12]. A hallux valgus angle in excess of 15° is considered by most authorities to be diagnostic of the deformity (Figure 2)[9 12].

Hardy & Clapham describe a critical lateral angle of deformity which is the point at which the hallux abuts the second toe[13]. It is at this point that the deformity begins to progress more rapidly with a marked increase in the associated 1-2 intermetatarsal angle[2].

An increased first metatarsal angle or metatarsus primus varus is a typical feature of hallux valgus[14]. Although an increased intermetatarsal angle is often associated with juvenile hallux valgus[5 12] , it has been argued that a raised hallux valgus angle and subluxation of the MTP joint remain more significant

Figure 2. Radiographic charting of the and intermetarsal angle (A) and hallux valgus angle (B)

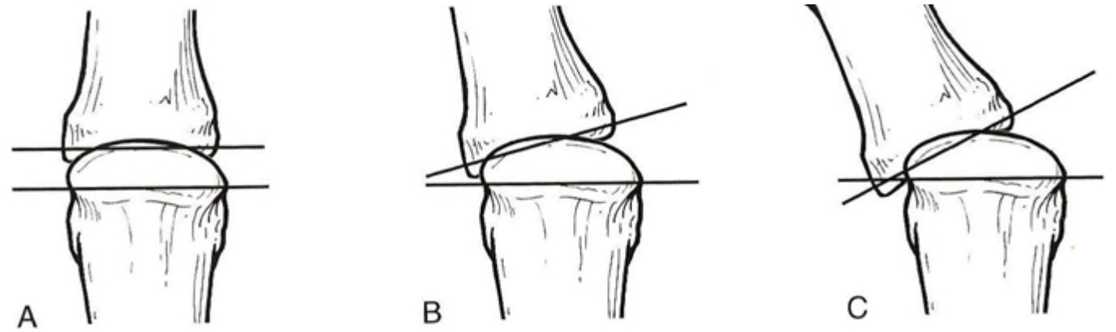


Figure 3. Metatarsal Head Congruency. Taken from: Martin, E and Pontious, J. Introduction and Evaluation of Hallux Abducto Valgus. In Banks, A. Downey, M. Martin, D. Miller, S. 2001. Eds. McGlamry's Comprehensive textbook of foot and ankle surgery. 3rd edition. Volume 1. Lippincott Williams and Wilkins. Philadelphia. Page 487. Figure 6.

features[4 12]. An angle in excess of 9° is considered pathological. An increased intermetatarsal angle may be masked by an underlying metatarsus adductus and if the suspicion exists, various radiographic techniques have been proposed by Kilmartin et al. and others to account for this anomaly[5 9 16].

Congruence of the 1st MTP joint can be objectively measured by placing a line across the articular cartilage of the metatarsal head and that of the proximal phalangeal base. If both lines are parallel, the joint is considered congruent (Figure 3A). If the lines cross outside of the joint, it is considered subluxed or incongruent (Figure 3B). Lines which cross within the joint represent a severely incongruent or dislocated joint (Figure 3C)[8].

An important characteristic of juvenile hallux valgus, as opposed to the adult form, is that adaptive changes may occur within the 1st MTP joint during development. One aspect of this is the angulation of the first metatarsal head cartilage, considered by some authors to be an important aspect of the hallux valgus deformity. Clinicians have a choice of two different measurements here: either the proximal articular set angle (PASA) or alternatively the distal metatarsal articular angle (DMAA)[4 18]. Whichever measurement you choose, the result offers the clinician a guide to the alignment of the articular cartilage. As the deformity progresses, the metatarsal head cartilage tends to deviate laterally, in line with the abduction deformity of the hallux. It is suggested but not proven that failure to correct a raised PASA angle (Figure 4) or deviated cartilage could lead to recurrence of the deformity as the joint will continue to articulate in a laterally deviated fashion[4].

The reliability of measuring the PASA angle on plain films has been questioned, and studies have previously demonstrated a poor correlation between the radiographic measurement and intra-operative measurement of articular alignment[5 18]. Furthermore, authors have consistently reported good post operative results with surgical procedures which actually cause a deterioration of the PASA angle, such as proximal closing wedge osteotomies or the rotation Scarf & Akin osteotomies[18] (see Figure 7).

