

## Research Article

# Evidence of Treatment Algorithms for Hallux Valgus

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**Abstract**

**Background:** Algorithms have been developed to aid in the decision process in order to choose an optimal surgical procedure for different types of hallux valgus. These algorithms are evaluated in this study with current level 1 and 2 studies.

**Materials and methods:** Criteria for typing hallux valgus and surgical procedures in the treatment algorithms as proposed by Coughlin and Robinson were categorized. PubMed searches were performed to obtain data regarding preoperative parameters and outcome of surgical procedures. Gathered data were used to assess validity of algorithms as well as the validity of factors used in preoperative planning of hallux valgus surgery and proposed advantages of specific surgical techniques.

**Results:** The PubMed search on preoperative criteria resulted in 196 references; four were classified as level 2 evidence. The PubMed search of surgical procedures resulted in 36 references of which seventeen were classified as level 1 or 2 evidence. Outcome was determined by severity of hallux valgus angle. The advantages of the certain procedures as advised in the algorithms to correct specific hallux valgus deformities have not been established in controlled clinical studies.

**Conclusion:** Widely accepted flow-charts for the treatment of hallux valgus are not based on level 1 and 2 studies. Hallux valgus angle is found to be the single significant parameter for prediction of the surgical outcome. Correction declines with hallux valgus angle exceeding 36 degrees, in these cases outcome of osteotomy becomes more uncertain.

## INTRODUCTION

Different types of hallux valgus have been described and categorized with associated flowcharts. These types are categorized as mild, moderate, and severe hallux valgus, first metatarsophalangeal (MTP) congruency, and tarsometatarsal (TMT) hypermobility. Correction is advised using specific matching procedures; however, flowcharts differ, they are derived from a historical experience based perspective and data are often based on level 3 evidence.

In defining hallux valgus type's opinions vary on whether the intermetatarsal angle (IMA), the hallux valgus angle (HVA), or both should be used as parameters for determining the severity of hallux valgus [1]. Controversy exists whether TMT hypermobility requires treatment by TMT arthrodesis [2], whereas others have found that a first metatarsal osteotomy can suffice [3,4]. Another topic of discussion is the optimal treatment strategy for severe

hallux valgus [5]. Some authors favour a proximal procedure [6], while others propagate a distal osteotomy [7,8]. Further, minimally invasive procedures recently have been popularized because it is claimed that complication rate is lower and recovery faster [9].

Algorithms should be supported by the findings from current level 1 and 2 studies. Purposes of this review are to assess the validity of factors presently used in preoperative planning of hallux valgus surgery and to examine whether proposed specific surgical procedures prove to do better in outcome.

## MATERIALS AND METHODS

### Factors in preoperative planning

The following factors used in preoperative planning were extracted from the reviews of Robinson and Coughlin to distinguish among different types of hallux valgus: Severity of

hallux valgus, first MTP joint congruency, and TMT instability (Table 1) [10,11]. References for these parameters and matching procedures were included.

A systematic literature search in PubMed was performed using the MeSH terms 'hallux valgus surgery' and 'algorithm' or 'distal metatarsal articular angle' (DMAA) or 'hypermobility' covering the years 1966 through 2014. Trials using this search strategy were selected when two authors (Axel Deenik and Aart Verburg) agreed on the level of evidence [12]. All studies are classified according to the same procedure. All level 1 and 2 in preoperative planning were selected.

### Surgical procedures

The surgical procedures for corresponding deformities were extracted from the reviews of Robinson and Coughlin and are organized in (Table 2) [10,11]. To verify parameters on this subject, a PubMed search was performed from 1966 till 2014 on the MeSH terms 'hallux valgus osteotomy' and 'randomized controlled trial' (RCT). All randomized controlled trials were selected for this review when two authors (AD and AV) agreed on the level of evidence. Given that existing guidelines consistently lack support from level 1 and 2 studies, additional cohort studies were added by author AD and verified by author AV. Cohort studies were only included when radiographic outcome parameters HVA, recurrences and hallux varus were available.

## RESULTS

### Factors in preoperative planning

With the PubMed search on 'hallux valgus surgery' and ('algorithm' or 'DMAA' or 'first ray hypermobility'), 196 articles were found. Four articles relevant in preoperative planning provided level 2 evidence [1,13-15]. Additional evidence is categorized according to the mentioned classification criteria of hallux valgus.