The sesamoids appear to drift laterally on plain radiographs. The 'drift' can be tracked with the progression of the deformity. Essentially, the concern here is the extent to which the fibula sesamoid is becoming visible in the intermetatarsal space. Sesamoid position can be graded from 1 to 8 using a scale proposed by Hass[19].

A long metatarsal has long been associated with hallux valgus[13]. The length of the first metatarsal should be compared with the second metatarsal. The method described by Hardy and Clapham reliably measures metatarsal length while avoiding error induced by varus positioning of the first metatarsal[4 12 13].

When interpreting radiographic findings, the clinician will not review each of the above factors in isolation

Figure 4. X-ray measurement of the PASA angle

but rather, will review the whole picture. Radiographic measurements read alongside the clinical findings give the clinician an appreciation of the extent of the deformity and he or she will then be able to match these findings to the most appropriate treatment. Although radiographs are perhaps of most use to the surgeon, their role in routine monitoring of juvenile hallux valgus at 2-3 year intervals should not be dismissed[2].

Classification of juvenile hallux valgus

Classification of hallux valgus requires somewhat arbitrary definitions of stages or milestones in the development of the deformity. Any attempt at classification should be based on a combination of clinical and radiographic findings.

Broadly, juvenile hallux valgus may be divided into mild, moderate or severe deformities, based primarily on the hallux valgus angle and congruence of the MTP joint. A congruent 1st MTP joint with a hallux valgus angle of less than 25° would typically be considered a mild deformity. A hallux valgus angle in excess of 25° with or without an incongruent 1st MTP joint may be considered a moderate deformity. A hallux valgus angle in excess of 40° is always associated with an incongruent joint and is considered to be a severe hallux valgus[4].

Pontius et al. describe two broad classifications of juvenile hv Type 1 and Type 2[18]. Type 1 is a severe congenital deformity with associated pathology, such as metatarsus adductus. Type 2 is a more moderate deformity of delayed onset with less associated pathology[5 18]. Type 1 and 2 have also been referred to as static and dynamic respectively[6].

Treatment of juvenile hallux valgus

There is at present insufficient evidence available to determine the most appropriate treatment of juvenile hallux valgus, whether conservative or surgical[20]. There is also a distinct lack of high quality level one controlled studies and meta-analyses of interventions for hallux valgus. With that in mind, we will now consider the various treatment options.

Conservative Treatment

Watchful Waiting

Most patients (and their parents) will initially attend for a consultation due to concern over the altered shape of the foot rather than for specific symptoms. Such patients may require reassurance and a period of watchful waiting could be considered. The extent of treatment should be determined by the level of symptoms and the understanding and comprehension of the patient. However, it should be borne in mind that hallux valgus is a progressive deformity which may well become increasingly symptomatic. Therefore, it may be preferable to recommend the use of night splints (see Figure 5) to minimise progression, orthotics to control symptoms, and arrange to undertake annual goniometric measurements of the hallux valgus angle[2 5].

Figure 5. Hallux Valgus Night Splint

Footwear

It is important to appreciate that most children with symptomatic bunions will benefit from conservative care and particularly footwear modification[4]. This should begin with basic footwear advice and if necessary, modification of footwear to accommodate the deformity. Despite the likely benefit, compliance with the use of modified footwear is variable, particularly amongst adolescents[21]. Footwear will only accommodate the deformity rather than offer any level of correction. That said, a well-fitted shoe may minimise the incidence of symptomatic juvenile hallux valgus[22]. Footwear assessment and appropriate advice should always form part of the management plan for children with hallux valgus.

Night Splints

Night splints (Figure 5) are available from a number of suppliers and are a cheap and potentially beneficial treatment option[2 5]. Splints attempt to actively correct the hallux valgus deformity by exerting an antagonistic force against the contracting lateral MTP joint structures. A 6 year study of the use of night splints and exercises found an improvement in the hallux valgus angle of approximately 3° in 50% of the cohort[23]. A 3 year study of night splints in 42 feet with juvenile hallux valgus demonstrated no statistically significant difference between pre and post treatment measurements thus suggesting that night splints may actually prevent the progression of hallux valgus[24]. The authors of the study concluded that night splints should be considered the first line treatment in juvenile hallux valgus and recommended their use should be continued until skeletal maturity[24].

Orthotics

The role of orthotics in the management of hallux valgus has been debated for many years. The essential premise when considering orthotics is that the hallux valgus deformity must be related to abnormal pronation of the foot. Therefore, it has been argued that an anti-pronatory orthotic will prevent the deterioration of hallux valgus, although there is little evidence to support this view[4]. There remains uncertainty as to the exact aetiology of juvenile hallux valgus and so directing treatment against pronation may not be beneficial[2]. With caution, it may be possible to describe the aetiology as multi factorial. In a now well-reported study, Kilmartin et al. demonstrated deterioration in the hallux valgus angle amongst children with hallux valgus following treatment with orthotics[25]. Kilmartin et al. concluded that orthotics do not prevent the progression of juvenile hallux valgus[11]. Further studies have demonstrated no difference in arch height between children with and without hallux valgus [26].Whether or not to prescribe an orthotic following hallux valgus surgery is also a controversial issue, some authors reporting the routine use of post operative orthotics while others do not use them at all[4 27 28].

Evidence for the effectiveness of orthotics in treating or correcting hallux valgus has been contested. However, there is evidence form a well-constructed trial by Torkki et al. on an adult population, which shows the use of orthotics can reduce the symptoms associated with the deformity in the short term[29].

Surgical Management

The outcomes of surgical intervention for juvenile hallux valgus are mixed, with failure rates of up to 75% being reported[24]. Of all the complications, recurrence seems to be the most significant concern with reported rates at between 10-52%[24]. Juveniles seem to be more prone to recurrence than any other group with hallux valgus[4].

The decision to operate should not be taken lightly and should only be made once conservative measures have failed and the patient continues to complain of symptoms, and chiefly is in pain. Surgery for juvenile hallux valgus is not without risk and the potential benefits and risks must be carefully considered, both with the patient and parents. Time spent carefully planning the operation and choice of procedure may decrease the incidence of post operative complications.

When the decision is made to operate, the clinician must consider the most appropriate timing of any surgery. Consideration will be given to the patient's lifestyle, current symptoms, age and skeletal maturity. MacFarlane and Kilmartin suggest that conservative measures should be continued until skeletal maturity when the results of surgical intervention are more predictable[24]. Others have similarly cautioned against early surgery, particularly in the presence of an open growth plate which, may actually be at the root of the high failure rates in juveniles[4 15 30].

However, it has also been argued that the presence of an open growth plate will allow for remodelling of the cartilage following intervention[31]. Epiphysiodesis techniques actually require the presence of an open growth plate while, distal or capital osteotomies are placed well away from the proximal growth plate. It must though be concluded that the presence of an open growth plate creates a degree of uncertainty to the eventual outcome.

Having taken the decision to operate, the clinician must consider the extent of surgery required. Decision making is guided by a combination of clinical examination and radiographic findings. Clinical examination allows for assessment of the overall function and motion of the first ray, however radiographic images will offer greater assistance in procedure planning. Measurement of the hallux valgus angle, intermetatarsal angle, joint congruency and sesamoid position will all be of value.

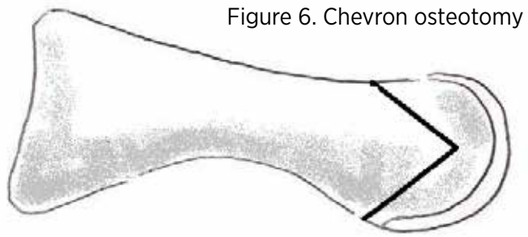
Mild deformities may typically benefit from soft tissue releases, though care should be taken to ensure that the joint is congruent. Moderate deformities may benefit from a combination of soft tissue releases and distal osteotomies, while severe deformities may require a combination of soft tissue release, proximal osteotomy and phalangeal osteotomy. An alternative to osteotomies and soft tissue procedures are the epiphysiodesis techniques which manipulate the open growth plate at the base of the metatarsal.

Surgical Procedures

Soft Tissue Procedures

Soft tissue procedures for the correction of juvenile

Figure 6. Chevron osteotomy



hallux valgus should be reserved for deformities characterised by a low hallux valgus angle and congruent 1st MTP joint. Failure to follow this rule will increase the risk of recurrent deformity and the need for subsequent revision. Soft tissue procedures are perhaps best considered as an adjunct to surgical repair by other means[5].