### Hallux valgus severity

HVA and IMA are advised as markers of hallux valgus severity (level 3) [16]. Correlation between HVA and IMA was early recognized (level 3) [17,18]. Robinson states that "hallux valgus severity is commonly classified in a traditional way according to radiological criteria" (level 4) [19].

Metatarsus primus varus has a higher incidence in patients with hallux valgus compared to a normal control group (level 2) [20]. The IMA is commonly used to determine the desired amount of translation. Mann introduced IMA as a tool for hallux valgus severity (level 3) [21] after observation of limitations in

**Table 1:** Criteria for classification of hallux valgus types.

	Coughlin	Robinson
Mild	HVA < 30; IMA < 13	IMA < 14
Moderate	HVA < 40; IMA > 13	14 > IMA > 20
Severe	HVA > 40; IMA > 20	IMA > 20
TMT instability	Yes	Yes
Congruent	Yes	Yes

correction with the McBride procedure of hallux valgus with HVA exceeding 30 degrees [22,23].

In an analysis of preoperative factors (level 3) [24], however, HVA was identified as the only significant factor in surgical correction. This conclusion is supported by a regression analysis of different preoperative factors, HVA was found to be the single significant parameter for prediction of surgical outcome. Outcome declined when the HVA exceeded 36 degrees (level 2) [1]. In using cut-off points, errors of measurement on radiographs of three degrees should be taken into account [15].

### Congruency

Piggott classified groups into 'congruous' and 'subluxated' in a 6.5-year follow-up study, he concluded that congruent joints with hallux valgus did not progress significantly (level 4) [25]. DMAA was introduced as a radiological marker to decide which surgical correction is necessary [26]. The clinical value of DMAA, however, in preoperative planning might be limited because of high inter observer differences [27,28]. If on radiograph increased DMAA is suspected, obtaining an interoperative view of the MTP joint is commonly advised.

### First ray mobility

Lapidus introduced hypermobility of the first TMT joint as a causative factor in hallux valgus development (level 4) [29,30]. TMT hypermobility can be measured with the Klaue device (level 2) [30], although this is clinically difficult to apply [31]. Quantification of TMT hypermobility with manual examination is subjective and not reliable [32-35]. A cadaver study showed that first ray mobility reduced after correction with proximal osteotomy combined with DSTP (level 3) [4].

Lesser MTP joint pathology, posterior tibial tendon dysfunction and medial arch degeneration are examples of other factors that might influence surgical strategy in hallux valgus in order to restore anatomy; however, they are not used in algorithms. In an anatomic study the influence of the abductor hallucis on medial arch was established (level 3) [36]. General joint laxity is discussed as a factor that might influence surgical strategy in hallux valgus (level 3) [37].

There is evidence that patient expectations differ from those

**Table 2:** Surgical procedures matched for correction of hallux valgus types.

	Coughlin	Robinson
Mild	chevron, Mitchell, or proximal osteotomy*	chevron osteotomy*
Moderate	Mitchell or proximal osteotomy*	scarf osteotomy*
Severe	proximal osteotomy, MTP fusion*	scarf, proximal osteotomy, Lapidus procedure*
TMT instability	Lapidus procedure*	Lapidus procedure*
Congruent	biplane chevron osteotomy	scarf osteotomy

\*Incongruent hallux valgus combined with a distal soft-tissue procedure

of orthopaedic surgeons (level 3) [35]. These patient expectations are not met in foot scores [36].

### Surgical procedures' results

The PubMed search on the Mesh terms 'hallux valgus osteotomy' and 'randomized controlled trial' resulted in 36 references, 17 were classified as level 1 and 2 evidence [17,37-53]. Correction osteotomy is an effective treatment for painful hallux valgus compared to non operative treatment (level 1) [40,52]. A mathematical model showed that proximal procedures allow for more translation (level 1) [46]. These advantages have not been validated in randomized controlled trials (level 2) [15,41]. An earlier Cochrane review comparing surgical procedures for correction of hallux valgus failed to show superiority of any technique [43,54]. Three randomized controlled trials did not show differences in correction (level 2) [41,51,55].

Additional evidence is categorized according to the mentioned classification criteria of hallux valgus (Table 3). Different procedures achieve adequate correction; in 4 to 17% of cases, recurrence or hallux varus occurs. After use of the Lapidus procedure, hallux varus or recurrence was reported in 12% of cases [6,56]. After MTP fusion, the average HVA was 20 degrees [57]. The specific complication of non-union occurred in ten percent. The total of alignment complications, recurrences, hallux varus, and reoperations, was roughly between five and ten

percent in all studies.

### Mild hallux valgus

Mann found good results with the McBride procedure, however, outcome declined in patients with HVA exceeding 30 degrees [22,23].

Distal osteotomy is the most propagated alternative. Klossoc and Saro compared two distal procedures and found no clinical differences between both groups (level 1) [54]. Either osteotomy or a soft-tissue procedure can provide adequate correction for mild hallux valgus (level 3) [58].

### Moderate hallux valgus

A more proximal procedure was advised in cases where HVA is 30 degrees or more (level 3) [59]. Other reports suggest that distal osteotomy can provide adequate correction with HVA under 36 degrees (level 2) [1] or in patients with metatarsus primus varus (level 2) [7] Forty percent of patients have a HVA within these 6 degrees of angular difference [24].

### Severe hallux valgus

A mathematical model showed that proximal procedures allow for more translation than distal procedures (level 1) [46]. However, in randomized controlled trials the correction of HVA or IMA on radiographs is equal between more proximal and distal procedures (level 2) [38,41]. The overall complication

**Table 3:** Procedures for proximal, distal, shaft osteotomies and tarsometatarsal or metatarsophalangeal arthrodesis.

Study	Author	Osteotomy	Distal soft tissue procedure	Akin	Recurrence	hallux varus	Hallux valgus angle	Standard deviation	Range
	Faber [40]	Hohmann	no	no	4%	2%	9.9	8	NA
		Lapidus	open	no	2%	6%	13.3	10.4	NA
	Park [61]	distal chevron	open	10.70%	none	2%	12.9	7.2	NA
		proximal chevron	Open	9.30%	2%	4%	12.2	6.9	NA
distal									
	Schneider [36,45,56]	chevron	open	no	1%	yes	13.5	NA	-10 tot 40
	Torkki [46,47]	chevron	through joint	no	7.50%	no	17.9	NA	2 tot 42
shaft									
	Kristen [55]	scarf	part*	part	6%	NA	13.4	NA	5 to 42
	Trnka	ludloff	yes	NA	4.50%	8	9	NA	-14 to 32
proximal									
	Sammarco	chevron	through joint	no	4%	1%	17	NA	-3 to 30
	Easley [39]	chevron	open	no	5%	12%	12.6	NA	NA
		crescentic	open	no	5%	10%	10.1	NA	NA
	Zettl	crescentic	open	no	1%#	9%	14.6	14.6	-40 to 46
lapidus									
	Sangeorzan [27]	Lapidus	open	no	8%	4%	11	NA	-3 to 30
	Coetzee [54]	Lapidus	open	partial	5%#	NA	16	3.1	NA
MTP fusion									
	Coughlin [3,4,10,16,26,33,51]	MTP fusion	no	no	14% nonunion		20.4	NA	May-35

rate was comparable in these randomized controlled trials [38,40,41], however, specific complications did occur more frequently in proximal procedures. These complications concern plantar flexion in Lapidus procedure [41], rotational malunion and complex regional pain syndrome after the scarf osteotomy [38,60].

## Congruency

Osseous correction should be obtained extra-articular in case of a congruent hallux valgus [9], the scarf osteotomy is popularized because it is flexible in redressing DMAA. In case of a non-congruent hallux valgus a distal soft-tissue procedure is necessary to obtain a congruent joint. Bock observed more severe cartilage lesions during surgery with increasing hallux valgus severity [61]. However, hallux valgus severity was not correlated with symptomatic arthritis [62].

## First ray hypermobility

The Lapidus procedure was popularized as treatment for first ray hypermobility, being also one of the atavistic factors causing hallux valgus by Hansen (level 3) [56]. Coughlin found that first ray mobility reduced after performing proximal osteotomy combined with DSTP (level 2) [3]. Faber performed a randomized controlled trial comparing the results of the Lapidus procedure and a distal osteotomy (level 2) [41]. In a subgroup in which first ray hypermobility was identified, no differences were found in correction. The Lapidus procedure was reported to be appropriate in addressing remaining malalignment of the first metatarsal in hallux valgus [63].