Osteotomies

Failure to perform a first metatarsal osteotomy is perhaps the primary reason for recurrence following operative treatment[4]. In combination with soft tissue procedures, osteotomies to correct juvenile hallux valgus will correct the osseous deformity. Osteotomies may be placed in the metatarsal, medial cuneiform or the proximal phalanx of the hallux. Osteotomies of the first metatarsal may be further divided into distal, mid-shaft and proximal osteotomies[4 5].

Distal procedures may correct a mild deformity and options include the chevron (Figure 6), Mitchell, Wilson, and Reverdin procedures5. Reverdin-type procedures have the added benefit of being able to reduce the PASA angle by removal of a rotational wedge in the transverse plane. Wedge removal will allow rotation of the cartilage to a corrected position, reducing the PASA (or DMAA) angle[4 5]. Distal procedures also allow for early post operative weight bearing and a rapid return to normal footwear.

The Mitchell and Wilson procedures are both commonly prescribed distal osteotomies, however they both have the risk of excessively shortening the first metatarsal[5]. Shortening will result in a relative elevatus of the metatarsal and subsequent transfer metatarsalgia[28 32 33]. Revision of these procedures when excessive shortening has occurred is technically demanding and may require arthrodesis of the 1st MTP joint with bone grafting to restore length. Loss of length in the juvenile foot should be avoided at all costs to avoid dysfunction of the foot during adulthood. Transfer metatarsalgia and forefoot instability may give rise to digital deformities and poor rates of patient satisfaction.

The chevron or Austin osteotomy is perhaps a more favourable capital osteotomy which minimises the risk of shortening[5]. Though typically applied to mild deformities, it may also be considered for moderate deformities[4]. When performing the chevron procedure, the metatarsal head can be transposed up to 50 percent of its width and so the degree of correction available is directly proportional to the width of the metatarsal head[34]. The chevron procedure has been demonstrated to reliably correct hallux valgus deformities with few complications[3]. The chevron osteotomy has also been demonstrated to be more successful than orthotics in relieving the pain associated with hallux valgus[29].

Mid-shaft procedures are capable of reliably correcting mild to moderate deformities in the adult population but little has been written of their use in juvenile hallux valgus. Various procedures have been proposed including the Mau, Ludloff and scarf osteotomies. The Scarf osteotomy (Figure 7) has been reported as a safe, effective and versatile procedure for the correction of juvenile hallux valgus[35]. As with distal procedures, the Scarf allows for early mobilisation and therefore a rapid recovery.

Proximal osteotomies are best suited to correcting metatarsus primus varus or deformities where the intermetatarsal angle exceeds 15°, however they should be approached with some caution as there is a very real risk that the epiphyseal growth plate will be disrupted[4 5]. Careful examination of the pre- operative radiographs is critical to determining appropriate placement of proximal osteotomies.

Various proximal osteotomies may be considered including: transverse or oblique closing wedge osteotomies; opening base wedge osteotomies (with bone grafting) or; crescentric osteotomies. The opening wedge is best reserved for an already short first metatarsal[5]. Double osteotomies have also been suggested whereby a proximal osteotomy is combined with a distal procedure such as a Reverdin

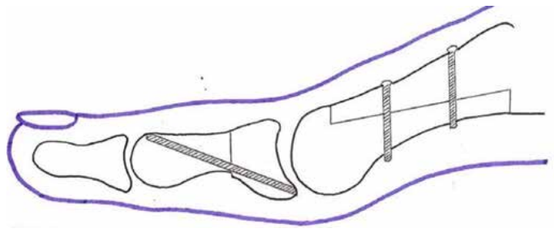


Figure 7 Scarf Osteotomy. Taken from: Kilmartin TE, O'Kane C. 2010. Combined rotation Scarf and Akin osteotomies for hallux valgus: a patient focussed 9 year follow up of 50 patients. J Foot Ankle Res;3:2.

osteotomy[5]. Such a combined procedure has the ability to correct both a large intermetatarsal angle and a deviated PASA angle[5].