Distal soft-tissue procedure (DSTP) is advised to correct lateral contracture. A distal soft-tissue performed in addition to a chevron osteotomy did show a significant improvement in correction, however, no difference in patient's satisfaction [44]. The outcome of DSTP can be unpredictable, possibly because limited evidence is available concerning which structures need to be released (level 3) [31,51]. A randomized controlled trial between a first web-space versus transarticular approach for correction of moderate to severe hallux valgus did not show differences (level 2).

Minimally invasive procedures have been developed to minimize soft tissue trauma. One RCT of 20 patients between percutaneous osteotomy and scarf osteotomy showed similar correction and outcome (level 2) [23]. Faster surgical procedures were found using this type of corrective surgery (level 2) [23,32].

Another development to focus on improving early mobilization is supported by low-profile plates or compression screw fixation. Calder showed that patients with screw fixation of a Mitchell osteotomy did recover earlier in comparison to those after suture fixation (level 2) [37].

## DISCUSSION

Evidence for widely accepted flow-charts are not based on level 1 and 2 studies. The advantages of the different procedures to correct specific deformities have not been established in controlled clinical studies.

It seems valid to distinguish different types of hallux valgus

in preoperative planning. However, there is limited evidence of differences in outcome between the currently used subtypes. The HVA was found to be the single significant parameter for prediction of the surgical outcome, because the outcome declined when the HVA exceeded 36 degrees.

It is accepted that successful correction of hallux valgus consists of balancing the soft tissues around the MTP joint and aligning the great toe and first metatarsal. Overall good outcome is achieved with distal, shaft or proximal metatarsal osteotomy, fusion of the MTP joint or TMT joint, all can address several types of hallux valgus. The theoretical advantage in correction of proximal procedures in comparison to distal ones has not been established in clinical studies [15,19,39,43]. Differences in correction between a proximal and a distal osteotomy are possibly less than assumed. Patients might be treated with more extensive procedures than required [15].

Minimally invasive surgery (MIS) reach a similar correction as in open distal osseous procedures and therefore seem a justifiable alternative, although evidence is limited [13]. Quicker surgical time is recorded, however, this result might be clouded because the MIS procedures concern simple osteotomies with K-wire fixation, which were compared with scarf osteotomies with screw fixation that involve more surgical steps and methodological flaws in this study [22]. Lower complication rate is found, however other studies show decreased range of motion in percutaneous procedures [33]. Further research is necessary to verify the exact possible advantages.

Controversy exists whether TMT instability should be judged as a cause or an effect of hallux valgus deformity. TMT fusion and DSTP is proposed as single procedure to treat TMT instability, although decrease of TMT instability and good outcome has been obtained in proximal osteotomy with DSTP [3]. This finding suggests that extrinsic anatomical features play a role in first ray mobility. Instability might be addressed through reduction of the metatarsal head within the plantar plate and corresponding structures, which results in stability of the MTP and TMT joints.

Different opinions exist in cases where correction might be difficult to maintain, like patients with severe hallux valgus or revision cases [5]. One RCT showed similar results between distal and proximal osteotomy in severe hallux valgus [25]. In some cases fusion of the MTP or TMT joint may be more effective.

Outcome might be influenced by uncommon types of hallux valgus or related foot problems like lesser MTP joint pathology, posterior tibial tendon dysfunction, degenerative flatfoot, adductus forefoot, the patient's age, neuromuscular disorders and arthritic diseases [62]. These items might be recognized and a focus for a new algorithm, which would still be limited to an experienced based algorithm, because to base such an algorithm on evidence based medicine will be even more difficult to achieve.

Selection bias was limited by agreement upon 2 authors (AD and AV) on presentation of all level 1 and 2 studies. Selection bias possibly did occur with including level 3 studies; however, level 3

studies will not influence the conclusion that limited evidence is available for current treatment algorithms.

## CONCLUSION

The present used treatment algorithms for hallux valgus surgery are primarily based on expert opinion and are not supported by level 1 and 2 studies. Neither is the possible advantage of specific surgical procedures based on controlled clinical studies. Correction osteotomy is more effective than non operative treatment in patients with hallux valgus. Many operative techniques are adequate in achieving a good outcome. The HVA was found to be the single predictive parameter and correction declines with a HVA exceeding 36 degrees.

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