Proximal procedures require a more substantial recovery period, usually encompassing a period of non-weight bearing and immobilisation. This is because the osteotomy is placed perpendicular to the weight bearing surface, placing the osteotomy at risk of plastic deformation and subsequent mal-union. A long-term complication of these procedures is iatrogenic metatarsus elevatus, characterised by a dorsal prominence of the metatarsal head and painful hallux limitus. Dysfunction of the 1st MTP joint then increases the risk of transfer metatarsalgia.

Hallux Osteotomies

Various hallux osteotomies have been described, though perhaps the most commonly applied is the Akin closing wedge osteotomy of the proximal phalanx. This may be oriented transversely or obliquely and may be placed proximally or distally within either the proximal or distal phalanx. The primary indication for the Akin procedure is hallux interphalangeus valgus and typically the Akin would be combined with a soft tissue procedure or metatarsal osteotomy[4 5]. The Akin procedure will not address the intermetatarsal angle or metatarsus primus varus.

Arthrodeses

Arthrodesis of the 1st metatarso-cuneiform joint (MCJ) may be considered for the correction of metatarsus primus varus. As with the proximal osteotomies, fusion of the 1st MCJ requires a prolonged recovery period including immobilisation. Fusion may also result in shortening of the first ray with a risk of transfer metatarsalgia[4 5].

Fusion of the 1st MCJ is best reserved for severe juvenile hallux valgus in which there is definite instability of the metatarso-cuneiform joint as in hypermobility syndromes. Fixation of the fusion can be difficult to achieve because of the close proximity to the growth plate. A solution here is to consider the use of Kirschner wires which may be passed across the growth plate and later removed, with only limited injury to the plate itself[5].

Cuneiform Osteotomies

An alternative to first metatarsal procedures is the cuneiform osteotomy. As with the 1st MCJ arthrodesis, cuneiform arthrodesis is best suited to severe hallux valgus deformities with notable instability[36]. In addition, the osteotomy may also address the obliquity of the distal cuneiform articular surface which can be a feature of severe deformity[5 36]. The osteotomy can correct the metatarsus adductus and also offer plantarflexion of the first ray, therefore creating further stability[5].

The true need for this procedure is then questionable. However, in the rare setting of a painful flexible juvenile flat foot deformity and symptomatic hallux valgus, a modified cuneiform osteotomy may be considered capable of correcting the hallux valgus deformity while also assisting the correction of the flat foot through improved stability of the medial longitudinal arch.

Epiphysiodesis

All of the procedures described above may be applied to both juvenile and adult hallux valgus. The exception is epiphysiodesis which is unique amongst options for the management of hallux valgus as it focuses attention on the growth plate. Epiphysiodesis aims to prematurely halt bone growth at the lateral portion of the growth plate, thus allowing the continued growth of the medial portion which potentially corrects the metatarsus primus deformity[5]. Development at the growth plate may be momentarily halted with staples which can later be removed. Alternatively, growth may be arrested through the insertion of bone graft[22]. Successful epiphysiodesis is challenging and requires careful pre operative planning. Considerations include the extent of growth yet to occur and the degree of growth required to correct the deformity. Epipysiodesis cannot correct distal deformities and so additional procedures may still be required[37].

Sheridan reported good results with a 4.5 year follow up though elevatus was noted in one case owing to incomplete arrest of the growth plate[38]. Seiberg et al. reported a 6.6° reduction in inter-metatarsal angle and 9.6 degree reduction in hallux valgus angle following epiphysiodesis[39].

Conclusion

For some patients (and their parents) juvenile hallux valgus can be a cause of significant concern. Though the deformity may initially appear asymptomatic, the progressive nature of the deformity and the subsequent development of symptoms should lead clinicians to carefully consider the assessment and management of this condition. Assessment should include a thorough history, clinical examination of the foot, and specifically the 1st MTP joint. Goniometric measurements of the 1st MTP joint angle should be documented and used to track the effectiveness of

any intervention. Radiographic examination should also be considered, particularly if surgical intervention is likely.

Treatment should begin with footwear modification in order to accommodate the deformity, while the use of night splints should be strongly recommended to minimise the progression of the deformity. Orthotics may also be helpful in controlling symptoms, but these should not be expected to correct the deformity. Recalcitrant deformity may benefit from surgical intervention, however it may be best to defer this until skeletal maturity. ■

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